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NALI 2026

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E-PROCEEDINGS

HUMAN-AI SYNERGY IN PEDAGOGY

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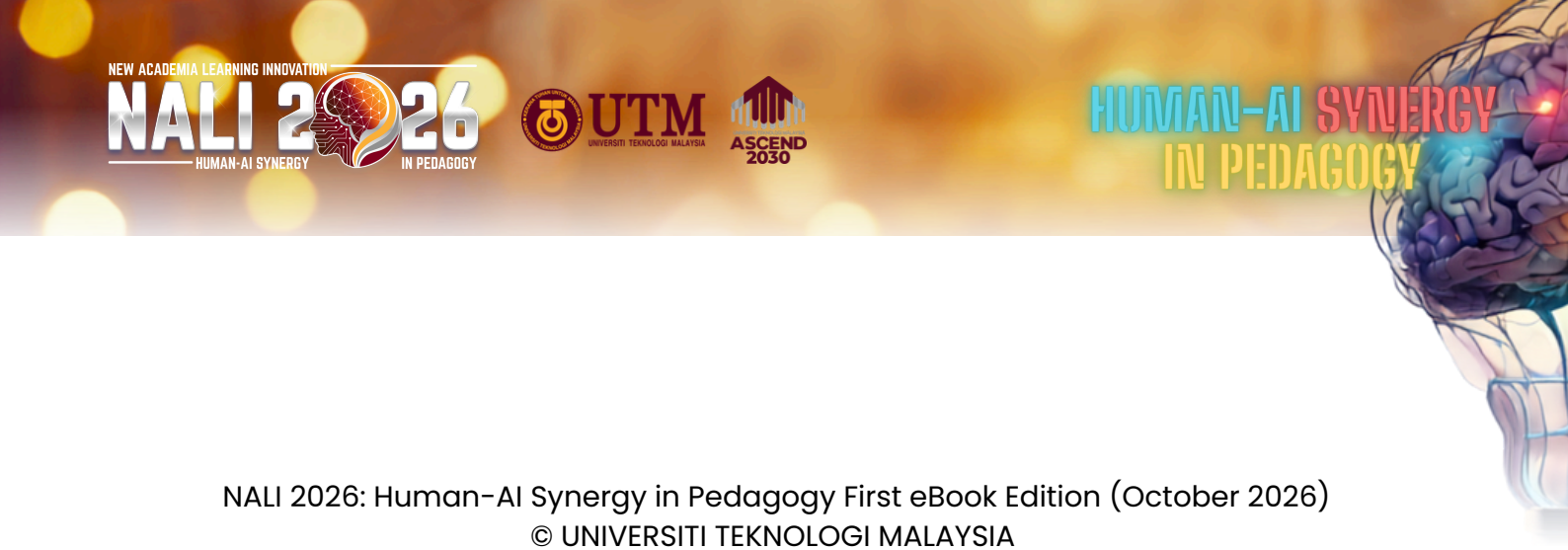


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NALI2026 FOREWORD FROM THE CHAIRMAN OF NALI 2026

Assoc. Prof. Ts. Dr. Azizul Azri bin Mustaffa
Chairman, NALI 2026

Assalamualaikum Warahmatullahi Wabarakatuh and Greetings,

Innovate with Purpose, Collaborate for Impact

Every meaningful educational transformation begins with a bold idea, but its true success lies in the difference it makes to learners.

It is my distinct pleasure to welcome all distinguished guests, speakers, educators, researchers, industry partners and participants to the New Academia Learning Innovation (NALI) 2026, hosted by Universiti Teknologi Malaysia.

This year's theme, "Human–AI Synergy in Pedagogy," reflects our commitment to exploring how human creativity and artificial intelligence can work together to transform teaching, learning and assessment. NALI 2026 goes beyond celebrating technological advancement. It provides a dynamic platform for showcasing innovative educational practices, exchanging transformative ideas and strengthening collaborations that can create lasting educational impact.

Through our innovation competition and exhibition, keynote and plenary sessions, and interactive workshops, we aim to connect educators and innovators who are passionate about addressing contemporary educational challenges.

I encourage every participant to look beyond the novelty of technology and focus on the value of innovation. The most meaningful solutions are those that enhance student engagement, strengthen learning outcomes, promote inclusivity and empower educators to inspire the next generation.

On behalf of the organising committee, I extend my heartfelt appreciation to the university leadership, our advisors, distinguished speakers, sponsors, strategic partners, judges, volunteers and participants. Your commitment and contributions are instrumental in making NALI 2026 possible.

Let NALI 2026 be more than a gathering of innovative minds. Let it be a catalyst for ideas that transform classrooms, empower educators and redefine the future of learning.

I wish everyone an inspiring, engaging and rewarding NALI 2026.

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ID 4: Student as Manager: Human-AI Synergy for Employability Pedagogy

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Highlights: Student as Manager: Human-AI Synergy for Employability Pedagogy is an innovative learning ecosystem that combines Human-AI collaboration with experiential learning to produce work-ready graduates. It is a pedagogical innovation that integrates Game Based Learning, Problem Based Learning, Challenge Based Learning, immersing the students in the authentic managerial role and using AI to provide personalized learning in a semester-long workplace simulation. Students become working managers, tackling industry problems and receiving adaptive feedback, learning analytics, and tailored coaching from AI. Innovation improves employability skills, fosters the partnership between industry and academia, provides a transferable and scalable pedagogical model to produce future-ready graduates for technology-driven workplaces.

Keywords: Human-AI synergy; Employability pedagogy; Experiential learning; Artificial intelligence; Higher education

Introduction

The demand for academic knowledge and work skills is growing for higher education institutions across the globe. While most graduates exhibit good disciplinary knowledge, employers still report gaps in leadership, communication, teamwork, adaptability, critical thinking, digital literacy and decision making. The lack of these skills leads to graduate underemployment and skills mismatch, especially in the fast-changing AI-driven work environment (Vlachopoulos & Pachni Tsitiridou, 2026).

The traditional teaching methods are still mainly teacher-oriented, test-oriented, and segmented, and the students lack the opportunity to have experience of the real responsibilities in the workplace before graduation. Pedagogical methods like Problem Based Learning (PBL), Game Based Learning (GBL), Challenge Based Learning (CBL), internships (SULAM), and business simulations have enhanced student engagement, but are not always integrated together and are limited to short-term learning (Alaagib et al., 2019).

To overcome these challenges, Student as Manager: Human-AI Synergy Employability Pedagogy proposes an integrated educational ecosystem that helps to equip students with the skills of practicing managers for an entire semester in artificial intelligence (AI) supported workplace simulations. Instead of studying management theory, students are given real-life managerial tasks, real-life industry issues to analyze, real-life strategic decisions to make, real-life organizational resource management, real-life multi-functional team management, and real-life competition with other organizations (Nallaluthan et al., 2025).

AI plays a supportive role in learning, complementing human expertise in the learning process through adaptive assessment, personalized feedback, dynamic case generation, virtual coaching, teamwork analytics, and evidence-based instructional support. This partnership between teachers, students, industry, and AI brings about real, personalized, and scalable learning experiences, enhancing the employability of graduates and contributing to Sustainable Development Goal 4 (Quality Education)(Hamadi et al., 2024).

Objectives

- Train students to be ready for the workplace through immersive experience in real managerial roles with Human-AI collaboration.
- Improve the employability skills of leadership, teamwork, communication, adaptability, critical thinking, ethical decision-making and digital literacy.
- Use AI-based adaptive assessment, learning analytics and real-time feedback to customize learning experiences.
- Enhance partnerships between higher education and industry with real-world challenges.
- Develop a transferable and scalable employability pedagogy for various disciplines and institutions.

NALI Approach

Novelty

The novelty of Student as Manager is that it is not just students taking part in isolated simulations but practising managers. Students run simulated organisations, undertake executive functions, address real industry problems and make informed decisions with AI-enhanced learning environments throughout an entire semester (Notebook LM; ChatGPT). This innovation combines GBL, PBL, CBL and AI tools in a unified employability ecosystem focused on Human-AI collaboration, which contrasts with the current methods that implement GBL, PBL, CBL, and AI tools separately.

Creativity

The essence of creativity of this pedagogy is the integration of three innovative approaches to learning: experiential learning, immersion in the authentic managerial role, and personalised learning supported by AI, all within a single learning ecosystem. Students take on executive positions in simulated organisations and address real industry challenges using Game-Based, Problem Based and Challenge Based Learning. Educators support reflection and decision making, and AI supports creativity by generating adaptive case studies, personalised feedback, learning analytics and virtual coaching. This team-based Human-AI design process produces learning experiences that are engaging and learner-centred, resulting in leadership, critical thinking, adaptability, teamwork and workplace readiness in authentic professional settings.

Innovativeness

This innovative pedagogy offers a new integrated learning environment where students immerse themselves in the managerial role while simultaneously benefiting from AI-powered personalised learning, transcending the limitations of traditional experiential learning or digital learning approaches. Students work as real-life managers for a semester, and AI helps with adaptive assessment, instant feedback, learning analytics, virtual coaching, and industry case generation. This Human-AI collaboration supports teacher facilitation, improves evidence-based teaching decisions, tailors learning trajectories, and builds employability skills through ongoing workplace simulation, establishing a scalable, transferable and future-proof pedagogical model for higher education.

Applicability

This innovative pedagogy model is highly flexible, replicable and scalable in various learning disciplines, institutions and learning environments. The framework can be adopted into the current curriculum with the help of easily accessible learning management systems and AI tools without the need for specialized laboratories or expensive simulation software. Subject-specific industry scenarios, managerial roles, and assessments can be customized for different subject areas and for learners to reflect their individual needs, while maintaining the fundamental Human-AI collaborative approach. The flexible, low-cost design enables ongoing sustainability by integrating the curriculum on an ongoing basis, working with industry, training teachers and using AI to deliver personalised learning that adapts to the needs of the workforce.

Key Findings, Innovation Description, Process and Implementation

Student as Manager: Human-AI Synergy for Employability Pedagogy is an experiential learning model that implemented over a semester and enable students to become active managers in a real simulated organizational environment, rather than passive recipients of business knowledge. The innovation combines Game Based Learning, Problem Based Learning, Challenge Based Learning, industry challenges and Artificial Intelligence to provide a seamless workplace learning journey. Students are grouped into mock companies and given managerial tasks like strategic planning, marketing, operations, HRM, finance and business development. In these positions, students use theory to analyse issues, make

management decisions, manage resources, work with team members and adapt to changing business situations.

The implementation is done in 6 stages. The lecturer first defines real problems in business and creates a simulated organisational environment. Second, students are introduced to the organisation, managerial roles, learning outcomes, assessment criteria and responsible AI practices. Third, students engage in collaborative and experiential activities to perform managerial tasks and to solve business problems. Fourth, AI tools facilitate learning through adaptive quizzes, case generation, personalised feedback, information analysis, virtual coaching, and learning analytics. Fifth, students constantly evaluate their choices, and they are given feedback from lecturers, fellow students, industry professionals, and learning activities with AI assistance. Lastly, students share their organisational results and suggested solutions with academic and industry assessors.

The implementation is done by involving students, lecturers, industry practitioners and AI technologies as complementary participants. The lecturer keeps on the job of facilitating, mentoring, assessing, guiding ethically, and ensuring quality, while AI takes over personalised learning support and data-driven feedback. Students continue to be accountable for critical thinking, decision making, teamwork, creativity and managerial judgement. Industry practitioners provide authentic industry perspectives and assess the relevance of student solutions. This Human-AI relationship is a way to ensure that technology is not used to replace human judgment and educator facilitation.

The effectiveness of the innovation is assessed by the students' performance, competency assessment for employability, engagement, reflective activities, feedback, and industry assessment. This can be demonstrated through the changes in students' leadership, communication, teamwork, problem solving, adaptability, strategic thinking, digital literacy and confidence in managerial decision making. The process of implementation is structured as a cycle of Challenge, Managerial Role, AI-Supported Learning, Decision Making, Feedback, Reflection, Industry Evaluation, and Improvement, enabling the pedagogy to be further developed and maintained in subsequent cohorts.

Share the evidence and results of the innovation's implementation. This can involve quantitative or qualitative data including performance gains, user feedback, better learning outcomes, adoption rates, and other relevant data. The outcomes should clearly show the originality, significance, effectiveness and overall impact of the innovation. Figure 1 visualize overall implementation process of Human-AI Synergy for Employability Pedagogy.

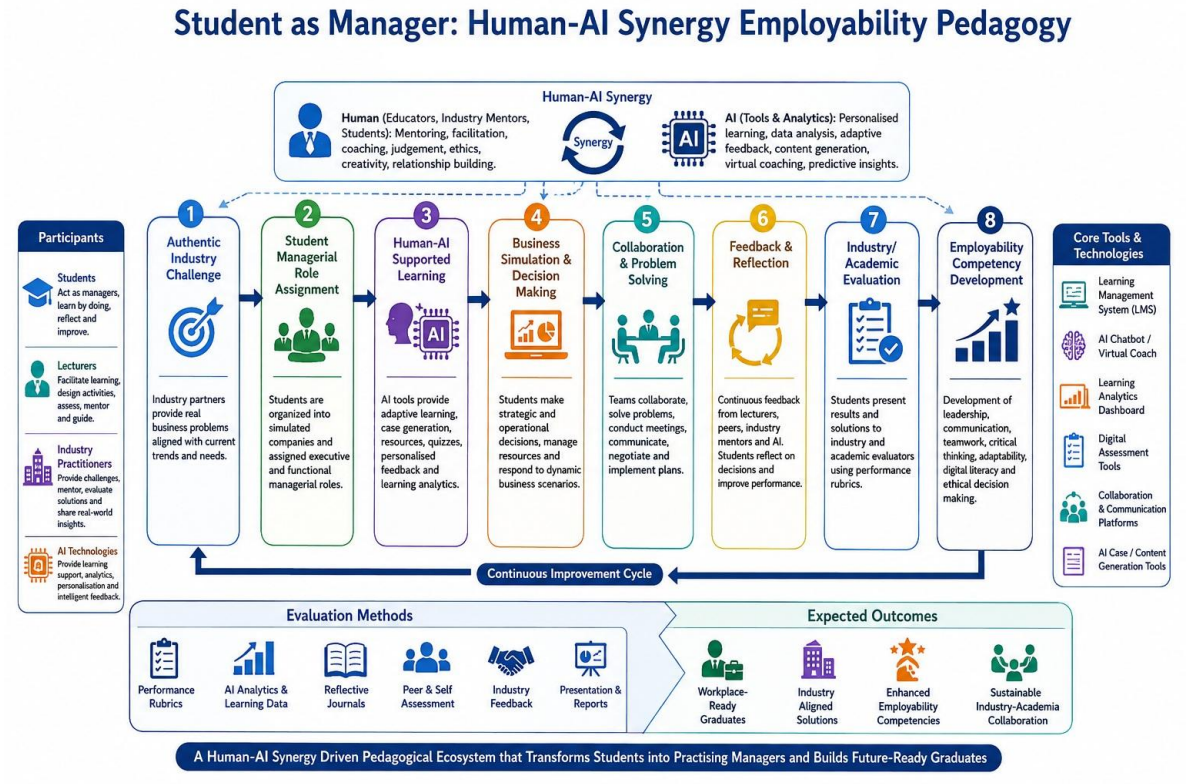


Figure 1: Human-AI Synergy for Employability Pedagogy Implementation process

Impact

This innovative pedagogy has a multidimensional impact for students, educators, institutions and industry stakeholders. The innovation offers students real-world managerial experiences, enhancing leadership, communication, teamwork, critical thinking, adaptability, digital literacy, responsible AI use, and workplace readiness. AI-powered analytics, adaptive evaluation, and personalized feedback assist educators in providing more focused instruction, mentoring, and formative intervention. At institutional level, the model facilitates employability of graduates, innovation of curriculum (QS Reimagine Education Award), industry engagement and evidence of quality and accreditation initiatives. Industry partners provide real-life challenges and assessments, enhancing university-industry collaboration. The scalable model enables ongoing curriculum development and equips students for more AI-driven work environments in the long term. Offer recommendations to lecturers regarding the integration, adaptation, and/or replication of the innovation in the teaching and learning process. Effective implementation in various educational settings should be emphasized in this section with practical strategies, considerations and best practices. If applicable, describe how innovation can be adapted to meet the different needs of learners, content areas, or institutions to ensure successful implementation and sustainment.

Recommendations for Classroom Practice

Lecturers need to incorporate the Student as Manager approach by using real-world industry problems, well-defined managerial roles, and structured Human-AI interaction. Lecturers should facilitate, mentor, ensure ethical use of AI, and be responsible for assessment, while AI should assist with personalized learning, adaptive assessment, feedback, and learning analytics. Business scenarios, managerial roles and assessment criteria can be changed to suit different disciplines. Institutions need to offer lecturer training, set up responsible practices with AI, involve industry partners, and continuously evaluate to improve the implementation and maintain the pedagogy across cohorts.

Acknowledgement

Special appreciation is extended to the Research Management and Innovation Centre (RMIC), Universiti Pendidikan Sultan Idris (UPSI) for its support and for providing the funding that contributed to the completion of this innovation pedagogy through UPSI Grant GPUBP 2022-0152-107-01. This financial support provided an important foundation for the development, implementation, documentation, and completion of the work presented in this innovation.

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ID 5: MindfulPlay AI: An AI-Supported Approach to Emotional Regulation and Learning Readiness

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Highlights: MindfulPlay AI addresses the need for brief, structured emotional-regulation support before classroom learning. Developed as a digital upgrade to the Bronze Award-winning tangible MindfulPlay Toolkit, the bilingual application guides children aged 4–6 through the Feel–Regulate–Ready cycle. An AI-supported, transparent recommendation layer selects from 21 regulation activities, while teachers retain final authority over implementation. The working prototype includes child check-ins, activity rotation, effort-based Mindful Stars rewards, consent safeguards, educator dashboards, reports, and a pilot implementation hub. A preliminary expert usability review involving three preschool teachers produced an overall mean rating of 4.85/5. The innovation offers a consistent, educator-guided approach that connects emotional awareness and regulation practice with learning readiness.

Keywords: Emotional regulation; Learning readiness; Explainable AI; Student-Centred learning; Teacher involvement

Introduction

Emotions are fundamentally related to and influence cognitive abilities, including attention, memory, and problem-solving, which are essential for learning (Xie & Fan, 2025). Emotional growth and regulation in children are essential elements of their holistic well-being and social adjustment (Aghaziarati & Nejatifar, 2023). Thus, when a child is emotionally unsettled, they may find it difficult to re-engage with classroom learning (Immordino-Yang & Damasio, 2007). Teachers frequently utilize reassurance and breathing techniques, or movement; however, these methods tend to be informal, poorly recorded, and lack integration with the child's evaluation of their learning readiness. Digital systems can offer prompt support, although AI designed for children necessitates clarity, suitability for their development, and significant human supervision (UNESCO, 2024).

MindfulPlay AI is a mobile-centric, bilingual educational program designed for children 4-6 years old. It integrates emotion recognition, real-time, teacher-supervised regulation, and subsequent post-activity reflection on learning readiness into one cohesive process. The application is intentionally non-diagnostic; it does not infer disorder, assess risk, or substitute professional expertise. Instead, it operationalizes human-AI synergy by pairing bounded, explainable activity recommendations with teachers' contextual knowledge.

Objectives

- To enable children to identify and communicate five common emotional states using accessible visual and bilingual choices.
- To provide brief, age-appropriate regulation activities through a transparent recommendation process with teacher override.
- To support children's reflection on readiness to learn after completing an activity.
- To provide teachers with privacy-conscious classroom records, evaluate the prototype through a preliminary expert usability review, and prepare the application for future classroom feasibility testing.

NALI Approach

Novelty

In contrast to a traditional mood tracker or an independent repository of calming resources, MindfulPlay AI completes the instructional cycle via the Feel–Regulate–Ready framework. The child identifies an emotion, is presented with an instant activity choice, and subsequently expresses whether they feel Not Yet, Almost, or Ready to learn. This links emotional consciousness to a visible classroom shift while maintaining the educator as the accountable decision-maker.

Creativity
The interface employs approachable emoticons, a cloud character, incremental tasks, and child-appropriate language to alleviate cognitive burden. Twenty-one activities are coordinated by Happy, Calm, Worried, Angry, and Sad, encompassing breathing, grounding, movement, sensory awareness, positive reflection, and concentration techniques. All child-oriented activities are accessible in English and Bahasa Melayu. A PIN-secured child access point distinguishes the playful experience from the roles of teachers, reporting, pilots, and administrators.

Innovativeness
The current prototype employs straightforward suggestion guidelines instead of obscure autonomous decision processes. This safety-oriented design ensures that every recommendation is foreseeable and verifiable, while also offering flexible assistance tailored to the child's chosen emotion. The platform additionally incorporates guardian-consent documentation, educator-managed profiles, preparedness assessments, weekly implementation evaluations, and comprehensive pilot supervision inside a single application.

Applicability
MindfulPlay AI corresponds with the NALI framework by emphasizing student-focused engagement, integrating digital and in-person assistance, providing significant digital educational resources, and fostering results-driven reflection. It may be utilized upon arrival, before lessons, during transitions, or when a teacher perceives that a student requires assistance. Its web-based, adaptable framework allows utilization on smartphones, tablets, and PCs without the need for specialized hardware.

Table 1: Alignment between MindfulPlay AI and the NALI model.

NALI ELEMENT	CURRENT AND PLANNED LEARNING EVIDENCE
Student-centred learning	Working emotion, activity, and readiness-response functions
Blended learning	Expert ratings of classroom suitability and teacher control
Digital resources	Verified bilingual interface and 21 regulation activities
Outcome orientation	Readiness-response function; child outcomes not yet assessed

Innovation Description, Process and Implementation

The functional application was developed iteratively from the previous MindfulPlay gamified emotional regulation MindfulPlay Toolkit. First, the core learning journey and safeguarding boundaries were established. Second, the child interface was developed around five emotional options and concise control tasks. Thirdly, teacher functionalities were incorporated for classroom management, consent-driven child profiles, activity overviews, reward system, and detailed reports. Fourth, the system integrated English–Bahasa Melayu language switching, 21 emotion regulation activities, a four-week pilot hub, and an administrative dashboard. A verified database layer preserves information, and administrative reports are compiled in an aggregate format rather than a diagnostic one.

A four-week classroom feasibility pilot is proposed as the next evaluation phase. The planned protocol involves 5–10 children per teacher completing two to three supervised check-ins weekly. Teachers will record usability, observed child engagement, and implementation confidence alongside brief qualitative observations. As this classroom pilot has not yet been conducted, the present paper reports prototype-development evidence and preliminary expert usability findings only.

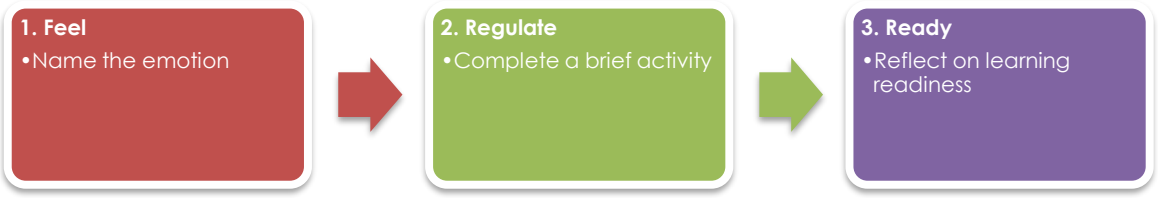


Figure 1: The MindfulPlay AI Feel–Regulate–Ready framework.

Key Findings

The development-phase evaluation confirmed a functional end-to-end prototype comprising five emotional check-in choices, 21 regulation activities, bilingual child-facing content, child PIN access, teacher and administrator dashboards, consent recording, reports, and persistent pilot feedback.

The underlying MindfulPlay toolkit received a Bronze Award at the International Invention, Innovation, and Design Competition (INDES) 2026, providing external recognition of the innovation's relevance and development potential. The digital iteration enhances that toolkit by providing instant activity alignment, learning-readiness reflection, and implementation analytics.

A preliminary expert usability review was conducted with three preschool teachers, who independently explored the MindfulPlay AI prototype and completed nine five-point rating items. The application obtained an overall mean rating of 4.85/5. Overall usability, age appropriateness, classroom suitability, and perceived potential to engage children each received a mean rating of 5.00/5. Navigation clarity and safeguard communication each received 4.67/5, while the relevance of suggested regulation activities received 4.33/5. All three reviewers indicated that they would consider using MindfulPlay AI in their classrooms. One reviewer recommended strengthening prompts for caregiver–child interaction and ensuring that AI is not presented as a reciprocal friend. As the review involved a small expert sample and no child participants, these findings represent preliminary perceptions of usability and classroom suitability rather than evidence of effectiveness or child learning outcomes.

Impact

The innovation is designed to support children to articulate their feelings and provides instant opportunities for them to practice emotional regulation and autonomy. For teachers, it structures co-regulation without replacing contextual judgement and creates concise records that support reflection rather than labelling. For institutions, the multilingual, mobile-centric framework offers a potentially scalable approach that can facilitate social-emotional development, inclusive methodologies, and the ethical application of educational AI. Sustained value may encompass multilingual growth, regionally endorsed activity trajectories, and ethically regulated personalization.

Recommendations for Classroom Practice

- Introduce the five feeling words through modelling before independent child use.
- Use MindfulPlay AI as a brief transition routine, not as punishment or compulsory emotional disclosure.
- Preview every suggested activity and adapt, change, or stop it according to the child and classroom context.
- Obtain guardian consent, minimize personal data, and follow institutional safeguarding procedures if distress persists.
- Review aggregate patterns for pedagogical planning; never interpret them as diagnosis or mental-health screening.

Other relevant information

Innovation title: MindfulPlay AI: An AI-Supported Approach to Emotional Regulation and Learning Readiness. Innovation team: Team ReguLearn. The working application is publicly accessible as an installable web application. Teacher and child records remain protected through authenticated access. The MindfulPlay System received a Bronze Award at INDES 2026. Copyright notification and trademark clearance are being considered, subject to confirmation of institutional ownership and applicable policies.

Acknowledgement

The authors acknowledge i-CATS University College and the three preschool teachers who contributed professional feedback during the preliminary expert usability review.

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ID 7: From Drone to Decision: A Human–AI Synergistic Learning Ecosystem for Combating Urban Heat Islands

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Highlights: HeatMapX AI is an innovative Human–AI learning ecosystem that enhances climate education through authentic project-based citizen science. By synergizing UAV thermal mapping, AI-assisted geospatial analysis and collaborative environmental inquiry, it enables students to investigate Urban Heat Island (UHI) phenomena using real-world data. AI functions as an intelligent learning partner, supporting thermal image interpretation, scientific communication, reflection and evidence-based decision-making, while educators facilitate critical inquiry, ethical reasoning and community engagement. Successfully implemented through the MBIP Urban Heat Island project, HeatMapX AI strengthens AI literacy, climate literacy, spatial thinking, and interdisciplinary collaboration, while generating actionable geospatial information that supports community awareness and evidence-based planning by local authorities.

Keywords: Human–AI synergy; Citizen science; UAV Thermal mapping; Authentic learning; Climate education

Introduction

The rapid advancement of Artificial Intelligence (AI) is reshaping higher education, shifting the focus from traditional teacher-cantered instruction towards dynamic, collaborative Human–AI learning ecosystems. While generative AI tools have become widely available, their application in education is still largely confined to automating content creation, powering tutoring systems and streamlining assessment. What remains comparatively underexplored is the potential to embed AI within authentic, experiential learning environments places where students don't just learn about problems but actively investigate real societal challenges by applying interdisciplinary knowledge. In the context of climate change education, this distinction is critical. Learners must move beyond theoretical understanding to develop the capacity for evidence-based decision-making. One of the most pressing and tangible climate challenges facing urban areas today is the Urban Heat Island (UHI) effect, which significantly impacts thermal comfort, energy consumption, public health, and the overall sustainability of our cities. While UAV thermal mapping has emerged as a powerful tool for monitoring these environmental conditions, students often encounter barriers in interpreting complex thermal imagery, connecting geospatial evidence to larger environmental processes, and translating their scientific findings into meaningful community action.

It is precisely at this intersection of technology, education, and societal need that HeatMapX AI was conceived. Developed as a Human–AI pedagogical ecosystem, HeatMapX AI integrates citizen science, UAV thermal mapping, geospatial analytics, and AI-assisted learning into a cohesive framework. The innovation was brought to life through the MBIP-funded project, "Teknologi Dron Termal Menjejak Pulau Haba Bandar", a collaborative initiative that brought together university students, researchers, schools, local communities, and government authorities in authentic climate investigations. Over the course of the project, the team successfully produced high-resolution thermal maps, facilitated multiple community workshops and Training of Trainers (ToT) sessions, and fostered widespread climate awareness through active citizen science participation.

What sets HeatMapX AI apart from conventional AI-assisted education is its philosophical approach to technology. Rather than positioning AI as a tool to replace or diminish the role of the educator, HeatMapX AI embraces AI as an intelligent collaborator. In this ecosystem, AI serves to augment the learning journey enhancing students' spatial reasoning, critical thinking, scientific communication, and reflective learning while the educator remains central to guiding authentic inquiry and nurturing ethical decision-making. This balanced partnership creates a richer, more meaningful learning experience that prepares students not just to understand the world, but to engage with it thoughtfully and responsibly. The impact and relevance of this approach have been widely recognised, indeed evidenced by the project's

consecutive invitations to serve as a key partner and expert panel for the UTM Library Citizen Science Boot Camp in both 2025 and 2026, as well as a series of talks and engagement sessions delivered across various community programmes. These engagements, which included collaborations with residential neighbourhoods, schools, and public events such as the Iskandar Puteri Low Carbon Carnival and the STI 100³ Programme at SMK LKTP Pemanis and the Seminar Geomatik Pintar ke Arah Pembangunan Lestari for the Northern Johor District Survey Office (JUPEM), reflect the project's success in democratising climate knowledge and fostering a culture of environmental stewardship beyond the university setting. This continued collaboration underscores the project's role in bridging the gap between cutting-edge technology, authentic climate research, and community-driven science education, while further cementing its position as a model for integrating AI into meaningful, real-world learning experiences that resonate across all levels of society.

Objectives

- Develop a Human–AI collaborative learning ecosystem for climate education through authentic project-based learning.
- Enhance student's AI literacy, geospatial competencies, spatial thinking and environmental problem-solving skills using UAV thermal mapping.
- Integrate citizen science and community engagement into higher education through authentic environmental investigations.
- Improve learning engagement using AI-assisted geospatial interpretation and reflective learning.
- Establish a scalable educational model supporting Education 5.0, Sustainable Development Goals (SDGs) and Human-AI Synergy in Pedagogy.

NALI Approach

Novelty

HeatMapX AI is a pioneering educational innovation that fuses UAV thermal mapping, citizen science, AI-assisted geospatial analysis, and community-based learning into a unified Human–AI ecosystem. Unlike conventional uses of AI for content generation or assessment, it positions AI as a collaborative cognitive partner. It works alongside learners to interpret thermal imagery, analyse spatial patterns, generate reflective questions, and communicate scientific findings effectively. In this way, AI evolves from a passive tool into an active participant in authentic inquiry, empowering students to think critically and engage meaningfully with real-world climate challenges.

Creativity

Through this interactive Human-AI learning ecosystem, students don't just analyse pre-packaged data, indeed, they collect their own thermal datasets in the field. AI steps in as a supportive partner, helping them make sense of complex environmental information, compare observations, validate their findings and work alongside communities and local authorities to develop real mitigation strategies. This integrated learning process is illustrated in Figure 1.

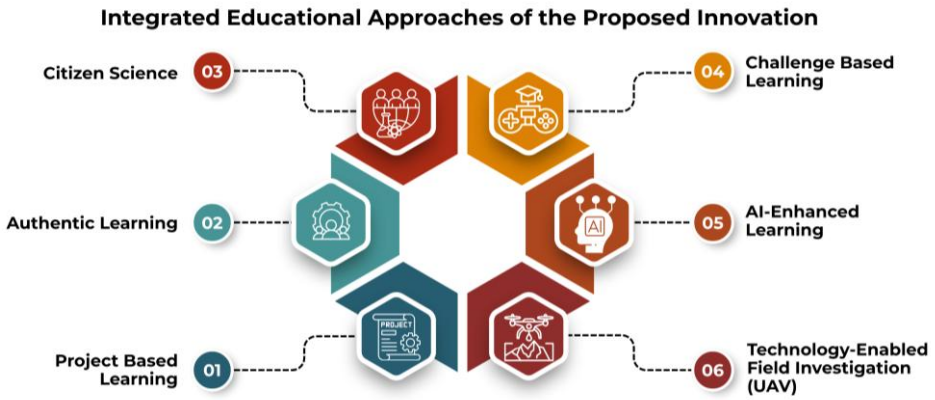


Figure 1: Integrated Educational Approaches of the Proposed Innovation

Innovativeness

Figure 2 outlines the innovation framework, illustrating the complementary roles of human intelligence and AI in the Human-AI learning process. Students retain responsibility for observation, critical thinking, ethical judgement and decision-making, while AI accelerates data interpretation, enhances scientific

communication and delivers personalised feedback. This collaboration enriches learning and empowers students to develop evidence-based responses to pressing environmental issues.

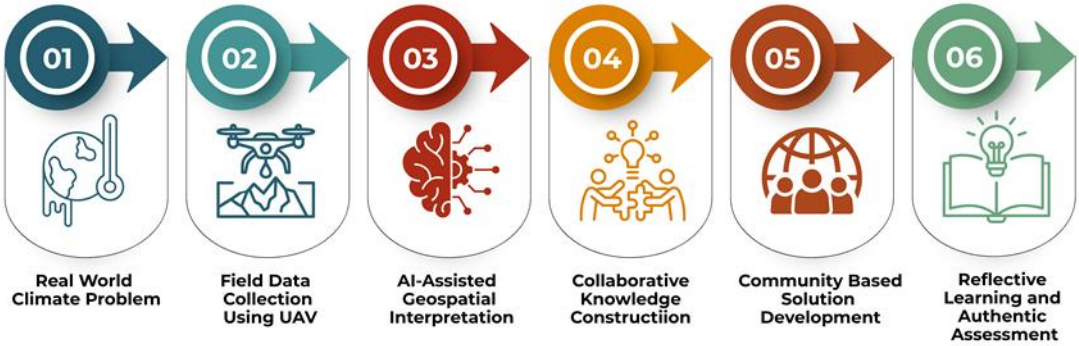


Figure 2: Conceptual Framework of the HeatMapX AI Learning Cycle.

Applicability

HeatMapX AI can be readily applied beyond Geomatics Engineering to a wide range of disciplines, including environmental science, geography, architecture, urban planning, civil engineering, remote sensing, sustainability and STEM education. The framework is designed to be flexible and practical, making it suitable for implementation in universities, schools and community-based learning initiatives. As cloud-based AI tools and UAV technologies become more widely available, institutions can adopt and adapt the approach with minimal barriers. By combining real-world problem-solving with interdisciplinary learning, HeatMapX AI helps develop AI literacy, climate literacy and spatial thinking while encouraging active community participation. Its close alignment with the United Nations Sustainable Development Goals (SDGs) further supports its long-term relevance, scalability, and potential for adoption across diverse educational settings.

Innovation Description, Process and Implementation

HeatMapX AI was implemented through MBIP Urban Heat Island project involving undergraduate students, post graduate researchers, schools, community members and local authorities. The innovation integrates authentic field investigations with AI-supported learning through a six-stage Human-AI learning cycle as illustrated in Figure 3.

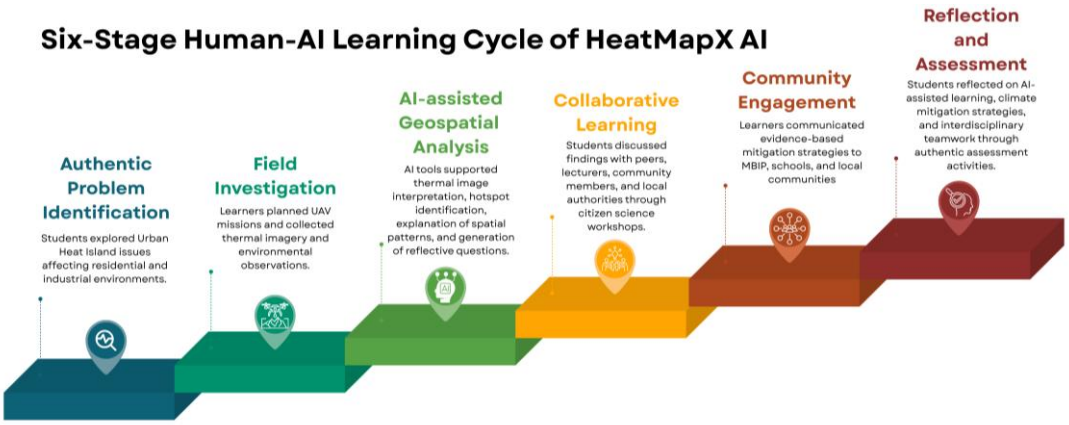


Figure 3: Conceptual Framework of the HeatMapX AI Learning Cycle.

The implementation followed a structured yet dynamic pathway. It commenced with authentic problem identification, progressed to field investigation using UAV thermal mapping, and leveraged AI for geospatial analysis to help students interpret thermal data and detect hotspots. Collaborative learning sessions facilitated discussion of findings, which were then channelled into community engagement activities. The process concluded with reflection and assessment to consolidate learning outcomes. Throughout the MBIP project, the approach was enriched and sustained through community workshops,

Training of Trainers (ToT), public demonstrations, citizen science participation and broader environmental outreach programmes.

Key Findings

The implementation of HeatMapX AI resulted in measurable educational and community impacts. Students developed technical, analytical and communication skills while participating in authentic environmental investigations. The key outcomes are summarized in Figure 4. Beyond enhancing student learning, HeatMapX AI strengthens collaboration among universities, local authorities, schools and communities through Training of Trainers (ToT), Citizen Science Boot Camps, climate awareness campaigns and public workshops. The MBIP project also produced high-resolution thermal maps that supported evidence-based environmental awareness and climate action.

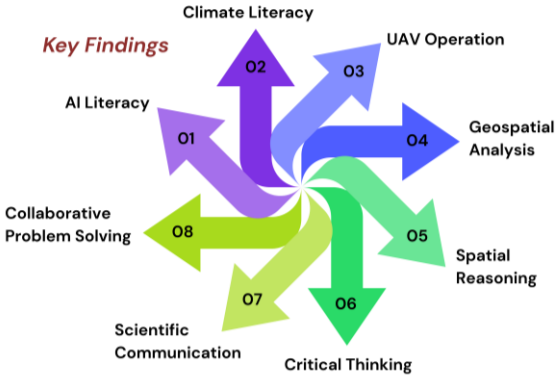


Figure 4: Key Educational and Societal Outcomes of HeatMapX AI

Impact

HeatMapX AI delivers meaningful benefits to students, educators, communities and institutional partners by integrating AI, UAV technology, and authentic environmental learning. Students develop practical skills in spatial thinking, data analysis, critical thinking and scientific communication through real-world investigations. Educators are empowered to adopt inquiry-based, project-driven teaching approaches, while communities gain greater awareness of local climate challenges and opportunities to contribute to citizen science. For institutional partners such as MBIP and UTM, the initiative demonstrates the value of cross-sector collaboration in supporting sustainable development and evidence-based planning. Together, these outcomes position HeatMapX AI as a practical and scalable model that connects technology, education and community engagement to create lasting environmental and societal impact (Figure 5).

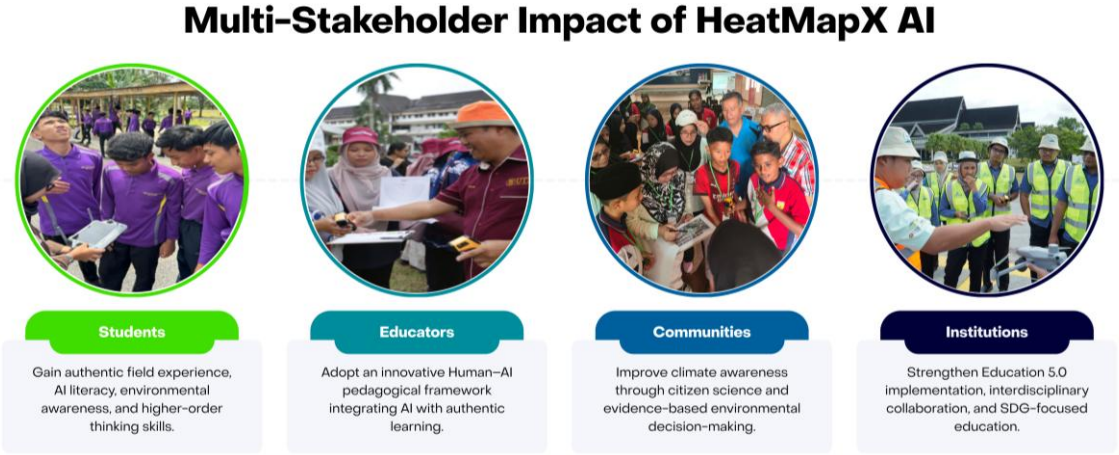


Figure 5: Multi-Stakeholder Impact of HeatMapX AI

Overall, HeatMapX AI extends learning beyond the classroom by bringing together universities, local authorities, schools, and communities to address real-world climate challenges through interdisciplinary

collaboration. The innovation supports the principles of Education 5.0 while contributing to SDG 4 (Quality Education), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action), demonstrating how AI-enabled learning can create both meaningful educational outcomes and positive societal impact.

Recommendations for Classroom Practice

HeatMapX AI is designed to be flexible and scalable, allowing its implementation across various teaching, learning, and community engagement contexts in higher education. The innovation can be integrated into:

- Project-based learning
- Capstone projects
- Field courses
- Laboratory sessions
- Interdisciplinary STEM education
- Community engagement programmed
- Citizen science initiatives

To maximize educational benefits, AI should be positioned as an intelligent learning partner rather than a replacement for human expertise. Educators should encourage students to validate AI-generated outputs through field observations, critical discussion, and evidence-based reasoning, thereby fostering responsible AI use, critical thinking, and deeper conceptual understanding.

Other relevant information

The educational innovation originated from the MBIP-funded community project "Teknologi Dron Termal Menjejak Pulau Haba Bandar, Lindungi Kawasan Kita!", supported under the Geran Komuniti Iskandar Puteri Rendah Karbon 5.0. The project received RM50,000 in funding and successfully engaged communities, schools, university students, and local authorities through UAV thermal mapping, citizen science, and climate education initiatives.

Acknowledgement

The authors gratefully acknowledge the financial support funded by the Iskandar Puteri City Council (MBIP) under Iskandar Puteri Low Carbon Community Grant 5.0 (Vote No. R.J130000.6852.4J779) as well as the Permit of Authorisation to Fly (ATF) for Unmanned Aircraft System (UAS) granted by the Civil Aviation Authority of Malaysia (CAAM) with permit no. [CAAM/BOP/ATF/P2025/07/0878]. Appreciation is also extended to the Geomatic Innovation Research Group (GnG), Universiti Teknologi Malaysia, community partners, participating schools, and all students who contributed to the implementation of HeatMapX AI and the Urban Heat Island citizen science initiative.

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ID 8: EQVS: A Smart Digital Assessment Governance System for CLO-Aligned Examination Design

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Highlights: EQVS is a smart digital assessment governance system developed to improve examination quality through constructive alignment of Course Learning Outcomes (CLOs), Bloom's Taxonomy, and institutional quality assurance. The innovation standardizes examination design, reduces manual errors, and supports consistent assessment practices across programmes. It has demonstrated significant institutional impact through successful implementation at Universiti Kuala Lumpur, enhancing assessment quality, governance, operational efficiency, and Outcome-Based Education (OBE) practices.

Keywords: Assessment governance; Constructive alignment; Outcome-Based education (OBE); CLO alignment; Digital assessment

Introduction

Assessment quality is fundamental to Outcome-Based Education (OBE), ensuring that examinations accurately measure the intended Course Learning Outcomes (CLOs). However, many higher education institutions still rely on fragmented manual processes that lead to inconsistent CLO alignment, subjective interpretation of Bloom's Taxonomy, formatting errors, and lengthy vetting cycles. These limitations reduce assessment consistency, increase administrative workload, and may affect the validity of student evaluation.

To address these challenges, the Examination Question Vetting System (EQVS) was developed as a Smart Digital Assessment Governance System integrating CLO alignment, Bloom's Taxonomy verification, digital workflow, and quality assurance into a single platform. More than a digital administration tool, EQVS is a pedagogical innovation that strengthens constructive alignment, improves examination quality, and supports continuous enhancement of student learning outcomes.

Objectives

- Improve examination quality through constructive alignment.
- Standardize assessment governance across programmes.
- Improve efficiency and traceability of examination vetting.
- Enhance learning outcomes through better quality assessments.

NALI Approach

Novelty

EQVS integrates CLO alignment, Bloom's Taxonomy verification, examination quality assurance, and digital vetting into a single assessment governance platform. Unlike conventional examination management systems, it embeds constructive alignment throughout the assessment design process, improving examination validity, consistency, and quality across academic programmes.

Creativity

EQVS transforms a fragmented manual examination process into a structured digital workflow. By integrating guided CLO selection, Bloom's Taxonomy action verbs, automated validation, standardized templates, and digital vetting, the system reduces human error while simplifying quality assurance and promoting collaboration among academic staff.

Innovativeness

EQVS shifts assessment management from administrative compliance to evidence-based educational practice. Automated verification of CLO mapping, Bloom's cognitive levels, mark distribution, and examination traceability improve assessment quality and operational efficiency while providing a scalable foundation for future AI-assisted assessment design.

Applicability

EQVS is readily adaptable across faculties and higher education institutions practicing Outcome-Based Education (OBE). Its modular design supports institutional scalability and future AI-assisted assessment enhancement.

Innovation Description, Process and Implementation

EQVS supports lecturers throughout the examination design process by providing automated compliance checking, digital vetting, moderation, and approval workflows. It supports constructive alignment by validating CLO mapping, Bloom's cognitive levels, mark distribution and formatting before final approval.

Key Findings

Implementation has improved standardization, reduced manual checking effort, strengthened examination quality assurance and increased consistency in assessment design. The system has been implemented institutionally within UniKL and provides a scalable foundation for continuous quality improvement.

Impact

Students benefit from higher-quality, fairer assessments aligned with intended learning outcomes, while educators experience reduced administrative workload and improved assessment consistency. The institution gains stronger governance, traceability, and accreditation readiness. EQVS has significantly improved operational efficiency, CLO alignment, and student learning experience, with positive student feedback increasing from 54% to 86%, supporting valid, reliable, and outcome-driven assessment.

The following results summarize operational, user, and assessment quality improvements observed after EQVS implementation.

1. Operational Efficiency and Process Improvement -

- Average exam preparation time reduced from approximately 6–10 days to 3–5 days
- Vetting duration reduced from 3–4 days to 1–2 days (≈50–60% improvement)
- Compliance with CLO alignment requirements improved from ~65% to over 90%

2. User Experience and Process Effectiveness –

- Lecturer satisfaction increased from 3.2 to 4.4 (out of 5)
- Vetter satisfaction increased from 3.0 to 4.5 (out of 5)
- Perceived ease of coordination improved by approximately 40%

3. Assessment Quality and Outcome Alignment –

- CLO alignment accuracy improved from ~60% to 92%
- Consistency in difficulty level (Bloom's compliance) improved from ~58% to 88%
- Balanced mark distribution across CLOs improved from ~65% to 90%

Recommendations for Classroom Practice

Institutions should integrate EQVS within existing assessment workflows and quality assurance practices. Future versions may incorporate AI-assisted question analysis, Bloom's classification and CLO alignment recommendations.

Other relevant information

Figure 1 illustrates the EQVS Digital Assessment Governance Framework, which integrates digital technology, constructive alignment, and assessment governance to support high-quality examination design.

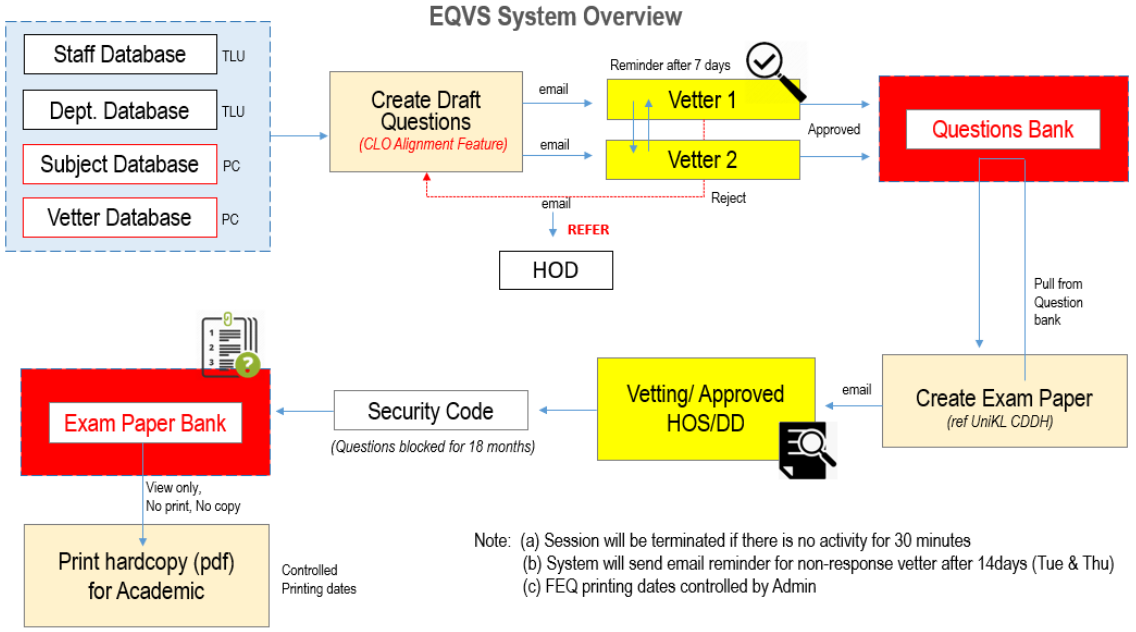


Figure 1: Digital Assessment Governance Framework of EQVS.

Lecturers develop examination questions within the EQVS platform. During this stage, as shown in Figure 2 below, the system provides structured guidance by displaying the relevant CLOs together with Bloom's Taxonomy levels and action verbs, ensuring that questions are aligned with the intended cognitive requirements

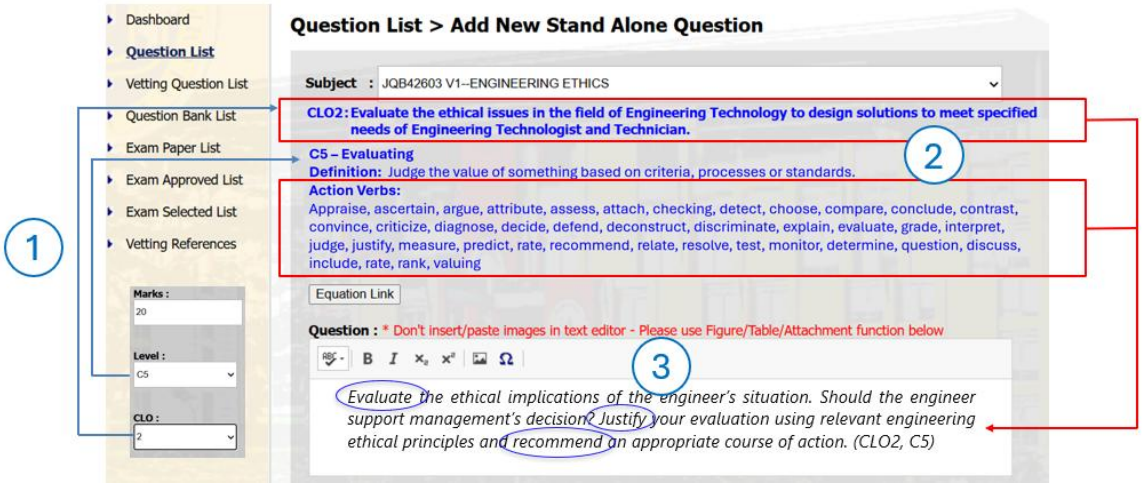


Figure 2: EQVS ensures lecturers & vetters comply with CLO-aligned question design

Student Feedback

To evaluate the impact of EQVS, student surveys were conducted before and after its implementation. Positive responses increased from approximately 54% to 86%, with students reporting clearer examination questions, better alignment with course learning outcomes, and greater opportunities to demonstrate higher-order thinking skills. These findings indicate that EQVS improves assessment quality and supports more valid, reliable, and outcome-based evaluation of student learning.

Assessment Aspect	Before EQVS (%)	After EQVS (%)	Improvement
Clarity of Questions	55%	85%	+30%
Alignment with Learning Outcomes	50%	90%	+40%
Appropriateness of Difficulty	60%	82%	+22%
Ability to Demonstrate Understanding	52%	88%	+36%

Figure 3: Impact of EQVS on Student Perception on Assessment Quality

Conclusion

EQVS demonstrates how digital assessment governance can strengthen constructive alignment, improve examination quality, and enhance student learning through standardized, evidence-based assessment practices. Beyond improving operational efficiency, innovation supports institutional quality assurance, advances Outcome-Based Education (OBE), and provides a scalable foundation for future AI-enabled assessment innovation in higher education.

Implementation and Validation

EQVS has been successfully implemented at Universiti Kuala Lumpur, demonstrating its effectiveness in strengthening assessment governance and Outcome-Based Education (OBE). Evidence from institutional implementation shows improvements in operational efficiency, examination quality, constructive alignment of Course Learning Outcomes (CLOs), and student assessment experience.

Acknowledgement

The authors acknowledge Universiti Kuala Lumpur and colleagues who supported the development, implementation and continuous enhancement of EQVS.

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ID 9: Integrated Assessment Management System (IAMS): A Configurable Platform for Executing and Managing Alternative Assessment in Higher Education

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Highlights: Alternative assessments such as projects, presentations, portfolios, and peer and self-assessment is pedagogically valuable but operationally heavy, carrying both an assessment burden and a management burden that conventional testing does not. The Integrated Assessment Management System (IAMS) is a generic, web-based platform that executes and manages any rubric-based or checklist-based assessment across multiple evaluator perspectives. Configured entirely by the course administrator, it handles multi-evaluator marking, individual accountability within team marks, reflective feedback, moderation, and auditable outcome evidence. IAMS was first deployed in a capstone course with 47 students and 34 evaluators, demonstrating operational success in practice.

Keywords: Alternative assessment; Multi-Perspective assessment; Peer and self-assessment; Individual accountability; Assessment management

Introduction

Alternative assessment methods, such as presentations, projects, posters, exhibitions, portfolios, reflective journals, observations, and self-assessment, have become central to authentic higher education. They evaluate competencies that written examinations cannot reach, including design ability, teamwork, communication, and professional judgement (Gulikers et al. 2004). Their pedagogical value is well established, yet they impose an operational burden that conventional test-based marking does not.

The assessment workload arises because alternative assessment often involves several evaluators and perspectives, including self, peers, supervisors, and internal and external evaluators, each applying rubrics that must remain consistent across markers. Within team-based work, individual contribution is difficult to observe, and awarding one shared mark to every member is widely regarded as unfair and a driver of free-riding (Hall & Buzwell, 2013). Peer and self-assessment can recover individual contribution, but their reliability depends on careful design and administration (Falchikov & Goldfinch, 2000) and has been examined specifically for capstone design projects (Foong & Liew, 2020). The management workload also arises because, even once an assessment is designed, running it is a logistical task: tracking who is marking what, chasing submissions, reconciling multiple evaluator streams, moderating marks, and producing auditable outcome evidence.

The Integrated Assessment Management System (IAMS) is built to carry both burdens. It is a generic, web-based platform for executing and managing any human-evaluated assessment that can be expressed as rubric or checklist. A course administrator configures assessment occasions, the evaluator roles, the rubrics, and the feedback question. IAMS then collects the judgements, computes individual accountability within team marks, returns feedback to students, supports moderation, and aggregates results into auditable attainment evidence.

Objectives

- To develop a generic, configurable platform that executes and manages any rubric-based or checklist-based assessment across multiple evaluator perspectives.
- To reduce the assessment burden through multi-evaluator rubric marking, individual accountability within team marks via a self-and-peer auto-rating factor, and reflective feedback returned to students.
- To reduce the management burden through evaluation-progress monitoring, automated deadline reminders, transparent aggregation of raw, averaged, and weighted marks, and moderation support for the course administrator.
- To demonstrate the platform through a first deployment in a multi-perspective, team-based capstone, the Chemical Plant Design Project (SMJC 4824).

NALI Approach

Novelty
Most peer and self-assessment tools capture only one or two evaluator perspectives and report at the end of a course. IAMS unifies a full set of evaluator roles, namely self, peers, supervisors, and internal and external evaluators, within one configurable platform, and applies them to any rubric-based or checklist-based occasion. An auto-rating mechanism that makes individual contribution explicit within team marks, and a configurable qualitative feedback instrument whose responses are returned to students. The system is a generic engine for various occasions, evaluator roles, rubrics, outcome mapping, and feedback questions are all administrator-defined.

Creativity
The creative core of IAMS is that the whole assessment instrument is configurable, its structure as much as its content. For each criterion, the administrator sets the number of performance levels, the descriptor for each level, and its mark value, so the measurement scale itself adapts to the course, spanning a simple two-level checklist scored one or zero through to a multi-level rubric with custom descriptors. Marking is equally flexible, whether as a single assessor on a full rubric, several assessors independently marking the same work, or assessors each taking assigned sub-criteria across all candidates.

Innovativeness
IAMS introduces two mechanisms that conventional single-rubric grading lacks. The first is a moderatable auto-rating factor that combines self and peer ratings into an individual-to-group ratio, adjusting team-derived marks so that individual contribution becomes visible, which recognises strong contributors modestly while reflecting non-contribution without an artificial floor. The factor is decision support rather than an automated verdict, since the administrator can override it for marks moderation, with original and adjusted marks preserved side by side. The second is full calculation transparency, in which any result can be traced from raw per-marker ratings through averaged and weighted scores, making multi-perspective, contribution-sensitive assessment auditable and defensible.

Applicability
Because IAMS is generic by construction, it adapts to any human-evaluated assessment that can be expressed as a rubric or checklist, in any discipline, by reconfiguring the occasions, roles, rubrics, and feedback questions rather than the engine. Its outcome-mapping and export functions support outcome-based education reporting, while the assessment design itself remains the responsibility of the educator. The first deployment demonstrates this adaptability under demanding conditions: a six-perspective configuration across individual and team occasions, more complex than most courses require, which indicates the platform's capacity for wider adoption and replication.

Innovation Description, Process and Implementation

IAMS is a generic, web-based platform for executing and managing rubric-based assessment. A course administrator defines the assessment occasions, the evaluators and their roles, the rubrics, the outcome mapping, and the feedback questions, so that one engine serves many assessment contexts while producing consistent, auditable records.

Two independent axes define an assessment. The occasion is any event that can be evaluated with a rubric or checklist, such as an exhibition (whether online or physical), a presentation, a poster, a report, an observation, a reflective journal, or a portfolio. The evaluator role is one of self, peers, supervisors, internal evaluators, or external evaluators: students hold the self and peer roles, while lecturers and invited assessors hold the others. A lecturer can be assigned either to a full rubric for selected candidates, or to selected sub-criteria across all candidates. The rubrics are fully configurable, since for each criterion the administrator sets the number of performance levels, the descriptor for each level, and its mark value; the same engine therefore spans a two-level checklist scored one or zero through to a multi-level rubric, so the instrument adapts to the course.

Three mechanisms give IAMS its value in practice. First, individual accountability within teamwork is operationalised through an auto-rating factor that combines self and peer ratings into an individual-to-group ratio, capped at 1.05 with no lower bound; the factor is decision support, and the administrator can override it for marks moderation. Second, qualitative feedback is captured through configurable open-ended questions and returned to students verbatim, with peer comments de-identified to preserve candour and supported by a lecturer-led debrief; the self, peer, and team-reflection questions are designed to support the reflective activity that is central to self-regulated learning (Zimmerman, 2002). Third, every assessment component maps to course and programme learning outcomes, so the system aggregates auditable attainment evidence. Throughout, original and weighted marks are preserved side

by side; the administrator can trace any result from raw per-marker ratings through averaged and weighted scores and export the full tabulation, and evaluation-progress monitoring with automated reminders keeps a large multi-evaluator exercise on schedule.

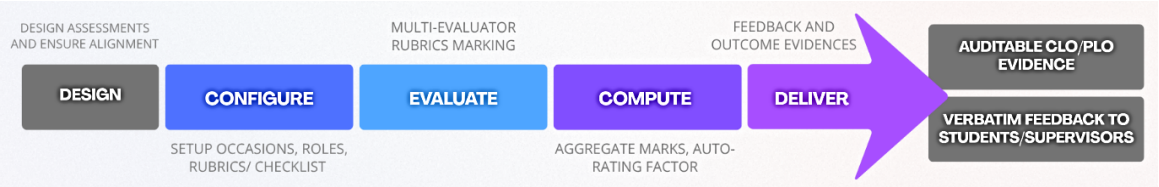


Figure 1: The IAMS assessment pipeline, from administrator configuration to delivery of feedback and auditable outcome evidence.

IAMS was first deployed in the Chemical Plant Design Project (SMJC 4824) in Semester 2 of the 2025/2026 session, a full-scale test of the platform involving 47 students and 34 evaluators in overlapping roles. The platform was configured with six evaluator perspectives, namely self, peer, academic supervisor, industrial supervisor, exhibition panel, and rubric-based report, across individual and team occasions. Both lecturer marking modes were used, since two lecturers independently marked each individual report in full, while several lecturers split the criteria of the team report among them. The qualitative instrument used maintained-and-improved questions for self and peer assessment together with three team-reflection questions, all returned to students and followed by a lecturer debrief. Assessment ran in waves aligned to the project milestones, with progress monitored across all evaluators and reminders issued, producing a single auditable outcome attainment record for the course.

Key Findings

The IAMS executed a complete multi-perspective assessment cycle for an authentic, high-stakes capstone course. It managed six evaluator perspectives across individual and team occasions for 47 students and 34 evaluators. It produced a single auditable outcome attainment record, consolidating into one system a process that would otherwise require the manual reconciliation of six separate evaluation streams. The multi-evaluator marking arrangements functioned as configured, with scores averaged per sub-criterion and rolled up automatically. The auto-rating factor produced differentiated individual marks from combined self and peer ratings, which the coordinator could inspect against the original marks and override where moderation was warranted, making individual contribution visible within team-based work. The qualitative instrument returned self, peer, and team-reflection responses to students within the assessment cycle. As for the exercise, progress monitoring and automated reminders supported the completion of marking by all evaluators.

Feedback on the application was gathered from students, evaluators, and coordinators during the deployment. Evaluators valued the marking view: one noted the application "makes the evaluation clear and tidy, with all the rubrics properly displayed," and another felt "less stressed for not seeing how much of their tasks other evaluators have done." Coordinators pointed to reduced manual setup, noting the system "avoided the messy setup of the Google Sheet and Google Forms every semester, as well as the formula setting for the final result calculations." A student valued the direct feedback, noting the application "directly shows us the comment, which is very helpful for me to understand what my teammates think." These responses are formative, reflecting users' experience of the tool rather than learning outcomes.

Impact

For educators, IAMS reduces the manual effort of running multi-evaluator alternative assessment, removing the reconciliation of separate evaluator streams and providing a consistent, defensible basis for grading team-based work. For students, it makes individual contribution visible within team marks and returns structured, de-identified feedback rather than a single shared mark. For institutions and programmes, it produces auditable outcome attainment evidence that can be exported to support outcome-based education reporting and accreditation. Because the platform is generic and configurable, any programme that uses rubric-based or checklist-based assessment can adopt it and gain the same reduction in assessment and management effort.

Recommendations for Classroom Practice

Educators adopting IAMS should first define the assessment occasions, evaluator roles, and rubrics for their own course, since the platform executes the design according to the educator configuration. When team-based work is assessed, the auto-rating factor should be introduced to students as a transparent and explained mechanism. When qualitative feedback is returned verbatim, a facilitated debrief helps ensure candid peer comments are received constructively. For high-stakes or accreditation-bearing assessment, assigning more than one marker to the same work and reviewing the raw, average, and weighted marks before finalising strengthens both consistency and defensibility. Instructors in any discipline can replicate the approach by reconfiguring these elements to suit their own subject, because the rubrics, roles, and feedback questions are fully configurable.

Other relevant information

IAMS operationalizes a multi-perspective holistic assessment approach grounded in the Design and Evaluation Framework for the Chemical Plant Design Project, a registered Malaysian copyright (IP/CR/00663, 2021), and presented at NALI 2022 (Liew et al., 2022). The IAMS software that now realizes this approach is protected by a source-code copyright (IP/CR/08479, 2026).

Acknowledgement

The authors thank the service-learning team of the software engineering programme, who initiated the development of IAMS as a student project, and the Malaysia-Japan International Institute of Technology (MJIIT), Universiti Teknologi Malaysia, which funded the extension and testing of the system. The authors also thank the students and evaluators of the Chemical Plant Design Project whose participation informed the first deployment of IAMS.

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ID 10: Co-Creating Gamified Simulations through the AI-Developed, Educator-Directed Pedagogical Transformation (ADEPT) Framework

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Highlights: Educators relying on simulation-based teaching face persistent barriers: commercial simulators are costly and inflexible, while building custom ones demands programming skills most faculty lack. The AI-Developed, Educator-Directed Pedagogical Transformation (ADEPT) framework removes this barrier: the educator directs the simulator design while Generative AI performs the coding, turning structured prompts into deployable, browser-based HTML simulators. Piloted across three business diploma courses with 105 students, the ADEPT framework enabled the development of five simulators with consistent pedagogical accuracy, which helped achieve student ratings of 4.4–4.5 with 90% of students supporting continued use.

Keywords: Pedagogical transformation; Business simulation; Experiential Learning; Technological pedagogical content knowledge; Human-AI collaboration

Introduction

Business education thrives on real-world decision-making, yet most classrooms rely on static case studies. Simulation-based learning bridges theory and practice, letting students apply concepts in a risk-free environment (Kolb, 1984; Prensky, 2001). However, commercial simulators are generic products that may not align with specific learning outcomes (Park et al., 2025), while building one demands advanced programming skills (Lockhart et al., 2025).

At Sunway College Johor Bahru (SYCJB), educators teaching Global Supply Chain Management, Digital Marketing and International Business emphasise decision-based learning through business simulators without any means to execute it – ADEPT was developed and piloted as a direct response. ADEPT positions AI as an educator-facing production partner translating pedagogical intent into deployable learning software.

ADEPT is grounded in two complementary theories, namely the Technological Pedagogical Content Knowledge (TPACK) framework and Kolb's (1984) experiential learning cycle (see Figure 1). At the production stage, TPACK ensures effective technological integration in teaching methods by considering the technological, pedagogical and content knowledge (Mishra & Koehler, 2006). ADEPT redistributes the technological component to Generative AI (GenAI) (Mishra et al., 2023) whereby the educator supplies the pedagogical and content knowledge while the AI supplies the technical capability. At the execution stage, Kolb's cycle explains how learning occurs: scenario play delivers concrete experience, the debrief prompts reflective observation, linking outcomes to course concepts builds abstract conceptualization and replay enables active experimentation.

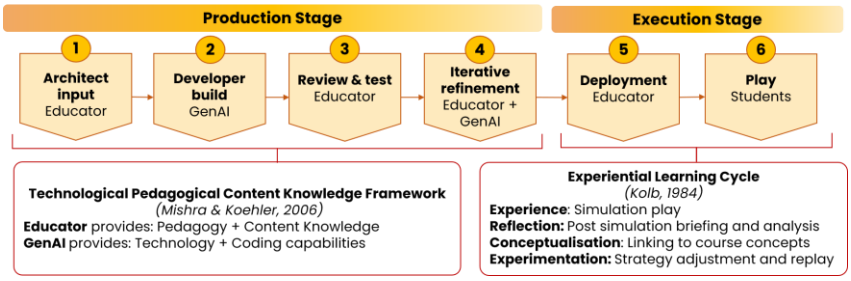


Figure 1: The conceptualization of ADEPT framework

Objectives

- To establish a replicable framework enabling educators to design and deploy browser-based HTML simulators using GenAI.
- To assess how closely the co-created simulators align with course learning outcomes and the educator's intent.

- To measure the simulators' impact on student engagement, motivation, knowledge retention and desire for continued use.

NALI Approach

Novelty

ADEPT shifts the focus of GenAI usage in education: the educator acts as the Architect, making pedagogical decisions, while AI as the Developer executes the technical build. To the authors' knowledge, this is the first structured co-creation framework enabling non-programming educators to produce simulators consistent with learning outcomes, the educator's own objectives, lesson materials and quality checklist.

Creativity

The Architect–Developer role design makes the division of labour intuitive for non-technical faculty. Structured prompting converts pedagogical intent into game mechanics and scenario design, while the educator's own lesson materials are integrated directly into gameplay, allowing the educator to brainstorm with AI in refining the simulator to suit learning objectives and student capabilities. A no-code rule governs the cycle: every refinement is expressed in natural language, turning development into creative dialogue.

Innovativeness

The ADEPT framework shifts simulator development from an outsourced product into an in-house production cycle. It converts educators from consumers into creators of educational technology, yielding an HTML file deployable through any learning management system (LMS) or web hosting platform without installation, licenses or specialist infrastructure.

Applicability

ADEPT directly operationalises the NALI approach and was applied across two full semesters in three courses, producing five deployed simulators. Requiring only structured prompts and a GenAI subscription, it is replicable and not discipline-specific, with expansion plans for management and IT subjects. The simulators based on the ADEPT framework have since been expanded beyond classroom activities, such as the BizSim Challenge 2026 and Social Media Campaign Extravaganza, which are simulation-based alternative assessments. For reference, the full prompt template set, the Pedagogical Accuracy Checklist and a sample simulator are openly available in a replication guide at the following link: https://github.com/vincentarsunway/ADEPT-.

Innovation Description, Process and Implementation

ADEPT is a six-phase iterative methodology (Table 1). In Phases 1–2, the educator specifies learning objectives, student level, scenario, mechanics and lesson materials in a structured template, from which the GenAI tools generate an HTML file. Phase 3 operates as a safeguard where educators review the draft against the Pedagogical Accuracy Checklist to ensure it matches their pedagogical intent. Phase 4 refines the simulator while Phase 5 deploys the finalised HTML file through the LMS or web hosting platforms. Finally, in Phase 6, students engage with the simulator in class or independently.

Table 1: The six-phase ADEPT framework

Phase	Actions		Deliverable	Development Progression
	Educator (Architect)	AI (Developer)		
1. Architect input	Completes structured prompt template	Interprets prompt; proposes design, mechanics, scoring	Design blueprint	10%
2. Developer build	Reviews blueprint; gives feedback; approves generation	Generates self-contained HTML file (UI, engine, assets)	Draft simulator	40%
3. Review and test	Evaluates draft against Pedagogical Accuracy Checklist; gives feedback	Revises per educator's instructions	Reviewed simulator	70%
4. Iterative refinement	Requests UI or mechanics enhancements without affecting pedagogical intent	Recommends and implements improvements until approval	Final simulator	90%

Phase	Actions		Deliverable	Development Progression
	Educator (Architect)	AI (Developer)		
5. Deployment	Downloads .html; uploads to LMS or web host	-	Deployed simulator	100%
6. Play	Facilitates gameplay; provides debrief questions linking outcomes to course concepts; collects performance data	-	Student engagement & learning outcomes	-

Source: Authors (2026)

Using ADEPT, educators across three business diploma courses at SYCJB developed five simulators: Global Expansion CEO; Facility Location; Logistics Tycoon; Supply Chain Management; and Social Media Ad Campaign. Each simulator was assessed during development using the Pedagogical Accuracy Checklist on Content Accuracy (35%), Learning Objective Alignment (40%) and Game Variables (25%). The simulators were piloted from January to July 2026 and evaluated through a five-point Likert survey provided to 105 students at the end of the semester.

Key Findings

The Pedagogical Accuracy Checklist review (Table 2) confirmed robust pedagogical alignment: weighted scores ranged from 4.4 to 4.8, all five simulators were rated Good or Excellent and Learning Objective Alignment, the heaviest-weighted dimension, scored between 4.5 and 5.0, evidencing near one-to-one constructive alignment between game mechanics and learning outcomes.

Table 2: Pedagogical Accuracy Checklist results by simulator

Simulator	Content (35%)	LO align. (40%)	Game var. (25%)	Weighted	Rating
Global Expansion CEO	4.5	4.8	4.8	4.7	Excellent
Logistics Tycoon	4.5	5.0	4.8	4.8	Excellent
Facility Location	4.5	4.5	4.5	4.5	Good
Supply Chain Management	4.5	5.0	4.5	4.7	Excellent
Social Media Ad Campaign	4.3	4.5	4.3	4.4	Good

Note: Weighted score = 0.35(Content) + 0.40(LO alignment) + 0.25(Game variables). Source: Authors (2026)

Student perceptions were uniformly strong (Table 3). Across all four items, the dominant response was Strongly Agree (60–66% of the cohort), while negative responses never exceeded 2%, indicating the simulators' learning and engagement effectiveness.

Table 3: Student perception survey results (n = 105)

Survey item	Mean	Agree (4–5)	Neutral (3)	Disagree (1–2)
Ease of understanding lessons with AI simulators	4.50	93 (89%)	10 (10%)	2 (2%)
Learning environment felt more fun and interactive	4.57	97 (92%)	7 (7%)	1 (1%)
Useful for learning and remembering the subject	4.47	93 (89%)	10 (9%)	2 (2%)
More motivated to participate in class	4.48	91 (87%)	12 (11%)	2 (2%)

Note: Five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Source: Authors (2026)

Furthermore, 90% of students wanted more AI-generated simulators in future classes (49% "Yes, definitely"; 41% "Yes, maybe"), with open-ended responses describing them as *"Business simulation is very fun as it helps me to understand global supply chain"* and *"Activity are also very useful to learn more knowledge and understand about the topic"*

Impact

For students, the simulators enact the full experiential learning cycle set out in Figure 1, with the 4.47 knowledge-retention rating reflecting cyclical reinforcement rather than surface enjoyment. For educators, ADEPT removes the coding wall that has excluded non-technical faculty from simulation-

based teaching, repositioning them as creators of learning technology. As the outputs are HTML files requiring only a browser, the simulators remain reusable across cohorts and offer a low-cost, low-bandwidth pathway towards immersive learning. ADEPT validates all three objectives: replicability through five simulators built across supply chain, marketing and international business using published prompts alone; pedagogical accuracy through near one-to-one alignment between AI-generated output and educator-defined outcomes (Table 2); and measurable impact through student engagement, motivation and retention alongside 90% continued-use demand (Table 3). The framework thereby advances SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities) by placing customised simulation-based learning within reach of institutions regardless of resource level.

Recommendations for Classroom Practice

Educators adopting ADEPT should begin with one clearly bound learning objective per simulator and use the Phase 1 template in full: enforcing constructive alignment before generation proved the most critical quality enabler. Refinement should remain prompt-based, and every simulator should pass the Pedagogical Accuracy Checklist before LMS deployment, which supports both in-class group play and independent revision. The framework adapts to other disciplines by substituting lesson materials.

Other relevant information

Recognition: Gold Award, NALI 2025, (Modular Artificial Intelligence for Connectivistic Learning); Finalist, Sunway Teaching and Learning Innovation Challenge (T-LINC) 2026 (Beyond Cognitive Copy Paste: A Practical Application of the AI-Driven Deep Learning Framework); invited Guest Speaker, EduTech Asia 2026 (GenAI as Co-Developer for Dynamic Simulator-based Gamified Alternative Assessments); Invited Speaker for Sunway College Johor Bahru's AI Forum 2025 (Topic: AI Gamification)

Commercialisation potential: The five simulators and phase-specific prompt templates constitute reusable institutional teaching assets. A Memorandum of Understanding has been signed with UTM's NexScholar for commercialisation of the Supply Chain Management and Social Media Ad Campaign simulators. A replication guide has been prepared, with a trainer-of-trainers pathway for external educators to follow and a patent application for the simulators' source codes is under consideration.

Acknowledgement

The authors thank Sunway College Johor Bahru for institutional support, the participating students whose feedback informed the evaluation and colleagues for their peer reviews.

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ID 11: Using AI-Generated Scripts and Student Personalisation through the P.E.E.R. Video-Supported Learning Framework

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Highlights: Students sometimes face challenges in applying speaking skills in formal discussion assessments, with limited access to relatable teaching videos that match their tasks and language level. Generative AI provides a useful starting point, but AI-generated scripts can sound too formal or robotic, use difficult vocabulary, and fail to reflect students' speaking styles. This innovation introduces the P.E.E.R. Video-Supported Learning Framework, combining Generative AI, student personalisation, and peer video demonstrations. Textual analysis identified how students personalised AI-generated baseline scripts through changes in vocabulary, ideas, and speaking style. Descriptive analysis of pre- and post-surveys showed that students found peer video experience useful in improving their understanding and preparation for the formal discussion.

Keywords: Peer video learning; AI-Supported learning; Textual analysis; Descriptive analysis; Peer video learning

Introduction

Students preparing for speaking assessments often lack relatable teaching materials, especially sample videos suited to their language level and assessment needs. Many online examples feature professional or native English speakers using corporate language and jargon, making them less suitable for Malaysian undergraduates. This gap led to the use of peer demonstration videos as relatable models. Meanwhile, Generative AI can support EFL speaking development when used in structured activities (Bhar, 2026), but its scripts may be overly formal or complex and lack students' personal voice (Werdiningsih et al., 2024). Combining AI support with student personalisation and peer interaction can address these limitations (Ma et al., 2025).

Therefore, this innovation introduces the P.E.E.R. Video-Supported Learning Framework (Personalise, Engage, Explore, Reflect) to identify how students personalise AI-generated baseline scripts and examine their perceptions of the framework in preparing for formal discussion assessment. The innovation used a formal discussion video demonstrated by selected students and an interactive online activity completed by UTM undergraduates. Comparative textual analysis compared baseline and revised scripts, while descriptive analysis of pre- and post-surveys examined students' perceptions and preferred learning resources. The findings support peer demonstration videos as a useful resource for understanding and preparing for formal discussion assessment.

Objectives

- To identify how students personalise and customise AI-generated baseline scripts for formal discussion assessment
- To examine students' perceptions of using the P.E.E.R. Video-Supported Learning experience to prepare for the formal discussion assessment

NALI Approach

Novelty

Compared to conventional speaking practices, this innovation combines Generative AI, student personalisation, peer demonstration videos, and interactive online activities in one structured process. Students do not simply use AI-generated scripts but revise them based on their own ideas, knowledge, and speaking style. The use of a student-produced peer video as a learning resource provides a distinctive feature of innovation.

Creativity

The creative element lies in producing a peer demonstration video using students as talents and their personalised scripts. The video presents a natural student-to-student performance that reflects the learners' language level and context. It is then integrated into an interactive online activity for learning and assessment.

Innovativeness
The P.E.E.R. Video-Supported Learning Framework (Personalise, Engage, Explore, Reflect) connects Generative AI, student personalisation, guided practice, peer demonstration, and interactive learning in one structured process. It moves students from an AI-generated baseline script to personalised content and practical speaking preparation, rather than using AI, video, and assessment as separate activities.

Applicability
The framework can be adapted to different language levels, speaking tasks, and communication contexts. It can also be applied to other subjects that require students to prepare, practise, and perform specific skills. The framework can be replicated by adjusting the prompts, tasks, peer videos, and assessment activities to suit different learning contexts.

Innovation Description, Process and Implementation
This innovation introduces the P.E.E.R. Video-Supported Learning Framework (Personalise, Engage, Explore, Reflect), a structured approach that guides students from AI-supported script preparation to personalised speaking performance. It combines Generative AI, student personalisation, role-play, educator guidance, peer video demonstration, and interactive online activities. AI serves as a starting point while students remain responsible for their own ideas, language, and communication.

The framework demonstrates novelty by combining AI-supported preparation with peer video demonstration. Its creativity lies in using student-to-student videos as relatable models, while its innovativeness comes from connecting Generative AI, personalisation, guided practice, peer learning, and interactive assessment. Its applicability allows it to be adapted to different speaking tasks, language levels, and learning contexts.

The framework consists of six connected steps. First, students use Generative AI to create a baseline script. Second, they personalise it by simplifying vocabulary, adding their own ideas, and adapting it to their speaking style. Third, they practise through peer role-play. Fourth, they receive educator guidance on language, delivery, body language, and interaction. Fifth, selected students record the formal discussion as a peer demonstration video. Finally, the video is integrated into an interactive multiple-choice quiz. The quiz provides immediate scores and two attempts, allowing students to review their answers and reflect on their understanding. Refer to Figure 1. The overall process can be illustrated as:

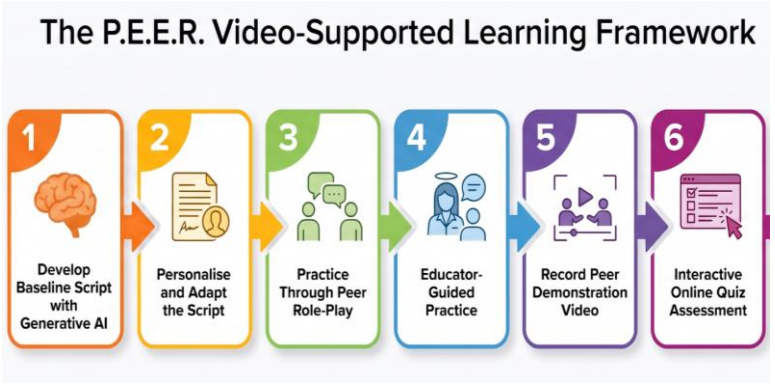


Figure 1: P.E.E.R Video Supported Learning Framework

Overall, the P.E.E.R. Video-Supported Learning Framework brings together AI-supported preparation, student ownership, peer modelling, and speaking assessment in a structured process. Generative AI provides a starting point, while students remain responsible for adapting the content to their own ideas and communication style. The peer video then provides a relatable model for applying these ideas in practice, supported by interactive learning activities.

Key Findings

Strategies used by students when personalising their AI-Generated Scripts
Textual analysis compared AI-generated baseline scripts with students' revised and personalised scripts. The analysis showed that students did not simply copy the AI-generated content but adapted it to suit their formal discussion tasks. Three main strategies were identified: simplifying difficult vocabulary, adding localised Malaysian ideas and examples, and adapting the content to their natural speaking styles. These changes transformed the AI-generated scripts into more personalised and context-appropriate speaking content.

Table 1: Script Personalization Strategies Used by Students

STRATEGY	AI BASELINE SCRIPT (ORIGINAL)	STUDENT-CUSTOMIZED SCRIPT (REVISED)	EDUCATIONAL IMPACT
1. Replacing Hard & Generic AI Words with Natural, Everyday Language	"We could also collaborate with local influencers to reach a wider audience."	"We can leverage social media platforms... to create buzz. We could also collaborate with local influencers..."	**Lowers Speaking Anxiety:** Personalising AI-generated scripts by simplifying difficult vocabulary makes the content easier for students to understand and use during speaking tasks.
2. Adding Local Malaysian Examples & Personal Ideas	"Press releases and interviews can help spread the word."	"I have a couple of friends in the New Malaysian Times..."	**Increases Willingness to Communicate:** Relatable peer demonstration videos provide realistic examples that help students better understand the assessment and see the task as more achievable.
	"Sus Coffee is known for its high-quality beans..."	"...hot meals... like the Pak Sus Nasi Lemak, Pak SUS curry mee..."	
3. Changing Script Style to Match Real Student Speech	"I'm Student 3, and I oversee product development at Sus Coffee."	"I go by the name Yugy... I was the one who made all the posters for that AND shot the advertisement."	**Promotes Natural Interaction:** Humanizing AI drafts helps students develop more natural, conversational speaking skills through realistic practice.
	(No natural interruptions during discussion)	"Sorry to interrupt, but I can't be the only one..."	

Perception of the P.E.E.R. Video-Supported Learning Experience

In order to examine the relevance of the P.E.E.R. Video supported learning, students' responses were collected before and after viewing the demonstration video. A total of 167 undergraduate students who completed the formal discussion participated in the pre- and post- surveys. Before viewing the video, 66.7% reported being only slightly familiar with the formal discussion format. Their main challenges were handling disagreements (35.4%), structuring content (30.6%), and giving opinions (21.3%).

After viewing the peer video, 79% found it very useful, 82% found it very helpful for assessment preparation, and 81.6% reported that it made the assessment clearer. Although professional/business videos remained the most preferred resource (68.4%), peer demonstration videos ranked second (57.9%). Students valued the relatable examples and suggested more videos with different situations and speaking styles. Overall, the findings support the use of peer videos to make assessment requirements clearer, more relatable, and easier to prepare for.

Impact

The P.E.E.R. Video-Supported Learning Framework helps students use Generative AI as a starting point while maintaining personalisation, originality, and ownership of their scripts. Peer demonstration videos provide relatable, level-appropriate models that help students better understand assessment requirements and prepare for the speaking task. The framework also provides educators with a structured approach to integrate AI and peer learning into speaking preparation.

Recommendations for Classroom Practice

The framework helps educators guide responsible use of Generative AI in language learning while encouraging students to personalise content and take ownership of their work. Peer demonstration videos can be tailored to students' language levels, assessment needs, and learning contexts. The framework can also be adapted to different subjects, language levels, and speaking tasks while maintaining student ownership, peer learning, and meaningful practice.

Other relevant information

The Formal Discussion Peer Video has been registered under Innocomms for copyright protection, with the registration currently in process, while the interactive online quizzes have successfully received copyright registration. Both serve as reusable digital learning outputs, with additional peer videos planned

based on students' preference for relatable examples. Figure 2 presents both outputs, showing how the peer demonstration video is integrated into the online learning activity.

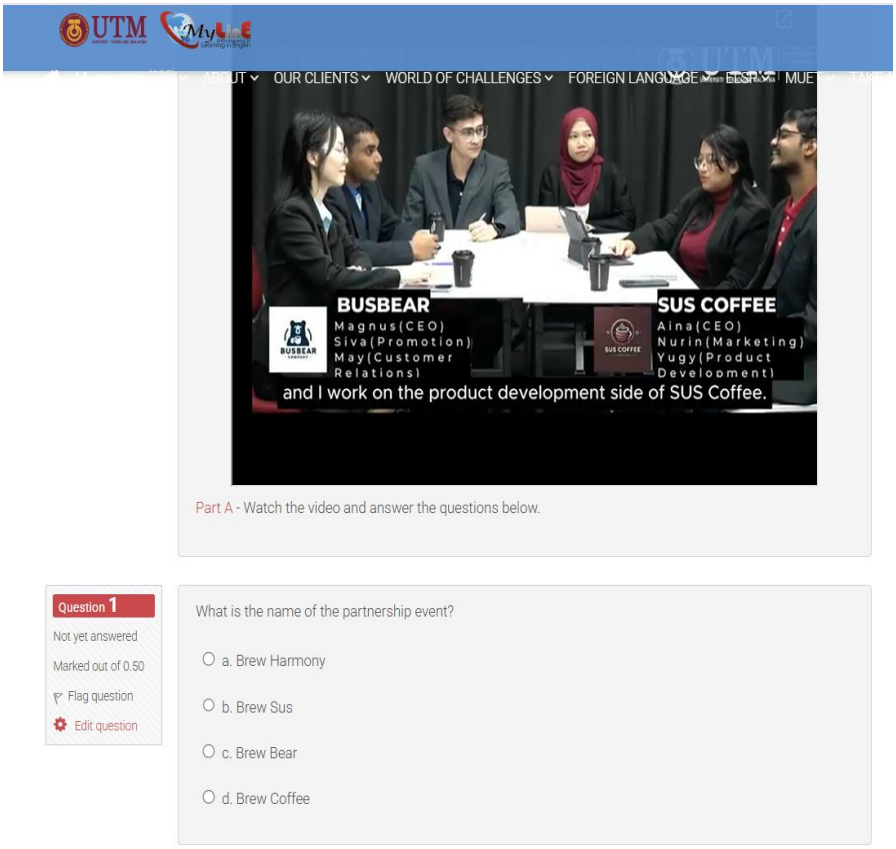


Figure 2: Formal Discussion Peer Demonstration Video and Interactive Online Task

Acknowledgement

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ID 12: Beyond Conventional Group Work: A Role-Based, Multisource Teamwork Assessment Framework for Small-Cohort Learning

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Highlights: Conventional group assessment often emphasizes the final product, making it difficult to evaluate individual contributions to teamwork, responsibility, decision-making, and collaboration, particularly in small cohorts. This innovation introduces a role-based, multisource teamwork assessment framework that integrates professional role assignment, structured team logbooks, peer assessment and lecturer evaluation. Implemented in SSCT2513 Fermentation Technology, students worked in five professional roles aligned with the course learning outcomes on collaborative problem-solving and decision-making. The approach generated richer evidence of teamwork processes and identified areas for improvement in role execution and reflection. It provided an authentic, human-centered foundation for future Human–AI synergy in assessment.

Keywords: Authentic assessment; Teamwork assessment; Small-cohort learning; Role-based learning; Human-AI synergy

Introduction

Group-based learning is widely used in higher education to develop students' collaboration, communication, problem-solving and professional skills. However, assessing group work remains challenging because the final product does not necessarily reveal individual contributions or the processes through which a team works (Francis et al., 2025). This challenge is particularly relevant when individual accountability and fairness need to be maintained within collaborative assessment.

To address this issue, a role-based, multisource teamwork assessment framework was implemented in SSCT2513 Fermentation Technology. The assignment was designed around CLO5, which requires students to work collaboratively, assume different roles, solve problems and make decisions to complete a given task. Students were assigned five professional roles: Process Engineer, Microbiologist, Bioprocess Designer, Data/AI Analyst and Industry Specialist, and worked collaboratively to develop an integrated scientific poster.

Innovation extends conventional group work by making the process of teamwork itself assessable through multiple sources of evidence. A structured team logbook captured task distribution, meetings, decisions and challenges, while peer and lecturer assessments provided complementary perspectives on individual contribution, collaboration, responsibility, problem-solving, professionalism and reflection. The framework therefore shifts the emphasis from "*What did the group produce?*" towards "*How did students work, contribute, decide and learn as a team?*" The approach reflects principles of authentic assessment, which emphasize meaningful, real-world tasks and the development of skills relevant to professional contexts (Sokhanvar et al., 2021).

Objectives

- To structure small-cohort group work through clearly defined professional roles and responsibilities.
- To triangulate evidence of teamwork through team logbooks, peer assessment and lecturer evaluation.
- To diagnose individual and team-level strengths and gaps in collaboration, responsibility, decision-making, problem-solving and reflection.
- To establish an authentic, human-centered and AI-ready framework for assessing teamwork while preserving human judgement and accountability.

NALI Approach

Novelty

The innovation shifts teamwork assessment from a product-oriented to a process-oriented, multisource approach. Professional roles, team documentation, peer assessment and lecturer evaluation provide richer evidence of individual contribution, collaboration, decision-making and problem-solving within a shared task (Dijkstra et al., 2016; Fellenz, 2006).

Creativity

The conventional group assignment is transformed into a professional team simulation, with students assuming roles as Process Engineer, Microbiologist, Bioprocess Designer, Data/AI Analyst or Industry Specialist. Students integrate their role-specific contributions into a single shared fermentation task, supported by a team logbook and peer assessment, thereby reflecting authentic professional practice (Sokhanvar et al., 2021).

Innovativeness

The innovation introduces triangulated evidence by combining the team logbook, peer assessment and lecturer evaluation. Lecturer's moderation of peer assessment using logbook evidence further strengthens the credibility of evaluating individual teamwork within a shared group product.

Applicability

The framework is adaptable across disciplines and collaborative tasks, particularly in small-cohort learning where individual contributions are difficult to distinguish. Its core components—professional roles, digital logbook, peer assessment and lecturer evaluation—can be modified to align with learning outcomes and assessment contexts using readily available digital tools.

Innovation Description, Process and Implementation

The innovation, *Beyond Conventional Group Work*, was implemented in SSCT2513 Fermentation Technology by redesigning group work as a role-based, multisource teamwork assessment. Students assumed defined professional roles and collaboratively developed a scientific poster, while their teamwork process was documented in a structured logbook and assessed through peer and lecturer evaluations. Evidence from these sources was triangulated to identify individual contributions, teamwork strengths and areas for improvement, with lecturer moderation of peer assessment based on logbook evidence. Figure 1 summarizes the workflow, from professional role assignment and collaborative task execution to process documentation, multisource assessment and feedback for improvement.



Figure 1: Workflow of the role-based, multisource teamwork assessment.

Key Findings

The role-based, multisource teamwork assessment framework was implemented in a small cohort of five students enrolled in SSCT2513 Fermentation Technology. The innovation generated evidence of teamwork from multiple sources, including team logbooks, peer assessments and lecturer evaluations, enabling a more comprehensive assessment of CLO5 and PLO8 than relying on the final group product alone. The team received 3.1/5 for the lecturer logbook assessment and 3.5/5 for the peer assessment, resulting in a combined weighted score of 6.6/10. The assessment generated evidence across multiple dimensions of teamwork, including contribution, responsibility, communication, collaboration, initiative, decision-making, problem-solving and professionalism.

Qualitative evidence from the logbook and peer assessment further revealed leadership, coordination and collaborative behaviors among team members. Students demonstrated the ability to organize meetings, distribute responsibilities, coordinate task completion and integrate individual contributions into a shared scientific poster. The documentation of meetings, decisions and challenges made aspects of the teamwork process visible that would not be readily observable from the final poster alone.

Importantly, the framework also identified areas requiring improvement. Students reported challenges related to delayed task initiation, limited early discussion, coordination difficulties and integration of individual sections. Lecturer evaluation similarly highlighted opportunities to strengthen collaboration, role execution and reflective practice. These findings demonstrate the framework's diagnostic value in revealing both strengths and weaknesses in teamwork performance.

Impact

The innovation strengthened the evidence available for assessing teamwork by combining professional roles, structured documentation and multisource assessment. It provided richer evidence of student participation, responsibility, communication, decision-making and problem-solving. For students, defined roles and logbook documentation promoted accountability and reflection on teamwork. For educators, triangulation of peer assessment, lecturer evaluation and process documentation provided a practical approach for distinguishing individual contributions in small-cohort group work. Overall, the framework made teamwork processes more visible and provided stronger evidence for evaluating CLO5 and PLO8, particularly in collaboration, communication, professional responsibility and decision-making.

Recommendations for Classroom Practice

The framework can be adapted to collaborative learning activities across disciplines. For effective implementation, educators are encouraged to:

- Assign clearly defined professional roles aligned with course learning outcomes.
- Use structured digital logbooks to document tasks, decisions, challenges and reflections.
- Combine peer and lecturer assessments to provide multiple sources of evidence of teamwork.
- Include reflection prompts to encourage critical reflection on teamwork and professional responsibilities.
- Strengthen future AI-related roles by defining tasks such as AI-assisted literature synthesis, data interpretation and critical evaluation of AI-generated outputs.

Other relevant information

The framework is resource-light and adaptable, using existing digital tools and assessment practices. Its roles, logbook and assessment criteria can be modified for different learning outcomes, cohort sizes and collaborative activities, including project-, problem-, laboratory- and case-based learning. It also provides a foundation for future responsible Human–AI collaboration while maintaining human judgement and accountability.

Acknowledgement

The authors gratefully acknowledge the Faculty of Science and Department of Biosciences, Universiti Teknologi Malaysia, for their support in facilitating this teaching innovation. The authors also thank the SSCT2513 Fermentation Technology students for their active participation and commitment, which provided valuable evidence for the development and refinement of the role-based, multisource teamwork assessment approach.

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ID 14: Cognitive and Tactile Synthesis: A Dual-Modality Framework Synergizing AI Agents with Experiential Pedagogy in Statistical Data Analysis

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Highlights: A dual-modality Human–AI framework was implemented in *Probability & Statistical Data Analysis* with 165 students to address difficulties in translating statistical concepts into practical application. Two role-specialized NotebookLM agents, Dr Sta and Dr Quant, support conceptual understanding and quantitative application before class, while face-to-face sessions emphasize experiential problem-solving, Problem-Based Learning (PBL), lecturer verification, and misconception correction. The implementation coincided with a reduction in failure rate from 12.12% to 3.03% and student engagement above 0.90. Its distinctive contribution is the purposeful integration of specialized AI preparation with human-guided experiential learning to strengthen application, participation, confidence, and self-directed learning.

Keywords: Human–AI synergy; Dual-modality framework; AI learning agents; Experiential pedagogy; Statistical data analysis

Introduction

Artificial intelligence is rapidly transforming higher education by enabling personalised learning support, flexible access to knowledge, and new forms of interaction between learners and digital systems. Yet, the educational value of AI depends not on its presence alone, but on how deliberately it is embedded within pedagogy. Recent scholarship therefore calls for AI integration that preserves human judgement, promotes learner agency, and connects technological support with meaningful learning experiences (Crompton & Burke, 2023; Bond et al., 2024; Qian, 2025; Wang & Jing, 2025). This need is particularly evident in quantitative courses, where students must progress beyond understanding statistical concepts to selecting appropriate methods, interpreting data, solving unfamiliar problems, and justifying analytical decisions.

Responding to this challenge, a dual-modality Human–AI pedagogical framework was implemented in Probability & Statistical Data Analysis, integrating two specialised NotebookLM agents, Dr Sta for conceptual learning and Dr Quant for quantitative application, with experiential and Problem-Based Learning (PBL). The framework embodies a Cognitive and Tactile Synthesis, where the cognitive modality supports AI-facilitated preparation before class, while the tactile modality emphasises hands-on statistical application, collaborative problem solving, lecturer verification, and misconception correction during face-to-face learning. Grounded in experiential and authentic collaborative learning principles (Duchatelet et al., 2024; Zhang & Ma, 2023), the framework positions AI as a complementary learning partner while preserving human judgement and guidance.

Objectives

- To implement a dual modality Human–AI teaching framework integrating Dr Sta and Dr Quant with experiential and problem-based learning in Probability & Statistical Data Analysis.
- To enhance students' conceptual understanding, quantitative application, readiness, and self-directed learning through AI-supported preparation and collaborative face-to-face learning.
- To evaluate the effectiveness of the dual modality framework based on student engagement, academic performance, learning outcomes, and potential for wider application.

NALI Approach

Novelty

The novelty of this innovation lies in the use of two specialised AI agents. The novelty lies in the dual modality design that connects cognitive AI preparation with tactile, lecturer-guided experiential learning. Dr Sta supports conceptual and theoretical preparation, while Dr Quant supports quantitative application, problem solving, and empirical tasks. Rather than relying on a single general-purpose AI tool, the framework assigns distinct pedagogical roles to specialised AI agents and directly connects their support to face-to-face learning.

Creativity
The creative element lies in how the two modalities are deliberately orchestrated. During the cognitive modality, students use Dr Sta and Dr Quant for personalised preparation, explanations, practice, and repeated exploration before class. During the tactile modality, this preparation is translated into hands-on statistical exercises, collaborative problem-based learning, discussion, and practical application under lecturer guidance. Student feedback showed engagement above 0.90 and positive appreciation of practical learning.

Innovativeness
The framework introduces a flipped dual modality learning process in which AI-supported preparation precedes human-guided application and verification. Classroom time is redirected from basic content delivery towards collaborative problem solving, hands-on statistical reasoning, misconception correction, and deeper application. The redesigned teaching process coincided with a reduction in failure rate from 12.12% to 3.03%, providing encouraging evidence of improved academic performance.

Applicability
The framework was implemented in Probability & Statistical Data Analysis (SCST1223) during Semester II, Session 2025/2026, providing evidence of its practicality within an authentic undergraduate teaching context. Its structure can be adapted to other quantitative, analytical, and STEM courses by configuring role-specialised AI agents with lecturer-vetted, course-specific materials and aligning experiential activities with disciplinary needs. This supports replication, scalability, and sustained use while preserving lecturer guidance and academic judgement.

Innovation Description, Process and Implementation

The innovation is operationalised through a structured dual modality Human–AI framework that connects AI-supported cognitive preparation with tactile, lecturer-guided experiential learning. The framework was implemented in Probability & Statistical Data Analysis (SCST1223) during Semester II, Session 2025/2026, involving 165 students across four sections. Two role-specialised NotebookLM agents were developed using lecturer-vetted course materials. Dr Sta supports conceptual and theoretical understanding, while Dr Quant supports quantitative application, statistical reasoning, and project-related empirical work.

The implementation follows a deliberate progression from AI-supported preparation to student readiness, experiential classroom learning, lecturer verification, and refined understanding. Before class, students interact with Dr Sta and Dr Quant to strengthen cognitive preparation. During face-to-face sessions, this preparation is translated into collaborative statistical problem-solving, hands-on activities, problem-based learning, discussion, and project-related tasks. The lecturer remains central by validating solutions, identifying misconceptions, and providing targeted guidance. This progression is illustrated in Figure 1.

The framework consists of complementary components with clearly differentiated pedagogical functions. Dr Sta and Dr Quant provide role-specific AI support, while the cognitive and tactile modalities connect preparation with application. Lecturer verification and refinement complete the process by ensuring accuracy, misconception correction, and continuous improvement. Table 1 summarises the implementation and pedagogical function of each component.

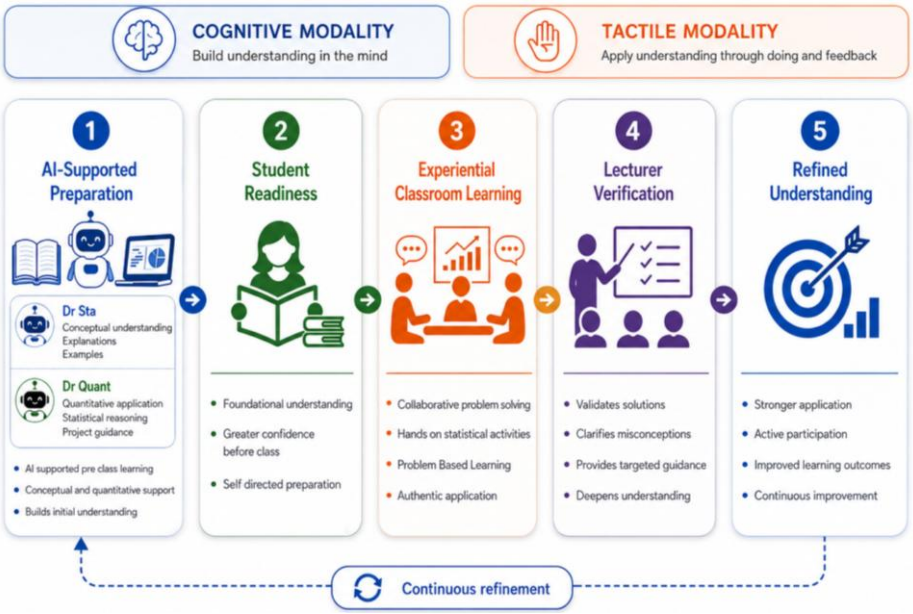


Figure 1: Dual Modality Teaching Innovation Framework integrating AI learning agents with experiential pedagogy.

Table 1: Core components and implementation of dual modality framework.

COMPONENT	IMPLEMENTATION	PEDAGOGICAL FUNCTION
Dr Sta	Lecturer vetted conceptual and theoretical materials	Supports conceptual understanding and pre-class preparation
Dr Quant	Quantitative materials, statistical problems, and project contexts	Supports application, reasoning, analysis, and project guidance
Cognitive modality	AI-supported preparation before class	Builds readiness and self-directed learning
Tactile modality	Hands-on exercises, collaborative tasks, PBL, and authentic application	Strengthens application and experiential learning
Lecturer verification	Review of solutions, misconception correction, and targeted feedback	Ensures accuracy and deeper understanding
Refinement	Repeated practice, feedback, and reflection	Consolidates learning and supports continuous improvement

Key Findings

The findings indicate that the dual modality framework supported improved student progression, engagement, and classroom participation. Students appeared better prepared to apply statistical concepts, while face-to-face sessions created more opportunities for discussion, lecturer verification, and misconception correction. The CLO pattern showed stronger foundational and applied learning than adaptive problem solving, suggesting that unfamiliar tasks requiring independent reasoning and justification still need further support. Student feedback also valued practical learning, guided examples, and direct lecturer interaction, reinforcing the importance of combining AI preparation with human guidance

Table 2: Summary of key findings.

EVIDENCE AREA	KEY FINDING	INTERPRETATION
Academic performance	Failure rate reduced from 12.12% to 3.03%	Positive shift in student progression
Relative reduction	75% reduction in failure	Fewer students remained in the lowest performance category
CLO attainment	CLO1: 89.25%; CLO2: 75.50%; CLO3: 64.00%	Stronger foundational and applied learning; adaptive reasoning requires further support
Student engagement	e-PPP > 0.90	High overall engagement
Student feedback	Valued practical learning, guided examples, and direct lecturer interaction	Supports continued Human–AI integration with lecturer guidance

Impact

This pedagogical innovation connects AI-supported cognitive preparation with practical, human-led learning, helping students approach complex statistical concepts with greater confidence, readiness, and self-directed engagement. For educators, the flipped model creates more face-to-face time for problem-solving, verification, misconception correction, and deeper academic mentoring. The framework also aligns High Impact Educational Practices (HIEPs) by promoting active, collaborative, and learner-centred learning. At the institutional level, it provides a scalable model for purposeful AI integration that preserves lecturer judgement and can be adapted to other quantitative and analytical courses.

Recommendations for Classroom Practice

Educators should develop AI agents using lecturer-vetted, course-specific materials and maintain consistent AI-supported preparation before class. Face to face sessions should prioritise hands-on activities, collaborative problem solving, lecturer verification, and targeted feedback. The framework can be adapted across disciplines by modifying agent roles, learning materials, and experiential activities while preserving human oversight.

Other relevant information

The innovation was implemented across four course sections, with Gemini Canvas supporting project guidance and NexScholar supporting collaboration, task tracking, and progress monitoring. These tools complemented the dual modality framework by strengthening project implementation and lecturer visibility of student progress.

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ID 15: PANDASPEAK: Human–AI Mobile Assisted Language Learning Application

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Highlights: PANDASPEAK is a human–AI mobile-assisted language learning application designed to address limited Chinese language speaking practice, delayed feedback, and low engagement among international learners of Chinese language. Innovation integrates generative AI-assisted speaking feedback, teacher facilitation, gamification, and authentic communication tasks within a PANDASPEAK-based virtual station rotation model. Building on an implemented PANDASPEAK blended-learning intervention, the PANDASPEAK supports continuous practice inside and outside the classroom. The foundational intervention produced meaningful improvements in learner motivation, engagement, participation, and spoken Chinese performance.

Keywords: Human–AI synergy; mobile-assisted language learning; PANDASPEAK; virtual station rotation; gamification; Chinese language

Introduction

International learners of Chinese frequently encounter difficulties with pronunciation, tones, fluency, vocabulary use, and participation in authentic communication. These challenges cannot be sufficiently addressed through occasional classroom speaking activities alone. Learners require deliberate practice, timely feedback, opportunities for social interaction, and structured support beyond scheduled class time. Although digital platforms make learning resources widely accessible, access alone does not ensure meaningful engagement; students often consume messages or download materials without actively practicing the target language. Concurrently, instructors struggle to provide continuous, individualized feedback especially when managing multiple voice recordings from each student.

To address these gaps, PANDASPEAK was designed as a structured mobile-assisted language learning (MALL) application rather than a conventional language drill app. Its pedagogical design is grounded in the Community of Inquiry (CoI) framework, integrating gamification principles, generative AI, and the station rotation model to support authentic, task-based cultural learning. Within this ecosystem, a generative-AI-assisted speaking layer provides real-time task feedback and a low-anxiety space for students to practice free from peer judgment, while instructors retain oversight for pedagogical decisions, feedback validation, and summative assessment.

Objectives

The innovation has five objectives:

- To increase international learners' opportunities to practice spoken Chinese inside and outside the classroom.
- To provide timely Generative AI-assisted feedback on pronunciation, tones, fluency, vocabulary, and task completion.
- To strengthen teaching, cognitive, and social presence within a PANDASPEAK-supported blended learning environment.
- To improve learner motivation, behavioural engagement, and confidence in authentic Chinese communication.
- To provide teachers with learning analytics that support targeted intervention and personalized teaching.

NALI Approach

Novelty

This innovation transforms PANDASPEAK from an informal learning tool into a structured mobile language learning ecosystem driven by human and artificial intelligence synergy. Unlike the conventional use of the platform, where instructors primarily broadcast materials and answer ad-hoc queries, PANDASPEAK scaffolds learning across four interconnected virtual stations: AI Speaking Coach, Gamification Interaction, Teacher Facilitation, and Real-World Challenge. Furthermore, the framework operationalizes the three core dimensions of the Community of Inquiry model through distinct pedagogical and technical

layers: generative artificial intelligence diagnostic feedback drives cognitive presence, targeted instructor intervention reinforces teaching presence, and gamified social interaction sustains social presence.

Creativity
Learners complete structured learning tasks and quests as they navigate the four virtual stations. Each learning cycle is anchored in an authentic communicative challenge, such as introducing oneself, planning a day tour, ordering food, asking for directions, or explaining a cultural tradition. To begin, students record an initial spoken response to generate an automated feedback report. They then refine their output through peer dialogue, targeted instructor guidance, and a culminating real-world performance task. Finally, learners compare their baseline and final recordings, submitting a concise reflection that justifies which suggestions they adopted, adapted, or dismissed. This iterative workflow trains learners to critically interrogate automated feedback rather than adopt it uncritically.

Innovativeness
PANDASPEAK incorporates gamified principles while keeping instructors in the loop. While generative artificial intelligence delivers immediate preliminary diagnostics, the instructor verifies critical pronunciation, pragmatic nuances, and cultural elements prior to summative assessment. This division of labor reduces repetitive evaluation workloads while preserving instructional quality. Instructors can create classes, assign targeted coursework to inactive learners, and monitor cohort leaderboards. Furthermore, PANDASPEAK leverages core game mechanics, including points, progression levels, achievement badges, and competitive leaderboards, to sustain engagement during independent practice. Learners experiencing pronunciation difficulties receive targeted phonetic tasks, whereas students demonstrate strong linguistic accuracy alongside constrained fluency advance to extended interactive communicative challenges.

Applicability
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Innovation Description, Process and Implementation

PANDASPEAK was engineered using the ADDIE framework: Analysis, Design, Development, Implementation, and Evaluation. During the analysis phase, learner needs were assessed across five key dimensions: mobile accessibility, speaking opportunities, teacher feedback mechanisms, peer interaction dynamics, and Chinese language resources. During the design phase, the Community of Inquiry framework, gamification principles, multimedia learning theory, and the virtual station rotation model were synthesized to align technological affordances with cognitive, teaching, and social presence. During the development phase, communicative channels, multimedia assets, asynchronous voice messaging, diagnostic quizzes, collaborative discussions, and learning quests were integrated into a unified instructional workflow. Within these quests, an artificial-intelligence speaking support engine generates automated transcripts, preliminary pronunciation diagnostics, fluency metrics, contextual vocabulary recommendations, and adaptive follow-up tasks.

Each instructional cycle proceeds through six structured stages:

1. Orientation: The instructor introduces the communicative objective and authentic real-world scenario.
2. Baseline Submission: The student records and submits an initial audio or video response.
3. Automated Diagnostic: The artificial intelligence engine generates a preliminary diagnostic report and recommends targeted practice.
4. Peer Collaboration: Students engage in peer dialogue, role-play activities, or collaborative problem-solving within PANDASPEAK.
5. Instructor Scaffolding: The instructor reviews aggregate cohort errors, validates machine feedback, and delivers targeted intervention.

6. Performance & Reflection: Students execute a culminating authentic task and submit a comparative reflection evaluating their progress.

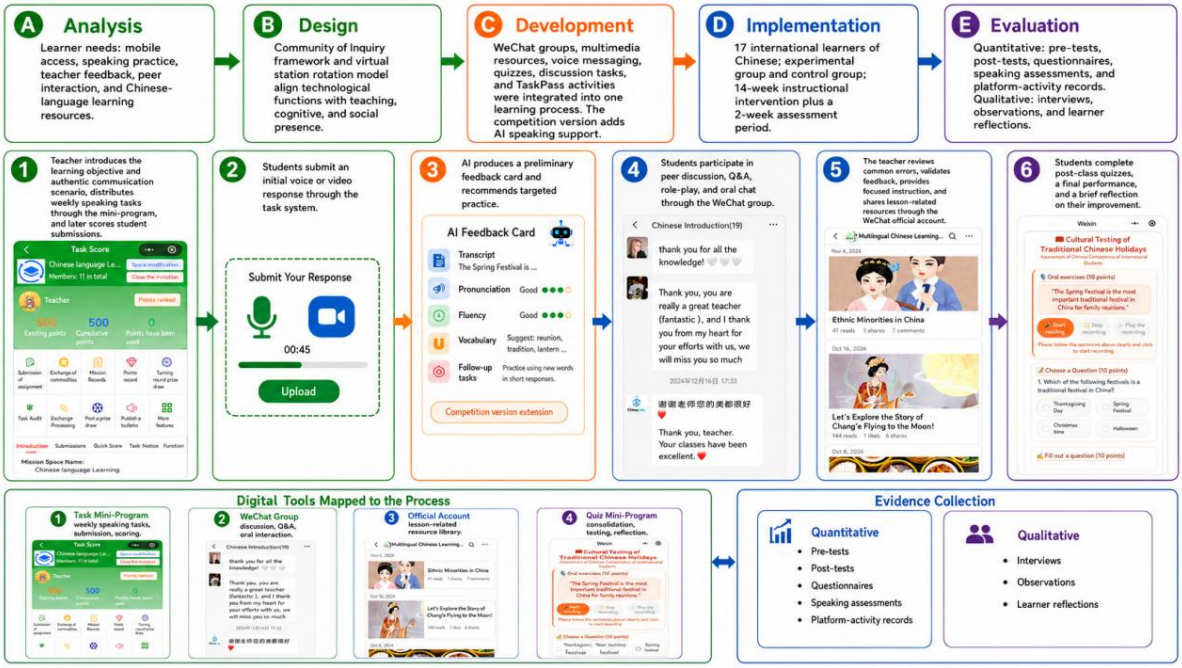


Figure 1: The PANDASPEAK-supported learning cycle (MALL) and platform functions

Figure 1 shows the foundational study involved 17 international learners of Chinese divided into an experimental group and a control group. The implementation comprised a 14-week instructional intervention followed by a two-week assessment period. Quantitative evidence was collected through pre-tests, post-tests, questionnaires, speaking assessments, and platform-activity records. Qualitative evidence was collected through interviews, observations, and learner reflections..

Key Findings

T The foundational PANDASPEAK-supported intervention produced improvements in motivation, engagement, platform participation, and speaking performance. The experimental group's motivation score increased from 3.63 to 4.15, while its engagement score increased from 3.62 to 4.10. The frequency of PANDASPEAK learning platform use increased from 3.55 to 4.10. The reported differences between the experimental and control conditions were statistically significant. Spoken Chinese performance in the experimental group increased from an average pre-test score of 68.8 to a post-test score of 85.5, representing an improvement of 16.7 points. The control group improved from 67.4 to 74.6. The reported between-group effect size for speaking performance was large. Activity records also indicated that learners in the experimental group spent more time engaging with learning materials, submitted more messages, and participated more frequently in spoken interaction than learners receiving conventional instruction. These results provide empirical support for the PANDASPEAK-based pedagogical foundation. A separate pilot evaluation will be conducted to determine the additional contribution of the AI-assisted feedback layer (see Table 1).

Table 1: Descriptive statistics and between-group comparisons for trial outcomes

Outcome	PANDASPEAK-supported M (SD)	Comparison M (SD)	Welch's t(df)		p	Hedges' g
Motivation, pre-test	3.63 (0.52)	3.57 (0.56)	0.23 (14.96)	.822	0.11	3.63 (0.52)
Motivation, post-test	4.15 (0.50)	3.79 (0.43)	1.58 (13.95)	.136	0.74	4.15 (0.50)
Engagement, pre-test	3.62 (0.51)	3.56 (0.49)	0.25 (14.60)	.809	0.11	3.62 (0.51)
Engagement, post-test	4.10 (0.44)	3.80 (0.41)	1.45 (14.45)	.169	0.67	4.10 (0.44)
Oral Chinese, pre-test	68.75 (4.30)	67.44 (2.30)	0.77 (10.42)	.459	0.37	68.75 (4.30)

Outcome	PANDASPEAK-supported M (SD)	Comparison M (SD)	Welch's t(df)		p	Hedges' g
Oral Chinese, post-test	85.50 (3.89)	74.56 (2.51)	6.80 (11.73)	< .001	3.22	85.50 (3.89)

Impact

For students, the environment increases opportunities for low-risk speaking practice and provides feedback before learners participate in more demanding real-time communication. The combination of asynchronous voice recording and synchronous interaction may reduce speaking anxiety while developing confidence and communicative competence.

For teachers, the AI-assisted layer reduces time spent on repetitive preliminary feedback and provides evidence for identifying learners who require targeted support. Teachers can therefore devote more time to complex language use, cultural appropriateness, interaction management, and personalized guidance.

For institutions, the model offers a relatively low-cost approach to extending classroom instruction without requiring a separate large-scale learning-management system. It also supports institutional goals related to digital learning, international education, learner-centered instruction, and responsible AI use.

Recommendations for Classroom Practice

Teachers should begin with clearly defined communication outcomes rather than introducing PANDASPEAK functions without a pedagogical purpose. Each online task should connect directly to an in-class activity or authentic communication performance.

AI feedback should be treated as formative rather than authoritative. Teachers should explain that speech recognition and generated feedback may contain errors, particularly when analyzing accents, tones, cultural meanings, or pragmatic language use.

Students should be required to document how they respond to AI feedback. A short reflection such as "accepted, rejected, or modified" can help learners develop AI literacy and avoid passive dependence.

For large classes, teachers may group learners according to common difficulties and provide targeted mini lessons. Peer assessment rubrics can also be used to increase interaction while maintaining manageable teacher workload.

Other Relevant Information

The project has potential for development as a PANDASPEAK Mini Program containing reusable speaking-task templates, AI feedback cards, learner portfolios, teacher analytics, and multilingual support. Future development will focus on improving speech-feedback accuracy, strengthening data privacy, designing teacher-control settings, and testing the model with larger and more diverse groups of international Chinese-language learners.

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ID 16: LiLis GaLang's Technique: From Classroom Education to Digital Learning

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Highlights: LiLis GaLang's Technique is a structured learning innovation designed to improve students' ability to accurately recall and construct Physics definitions through four sequential actions: Li (Fold), Lis (Write), Ga (Underline), and Lang (Repeat). In the original classroom implementation involving 26 students, mean scores improved from 1.62 in the Pre-Test to 4.73 in Post-Test 1 and 5.00 in Post-Test 2. Building upon this empirical foundation, LiLis GaLang is now being extended from a simple paper-based technique into a digital learning environment, creating opportunities for wider accessibility, scalability, and future Human-AI supported learning.

Keywords: Physics definitions; LiLis GaLang's Technique; active recall; digital learning; educational innovation

Introduction

Accurate understanding and recall of Physics terminology are fundamental to students' mastery of Physics concepts and their ability to construct precise examination responses. The classroom problem that led to LiLis GaLang's Technique involved students who were unable to confidently and accurately define Physics concepts and terms, particularly when essential scientific keywords were omitted. The technique was therefore developed as a simple, structured and low-cost learning strategy that engages students in repeated retrieval and reconstruction of Physics definitions.

LiLis GaLang represents four sequential learning actions: Li–Lipat (Fold), Lis–Tulis (Write), Ga–Garis (Underline), and Lang–Ulang (Repeat). The original technique requires only paper and a pen, making it a simple and accessible classroom learning strategy. Repeated retrieval and active recall have been identified as effective learning strategies for strengthening students' learning and retention (Dunlosky et al., 2013). Building upon this established paper-based approach, the current development aims to translate the same pedagogical sequence into a digital learning environment, creating opportunities for greater accessibility and scalability while maintaining the learner's active cognitive role. The digital extension also provides a foundation for future Human-AI supported learning, in which technology may facilitate prompts, feedback, and repeated practice without replacing students' active engagement in the learning process.

Objectives

- To improve students' ability to accurately recall and define Physics terms using the structured LiLis GaLang Technique.
- To promote active and repeated learning through the Li–Lis–Ga–Lang sequence.
- To extend the established paper-based technique into a digital learning environment while maintaining its original pedagogical principles.
- To enhance the potential accessibility, scalability and sustainability of LiLis GaLang for wider educational use.

NALI Approach

Novelty

LiLis GaLang transforms the memorisation of Physics definitions into four identifiable learning actions: Li–Lipat (Fold), Lis–Tulis (Write), Ga–Garis (Underline), and Lang–Ulang (Repeat). Instead of repeatedly reading a definition, students conceal the reference information, reconstruct the definition from memory, identify essential scientific keywords and repeat the process. The novelty of the current innovation lies in upgrading the established paper-based technique into a web-based digital learning environment. The website is being developed to preserve the original Li–Lis–Ga–Lang sequence while increasing accessibility and supporting students in learning and practising Physics definitions beyond the classroom.

Creativity

The original innovation creatively transforms an ordinary A4 sheet into a structured learning tool. The paper is folded into eight sections, and students progressively reproduce a Physics definition while concealing their previous responses. This process combines writing, keyword identification, repetition and

self-checking. In this web-based prototype, the same learning concept is being redesigned in the form of a website. The website presents the technique, its learning steps, research evidence and supporting materials in a more organised, visual and user-friendly format. This digital presentation allows students and educators to understand and access the technique through a single online platform.

Innovativeness

LiLis GaLang was originally developed as a simple paper-based learning technique comprising four sequential actions: Li–Lipat, Lis–Tulis, Ga–Garis and Lang–Ulang. Its simplicity allows the technique to be implemented without specialised equipment or technology. The current innovation represents the next stage of development by transforming the paper-based technique into a LiLis GaLang educational website. The website does not replace the original technique. Instead, it serves as a digital extension that introduces, documents and provides structured guidance on the implementation of the Li–Lis–Ga–Lang learning sequence. This website, will function as a platform for presenting the innovation, explaining the learning process, displaying research findings and providing access to relevant instructional resources. Interactive exercises, automated assessment, personalised feedback and AI-supported learning are proposed as future developments. This progression creates opportunities for future AI-supported education, particularly in the areas of adaptive support, personalised learning, assessment and feedback, which have been identified as important applications of artificial intelligence in education (Zawacki-Richter et al., 2019).

Applicability

The original LiLis GaLang Technique requires minimal resources and can be implemented using only an A4 sheet. It is therefore suitable for conventional classrooms, including learning environments with limited access to technology. The development of the website expands the applicability of the technique by allowing students, teachers and other users to access information and guidance digitally. The website may support classroom teaching, revision, independent learning and home-based practice. Although the technique was initially developed for Physics definitions, its four-step structure also has the potential to be adapted to other subjects involving terminology, facts, concepts and principles that require accurate recall.

Innovation Description, Process and Implementation

The original LiLis GaLang Technique begins with an A4 sheet folded into eight sections. Students select a Physics term and its definition, conceal the reference information, reproduce the definition from memory, underline the essential scientific keywords and repeat the process. During the original study, the intervention was implemented over seven days.

The current innovation upgrades this established paper-based technique through the ongoing development of a LiLis GaLang educational website. The website is designed to introduce the technique, explain the meaning of Li–Lis–Ga–Lang, demonstrate the learning process and provide organised access to supporting materials.

The website development process involves converting the original classroom content into a digital structure, organising the learning information into clear sections and designing a user-friendly interface that can be accessed through computers and mobile devices.

The present version serves as the first phase of digital transformation. It provides information about the technique, its development journey, research evidence, implementation steps, publications and related resources. The interactive practice components are still being developed. The website retains the fundamental principles of the original technique, namely active recall, repeated reconstruction, keyword identification and independent practice. Therefore, the digital platform extends the original innovation without changing its pedagogical foundation.

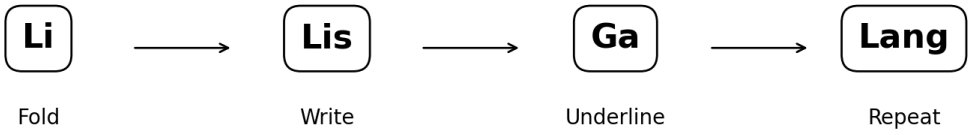




Figure 1: The evolution of LiLis GaLang from a paper-based learning technique to a web-based digital learning platform.

Key Findings

The empirical findings presented in this innovation are based on the original paper-based implementation of the LiLis GaLang Technique. The initial study involved 26 Form Five science-stream students and employed a one-group pre-test and post-test pre-experimental design (Abd Hamid & Abu Samah, 2022). Students completed a pre-test before using the LiLis GaLang Technique, followed by post-test 1 and post-test 2. Post-Test 1 examined students' performance after the implementation of the technique, while post-test 2 provided further evidence of students' continued ability to reproduce Physics definitions accurately after repeated practice.

The mean score increased from 1.62 (SD = 1.134) in the pre-test to 4.73 (SD = 0.604) in post-test 1 and subsequently reached 5.00 (SD = 0.000) in post-test 2. The Friedman test indicated a statistically significant difference across the three assessments, $\chi^2(2) = 49.470$, $p < .001$.

The progression in scores demonstrates a substantial improvement in students' ability to recall and construct Physics definitions accurately following the implementation of the paper-based LiLis GaLang Technique. Figure 2: Students' performance across the Pre-Test, Post-Test 1 and Post-Test 2 following the implementation of the paper-based LiLis GaLang Technique.

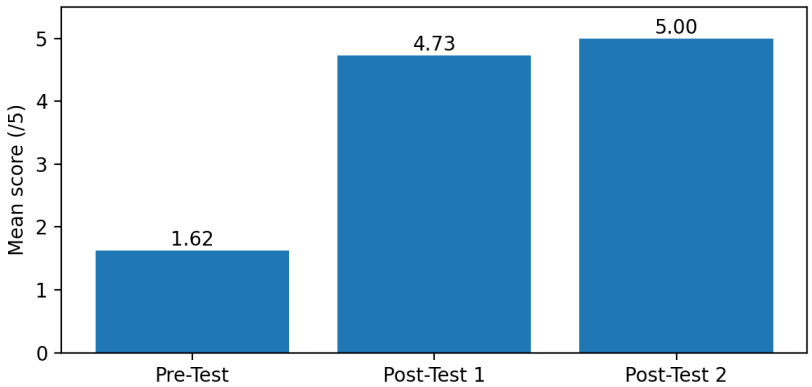


Figure 2: Students' performance across the Pre-Test, Post-Test 1 and Post-Test 2 following the implementation of LiLis GaLang's Technique

Students also reported positive perceptions towards the technique. Confidence was examined through students' perceptions rather than inferred from achievement test scores. Therefore, the two post-tests provide evidence of performance across repeated assessments, while students' confidence and perceptions are supported separately by the questionnaire findings. These empirical findings refer to the original classroom-based implementation; the digital extension represents the next stage of development and requires separate evaluation.

Impact

LiLis GaLang provides students with a structured alternative to passive memorisation. It encourages students to reconstruct definitions repeatedly, identify essential scientific keywords and check their own understanding. For educators, the original technique offers a simple, practical and low-cost classroom strategy that can be implemented without specialised equipment.

The ongoing development of the website extends the potential impact of the innovation by improving its visibility and accessibility. The website allows information about the technique, implementation procedures and research evidence to be accessed beyond the original classroom context. The digital platform also supports the preservation and wider dissemination of the innovation. It provides a central reference point for students, teachers and other interested users who wish to understand or apply the technique.

Hopefully this website will impact relates primarily to access, documentation and dissemination. Future interactive components may further support independent practice, wider implementation and digital learning. The ongoing digital transformation of LiLis GaLang is also aligned with the Thirteenth Malaysia Plan (RMK13), 2026–2030, which emphasises comprehensive digitalisation, advanced technologies and education reform. By extending an established paper-based learning technique into a web-based educational platform, the innovation supports wider access to digital learning while preserving the original active-recall process.

Recommendations for Classroom Practice

- Educators may first introduce the original paper-based LiLis GaLang Technique so that students understand each stage of the Li–Lis–Ga–Lang sequence.
- Teachers may demonstrate how to fold the A4 sheet into eight sections, reproduce definitions from memory, underline scientific keywords and repeat the process until the definition can be constructed accurately.
- The website may then be used as a supporting platform to introduce the technique, explain the steps and provide access to instructional and research materials.
- Once the interactive components have been completed, the website may be used to support digital practice involving concealed information, student-generated responses, keyword identification and repeated recall.
- Future studies should evaluate the website independently. The evaluation may examine its usability, student acceptance, learning experience and effectiveness. Comparisons may also be conducted between the paper-based technique, the website-supported technique and a blended approach combining both formats.

Other relevant information

LiLis GaLang has progressed through several stages of development. It began as a classroom-based paper technique, was empirically evaluated and was subsequently published in 2022 (Abd Hamid & Abu Samah, 2022). The current competition entry represents the next phase of the innovation: the ongoing transformation of the established paper-based technique into a web-based educational platform. The present website introduces and documents the technique, explains its implementation, presents research evidence and provides access to related learning resources. It represents the first stage of digital development rather than a fully completed interactive learning system. Future development will focus on interactive exercises, automated assessment, immediate feedback, progress monitoring and possible AI-supported learning functions. These enhancements will be evaluated separately before claims regarding the effectiveness of the digital version are made. This development supports the national digitalisation agenda under the Thirteenth Malaysia Plan (RMK13), 2026–2030, particularly through the expansion of accessible and technology-supported learning opportunities.

Acknowledgement

The authors gratefully acknowledge the students who participated in the original implementation of the LiLis GaLang Technique. Appreciation is also extended to Universiti Teknologi Malaysia for the academic guidance and support associated with the continuing development and digital transformation of the innovation.

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ID 17: EQUI-NOMICS Simulator: An Interactive Digital Platform for Simulating Health Equity and Evaluating Socioeconomic Impacts

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Highlights: The EQUI-NOMICS Simulator is an innovative, interactive web-based platform that enables students to explore complex relationships between socioeconomic factors, resource allocation policies, and health equity outcomes through dynamic digital simulation. Students manipulate key socioeconomic variables and policy interventions in real-time to observe simulated population health impacts across diverse demographic groups. This immersive, simulation-based learning approach has demonstrated significant improvements in student engagement (89% positive feedback), comprehension of health economics concepts, retention of policy trade-offs, and critical thinking about equity-driven resource allocation—competencies essential for public health leaders designing equitable healthcare systems.

Keywords: Health equity; Digital simulation; Interactive learning; Health economics; Public health policy

Introduction

Teaching complex public health economic concepts and social determinants of health equity presents persistent pedagogical challenges in health professions education. Traditional passive lectures and didactic instruction frequently fail to engage students with the dynamic, multi-causal nature of health systems and their relationship to socioeconomic determinants. Students struggle to visualize how macro-level policy decisions regarding resource distribution translate into micro-level health outcomes across diverse socioeconomic groups. This cognitive gap between abstract theory and applied health systems thinking undermines the development of critical competencies required for public health leaders, epidemiologists, and health policy professionals who must design and implement equitable healthcare systems.

The EQUI-NOMICS Simulator addresses this pedagogical challenge through immersive, interactive digital learning technology. Built on open-source web technologies, the platform enables learners to assume the role of health policymakers, manipulate key socioeconomic variables (income distribution, educational access, healthcare accessibility), adjust resource allocation mechanisms, and implement policy interventions in real-time while observing simulated health equity outcomes. This experiential, game-based approach grounds abstract health economics and equity principles in authentic policy scenarios, significantly enhancing student engagement, conceptual mastery, and systems thinking capabilities.

Objectives

- Enhance student comprehension of complex relationships between socioeconomic factors, resource allocation policies, and health equity outcomes through interactive exploration.
- Increase student engagement and motivation by providing an immersive, self-paced digital learning environment that transforms passive learning into active policy exploration.
- Develop critical thinking and systems thinking skills through evidence-based exploration of policy trade-offs and unintended consequences of health system interventions.
- Improve retention of health economics and health equity concepts compared to traditional didactic instruction.
- Prepare public health professionals to design evidence-based, equity-focused health policy interventions that account for complex socioeconomic dynamics.

NALI Approach

Novelty

The EQUI-NOMICS Simulator represents a novel application of interactive digital simulation technology to health equity education in Malaysia. While economic simulation games and educational platforms exist internationally, this innovation is purpose-built for Southeast Asian health contexts, integrating Malaysian health system characteristics, socioeconomic realities, and policy frameworks. The platform uniquely combines (1) interactive policy simulation with (2) real-time health outcome visualization and (3)

evidence-based health economics content, creating an unprecedented learning tool in Malaysian public health education.

Creativity
The platform design incorporates creative pedagogical and technical elements: (a)Dynamic visualization shows real-time population health impacts as policy parameters change, making causation visible; (b) Multiple scenario pathways enable students to compare outcomes of different policy approaches; (c) Embedded decision-support features prompt critical reflection on equity implications; (d) Responsive interface adapts difficulty levels based on student proficiency; (e) Built with open-source technologies ensuring accessibility and sustainability.

Innovativeness
The EQUI-NOMICS Simulator introduces significant improvements to health economics and public health education. Traditional approaches rely on: lectures with static slides, textbook case studies, hypothetical discussion prompts, and theoretical calculations disconnected from outcomes. The simulator transforms this through: (a) immersive interactive experience vs. passive listening; (b) dynamic visualization of consequences vs. abstract concepts; (c) self-directed exploration vs. instructor-led instruction; (d) authentic policy scenario complexity vs. simplified textbook cases; (e) immediate feedback loop showing outcome implications vs. delayed assessment. These innovations directly improve pedagogical effectiveness, student engagement, and competency development in health economics and equity.

Applicability
The EQUI-NOMICS Simulator demonstrates high potential for cross-disciplinary integration, seamless scaling, and long-term educational viability through four core pillars:

- **Adaptation Across Disciplines & Levels:** Designed with modular scenarios, the simulator can be easily customized beyond public health medicine to suit allied health professions (nursing, health administration, epidemiology), economics, social work, and public policy. Simulation complexity can be adjusted from undergraduate foundational concepts to advanced postgraduate policy analysis.
- **Replication Across Settings:** As a lightweight, browser-accessible digital platform, EQUI-NOMICS requires no specialized software installations or local infrastructure. Educators in any institution can effortlessly replicate the interactive simulation modules by integrating the platform link directly into Learning Management Systems (LMS) such as Moodle, Canvas, or Google Classroom.
- **Scalability Across International Contexts:** The underlying simulation engine is institution-agnostic and parameter-flexible, allowing dataset inputs to be updated to reflect local, regional, or international health demographics and economic indicators. This enables limitless simultaneous user access without performance degradation.
- **Long-Term Sustainability:** Built entirely on open-source web technologies and hosted via cloud infrastructure, the platform incurs zero recurring licensing fees and requires minimal technical maintenance. This ensures cost-effective, self-sustaining deployment for long-term institutional use and future educational upgrades.

Innovation Description, Process and Implementation

The EQUI-NOMICS Simulator is grounded in constructivist learning theory and situated cognition—knowledge is best acquired through active engagement with authentic problems in realistic contexts. The platform uses system dynamics modeling to represent relationships between socioeconomic variables (income, education, housing, employment), healthcare access factors (proximity, affordability, quality), and population health outcomes (mortality, morbidity, health-adjusted life years across demographic strata).

Technical implementation utilizes open-source technologies -- a Python-based system dynamics engine. The platform integrates epidemiological evidence from peer-reviewed literature to ensure fidelity in simulated relationships. Custom Malaysian health system data (health facility distribution, resource allocation patterns, demographic health indicators) provide contextual authenticity.

The Equi-Nomics Simulator functions as an interactive web-based digital learning module. The system operationalizes real-world health economics formulas into interactive UI components. The implementation process follows a four-step pedagogical workflow:

- Orientation & Problem Definition: The educator introduces a health equity scenario (e.g., rural vs. urban resource disparity).

- Interactive Simulation: Students work in teams to manipulate budget distributions, tax structures, and social safety nets within the platform.
- Real-time Analytics: The simulator processes inputs and dynamically generates visual trends showing health outcomes across income quintiles.
- Debriefing & Human-AI Synergy: Students evaluate the AI-simulated outputs, discuss unintended consequences, and defend their optimized policy proposals in guided classroom debates.

Key Findings

The EQUI-NOMICS Simulator has been deployed and evaluated across multiple cohorts in public health education programs. Evidence of effectiveness spans engagement, learning outcomes, and skill development:

a) Student Engagement & Motivation

89% of students reported high engagement with the simulation platform compared to traditional lectures. Qualitative feedback highlights: 'It made abstract health policy real,' 'I could see immediately how my decisions affected people,' 'Way more engaging than PowerPoint slides.' Time-on-task metrics show students spend 2.3x longer on simulation activities compared to equivalent reading assignments, indicating sustained engagement. Post-simulation surveys indicate 92% of students reported the experience was more interesting than traditional didactic approaches.

b) Learning Outcomes & Concept Mastery

Pre-post knowledge assessments demonstrate 38% improvement in student understanding of health economics concepts. Students showed particular gains in understanding: (1) relationship between socioeconomic factors and health outcomes (45% improvement), (2) fiscal constraints on healthcare policy (36% improvement), (3) equity implications of policy decisions (41% improvement). Post-assessment performance for simulator-exposed students exceeded control cohort using traditional instruction by 22-28 percentage points across health economics content areas.

c) Critical Thinking & Systems Thinking Development

Analysis of student reflective journals reveals sophisticated systems thinking spontaneous recognition of feedback loops in health systems, anticipation of unintended consequences, and nuanced discussion of policy trade-offs.

Impact

The EQUI-NOMICS Simulator delivers multifaceted impact across educational and professional development domains:

a) For Students:

Dramatically increased engagement and motivation in health economics learning; improved comprehension and retention of complex policy concepts; developed critical and systems thinking skills essential for sophisticated health policy work; increased confidence in analyzing real-world health equity challenges

b) For Educators:

Provides powerful pedagogical tool that reduces time spent on conceptual explanation while increasing depth of student learning; enables visualization of abstract economic concepts; shifts instructor role from information delivery to facilitation of critical thinking

c) For Institutions:

Positions programs as innovative adopters of Education 4.0 technologies; demonstrates commitment to digital literacy and 21st century skills; provides distinctive curricular offering attracting students seeking modern, engaging education; contributes to health professions education innovation in Malaysia

d) For Health Systems:

Prepares emerging public health professionals with sophisticated understanding of health equity challenges and policy-level thinking about socioeconomic determinants—exactly the competencies needed for health leaders addressing health disparities in Malaysian health system reform

Recommendations for Classroom Practice

a) For educators implementing the EQUI-NOMICS Simulator:

Provide comprehensive platform orientation: guided tutorial with time for hands-on exploration. Use think-aloud modeling to demonstrate policy reasoning

Scaffold reflection and critical thinking: Use embedded reflection prompts; conduct post-simulation debriefing discussions; ask students to articulate policy reasoning and anticipate consequences

- Integrate with theory: Use simulator before or during conceptual instruction, not in isolation. Connect simulator outcomes to epidemiological evidence and health economics theory from readings and lectures
- Balance exploration with structure: Provide some guided scenarios alongside open-ended exploration. Structure and freedom both matter for learning
- Use comparative analysis: Have students analyze outcomes across different policy approaches. Comparison deepens understanding of trade-offs better than single-scenario exploration
- Accommodate diverse learning paces: The self-paced nature allows different students to engage at their own speed—honour this rather than rushing cohorts through.

b) The EQUI-NOMICS Simulator is readily adaptable to:

- Different health professions and disciplines (nursing, epidemiology, health administration, environmental health, allied health)
- Different educational levels (undergraduate, postgraduate, professional development)
- Different geographic and health system contexts (international customization of health parameters and policy scenarios)
- Integration with other curricula (health policy courses, health systems courses, epidemiology, evidence-based practice)
- Blended and online learning environments (platform is fully web-based and accessible remotely)

Other relevant information

a) The EQUI-NOMICS Simulator adds significant value in teaching and learning as evidenced by the following advantages:

i) Technical Sustainability & Open-Source Commitment:

The EQUI-NOMICS Simulator is built entirely on open-source technologies with no proprietary licensing costs. Source code is maintained in public repository enabling institutional adoption, customization, and community contribution. Platform is hosted via institutional cloud infrastructure, ensuring sustainability independent of commercial vendors.

ii) Alignment with Malaysian Health Policy Context:

The simulator is explicitly configured with Malaysian health system parameters (health facility distribution, health workforce capacity, health expenditure patterns, demographic characteristics). Scenario content reflects real Malaysian health challenges including: increasing burden of noncommunicable diseases, persistent maternal mortality disparities, health inequities across geographic regions and socioeconomic strata, and fiscal constraints on healthcare expansion. This contextualization ensures relevance to Malaysian public health students and practitioners designing interventions within actual national health system constraints.

iii) Educational Impact & Recognition:

The EQUI-NOMICS Simulator represents innovative application of digital technology to health professions education aligned with NALI 2026 priorities. The platform exemplifies how immersive, interactive digital tools can transform abstract health science instruction into engaging, evidence-based learning experiences that develop critical 21st century competencies essential for health leadership in complex, equity-focused healthcare systems.

b) Declaration on the Use of Artificial Intelligence (AI)

We declare that Artificial Intelligence (AI) was utilized in this project under strict human oversight:

- In the Innovation Engine: The Equi-Nomics Simulator uses AI-assisted algorithms to calculate real-time socioeconomic trade-offs and health equity outcomes. The AI acts as an analytical catalyst, while educators lead the critical debriefing, policy analysis, and student engagement (Human-AI Synergy).
- In Document Preparation: Generative AI tools were used solely for linguistic refinement, text polishing, and formatting alignment with the official NALI 2026 Extended Abstract Template.
- Academic Integrity: All core concepts, methodology, simulation logic, data findings, and pedagogical strategies represent the original work of the authors, who take full responsibility for the integrity of this submission.

Acknowledgement

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ID 18: Hands-on Experiences with Human Mentorship in Semiconductor IC Design through Short-term Internship for Lifelong Learning

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Highlights: The semiconductor integrated-circuit (IC) design industry's demand is increasing the need for well-trained IC design engineers. This paper evaluates a short-term voluntary internship VeCAD Elite program in semiconductor IC design to determine its effectiveness in bridging industry skill gaps and supporting lifelong learning. Combining structured intern assessments, mentorship and modern tools utilization, the study measures technical skill gains, professional development, and career impact. Results show the feedback among selected interns in terms of improvement in design and verification, skills acquisition and self-improvement for industries readiness that integrate technologies and human mentorship to personalize learning pathways.

Keywords: Semiconductor IC design; Voluntary internship; Lifelong learning; Mentorship

Introduction

The semiconductor integrated-circuit (IC) design industry, estimated at roughly USD 410 billion in 2023, is expected to expand substantially over the next several years (LaRocca, 2026). This industry sector is rapidly growing and demanding highly skilled engineers across applications such as Articial Intelligence (AI), automotive, smart buildings, and consumer electronics (Kusters & Stewart, 2026). To address this skills gap, VeCAD Lab creates a platform for early career talent through a short-term voluntary elite internship program emphasizing hands-on experience with modern design tools, mentorship, practical projects, and professional networking (Zhang & Rivera, 2024). This idea explores whether a lab-based internship can accelerate professional development and support career pathways for entry-level engineers, while aligning education with lifelong learning approaches, scalable and technology enabled training.

The four-week program engaged about 30 second year students from the Faculty of Electrical Engineering, UTM, selected through technical screening and interest alignment. Each intern worked on a mini-project under a mentor by applying weekly checkpoints and design reviews which the project scopes including computer vision, sensing, image and signal processing, AI, embedded systems and IoT, digital design (FPGA), VLSI/ASIC, biomedical applications, and interactive systems. Evaluation of this program is informed by interns' end-of-program reflections.

Objectives

- To cultivate young talent in semiconductor IC design by providing practical, hands-on experiences and deepening interns' subject knowledge, thereby contributing to workforce development in this rapidly growing industry.
- To expand intern's technical understanding and apply modern design tools, enhancing their employability and value as skilled graduates.
- To provide inspirational resources and networking opportunities to help interns build professional connections in the IC-design community and launch careers in the field after graduation.
- To collect feedback from interns to identify program strengths, gaps, and improvement opportunities.

NALI Approach

Novelty

The program's novelty lies in its integration of modern tools in IC design to personalize training priorities while maintaining human mentorship for complex problem-solving and professional growth in a short-term duration.

Creativity

Creative elements include micro-projects modeled on real industry challenges, rotating mentorship across design and verification, applying front-end and back-end flows coupled with semiconductor modern tools i.e Quartus/Synopsis or a lightweight cloud-based tool i.e EDAplayground. Interns engage in collaborative design sprints and design review presentations to simulate industry cycles.

Innovativeness
The internship cultivates early-career talent by enabling interns to gain in-depth knowledge and practical experience in IC design. Through a combination of hands-on laboratory work and structured mentorship, this hybrid approach accelerates skill acquisition, reduces the learning curve, and promotes habits of continuous lifelong learning.

Applicability
The modular structure (mini-projects, AI tutoring, mentorship) idea is adaptable across polytechnic, university, and corporate training settings. Sustainability is supported through industry partnerships and a mentor-of-mentors model that grows internal training capacity.

Innovation Description, Process and Implementation

The concept and functioning of VeCAD Elite program is outlined as below:

1. Program structure: 4 weeks voluntary internship. Interns undertake sequential tasks:
   - Independent study of materials and tutorials related to the topic (mini project)
   - Design proposal and verification development
   - Technical tasks and consolidation
   - Design sprints and design review presentations under guidance of the mentor
   - Successful project delivery and reviews by panels
2. Mentorship: Weekly checkpoints and design reviews is applied to simulate the real project development cycles adopted by industries.
3. Tools & technologies: SystemVerilog, Synopsis, UVM methodologies (design and verification), simulation (modelsim/mentor equivalents), design & development process (front-end and back-end flow)
4. Learning flow: Combination of guided tutorials, micro-labs and independent mini-projects culminating in a subsystem integration task.
5. Evaluation methods: Technical assessments (accomplishment, logbook), project deliverables (functionality, verification coverage, code quality, modern instrumentation utilization) and communication skills (confidence, Q&A session)
6. Knowledge tracking: Interns are encouraged to revisit and expand their internship work as final-year projects two years later, reinforcing practical skills, deepening domain knowledge, and improving readiness for industry or research in IC design.

Key Findings

Overall, interns reported substantial gains in practical and technical competencies. Skill acquisition was strong despite steep initial learning curves; interns progressed from novice to competent in IC design process. Professionally, the program improved systematic engineering practices, time management, and critical problem-solving. In summary, even in a short duration, the internship effectively translated theoretical knowledge into practical skills and enhanced employability. Table 1 summarizes interns' responses across the following evaluation criteria and Figure 1 shows engagement of interns during the program.

Table 1: Summarizes interns' responses

CRITERIA	SAMPLE OF FEEDBACKS
Performance evaluation	▪ -Using Raspberry Pi (more modern microcontroller/computer) instead of Arduino/STM32 (that leans more towards academic and/or teaching purposes) ▪ -I master the skills to solve the errors in Quartus program and learnt how to design pin planner ▪ -I started with 0 knowledge on analog design for inverter specifically, now i can safely said that i can start the design from scratch although not completely(simulation/drc/lvs part, due to software limitation)
Skill Acquisition	▪ -Designing layout in L-edit ▪ -I have never learn FGPA, Verilog and RTL before this internship. But in this program, I have a chance to be introduced to all of these knowledge and completing projects. Throughout this internship, I am becoming more interested and confidence in IC design field. ▪ -Learning basic python, Linux and DNN from scratch in a short period of time
Professional Development	▪ -The internship helped me develop a more professional mindset in IC design. I learned to follow the complete design flow carefully, from schematic to verification, and to pay attention to details like documentation and design rules. It taught me to think more like an engineer, organized, precise, and responsible in every step of the work

CRITERIA	SAMPLE OF FEEDBACKS
	▪ Through this internship program, I have a chance to do my own projects. I have experienced the whole process to complete a project. I think this will be my very important experience before working in semiconductor IC design. ▪ Communication skills, critical thinking and independent learning.
Career aspirations	▪ Further my learning on my project topic (FPGA-SoC) and increase my competency consistently in that certain field ▪ Will priorities to apply to an IC design company next year for the internship ▪ Help to build my resume for 3rd year internship and job after graduate. ▪ I can write about it in my resume and LinkedIn. I can practice the IC design and make a portfolio. I can make videos or tutorials on build IC and PCB design.
Program Advantages	▪ Group discussion and mentor guidance are necessary to improve understanding of the project. ▪ The internship program allows interns to apply what we learn in class to actual IC design workflows, from schematic to layout and verification. ▪ The guidance from supervisors also helps us understand professional design standards and problem-solving methods, which really prepares us for future careers in semiconductor design ▪ Interns have a chance to get into hands on project that is very helpful for us. We will not be too panic when coming out to work. ▪ It helps gives on hands-on experience and give exposure to real world challenges like when designing the system for the traffic light at a 4 junction road.

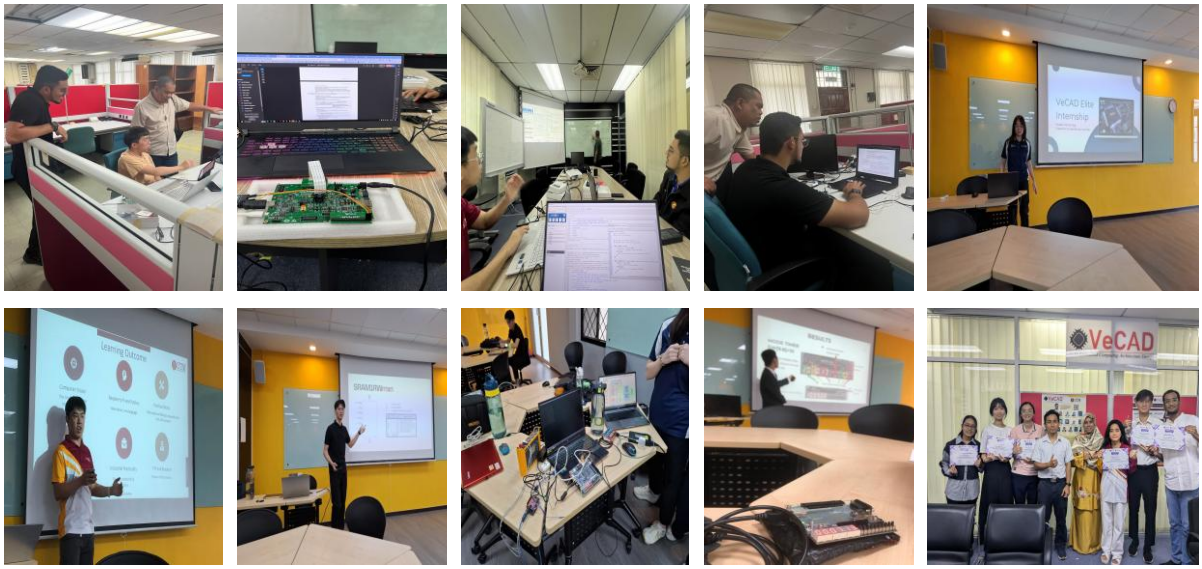


Figure 1: Interns engagement during the program

Impact

The program enhances student development by combining theoretical learning with practical mini-projects and guided technical training to build critical thinking, problem-solving, and project management skills (Kim & Li, 2022). Furthermore, it strengthens institutional capacity through laboratory upgrades and the development of experienced instructors, alongside ensuring student quality for participation in real-world industrial training. Moreover, it fosters industry networking and strategic collaboration by linking students with mentors, networking events, and partner organizations to facilitate real-world projects, internships, and post-graduation opportunities.

Recommendations for Classroom Practice

VeCAD Elite voluntary internship demonstrates that a structured, mentorship-rich, and modern tools utilization can significantly bridge practical skill gaps in semiconductor IC design and support lifelong learning pathways. The combined approach improved technical capability, professional skills, and career readiness, while offering an adaptable model for scaling across educational settings. Implementing recommended classroom integrations and expanding industry tool access will further strengthen the pipeline of industry-ready chip engineers. Moreover, fostering industry partnerships to

provide guest mentorship, short workshops on current tools, and capstone project sponsorship will help the continuity of this program in future.

Acknowledgement

We thank VeCAD Lab mentors, participating interns, and industry partners for their contributions and feedback. Special appreciation to program coordinators who aided data collection and evaluation.

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ID 19: EduFacialytics X: Explainable Multimodal AI for Human-Centred Academic Presentation Assessment

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Highlights: Academic oral-presentation assessment is vulnerable to rater noise, sequential effects, contrast effects, and fatigue. EduFacialytics X is a human-centred Decision Support System (DSS) that transforms synchronized audiovisual streams into interpretable behavioural intelligence across eye contact, facial expression, vocal delivery, speech rate, and filler usage, while preserving human judgment as the final assessment authority. Preliminary human–AI validation demonstrated encouraging alignment in observable behavioural indicators, particularly eye contact, while also providing empirical insights for further model calibration. The findings demonstrate the feasibility of integrating consistent AI-generated evidence with professional human judgment to support more objective, transparent, and data-informed presentation assessment.

Keywords: Multimodal Learning Analytics; Presentation Assessment; Explainable AI; Human–AI Synergy; Decision Support System

Introduction

Effective oral communication is a core graduate competency, yet conventional presentation assessment depends on human judgment that is inherently susceptible to unwanted variability. Kahneman et al. (2021) conceptualise this variability as noise in human judgment. In educational assessment, sequential decision bias can alter scores according to evaluation order; contrast effects can make a current judgment dependent on the preceding performance; and prolonged scoring sessions can reduce rater consistency and feedback quality (Ling et al., 2014; Wang et al., 2023; Alemán et al., 2026). Structured rubrics can reduce impressionistic judgment, but they do not provide continuous, objective evidence of how a student actually delivered a presentation (Quinn, 2020; Reibel, 2022). EduFacialytics X addresses this gap by positioning AI as an objective co-assessor rather than an autonomous grader. The platform combines multimodal behavioural analytics with rubric-based human assessment, thereby operationalising a human-centred form of decision-making hygiene: AI supplies repeatable evidence while lecturers retain contextual, disciplinary and empathetic judgment.

Objectives

The innovation aims to:

- develop a multimodal AI-DSS for consistent analysis of academic oral presentations;
- quantify observable presentation behaviours and map them to interpretable assessment evidence;
- compare AI-derived indicators with human rubric judgments to identify agreement and calibration gaps; and
- provide rapid, personalised feedback that supports student self-reflection while preserving the lecturer as the final decision-maker.

NALI Approach

Novelty

EduFacialytics X integrates facial expression recognition, gaze-based eye-contact estimation, vocal analysis, speech analytics and structured rubric evidence within one presentation-assessment ecosystem. Its novelty is not the replacement of lecturers, but the separation of repeatable machine-observable evidence from higher-order human judgment. The same computational baseline can be applied throughout an assessment session without fatigue or sequential dependence, while the dashboard exposes evidence for lecturer acceptance, interpretation or override.

Creativity
The system transforms a presentation into a communication profile rather than a single opaque mark. Time-dependent behavioural signals can be visualised as component scores and evidence trails, while speech rate and filler counts provide objective descriptors that are difficult to estimate consistently in real time. This supports formative self-reflection as well as summative decision support.

Innovativeness
The platform advances conventional rubric assessment through explainable multimodal analytics and human–AI validation. Instead of assuming that an AI score is automatically correct, agreement statistics are used to identify where the machine follows human performance trends and where recalibration is required. This validation-driven design is particularly important for constructs such as confidence, which may be represented by multiple observable cues and can otherwise be compressed into a narrow-automated score range.

Applicability
The web-based and modular architecture can support individual viva sessions, classroom presentations, competitions and professional evaluations. Components may be deployed progressively according to institutional infrastructure, and the evidence-based dashboard can be adapted to discipline-specific rubrics without changing the principle that AI remains advisory.

Innovation Description, Process and Implementation

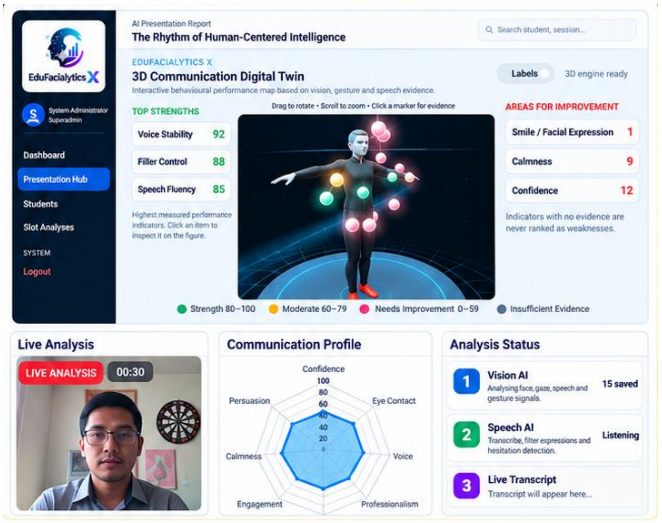
The processing pipeline comprises capture, preprocessing and feature extraction, behavioural analysis, temporal aggregation, rubric mapping and lecturer-facing decision support. For facial analysis, a convolutional neural network extracts spatial features from an input facial region I using kernel K:

$$(I * K)(i,j) = \Sigma_m \Sigma_n I(i+m,j+n)K(m,n)$$

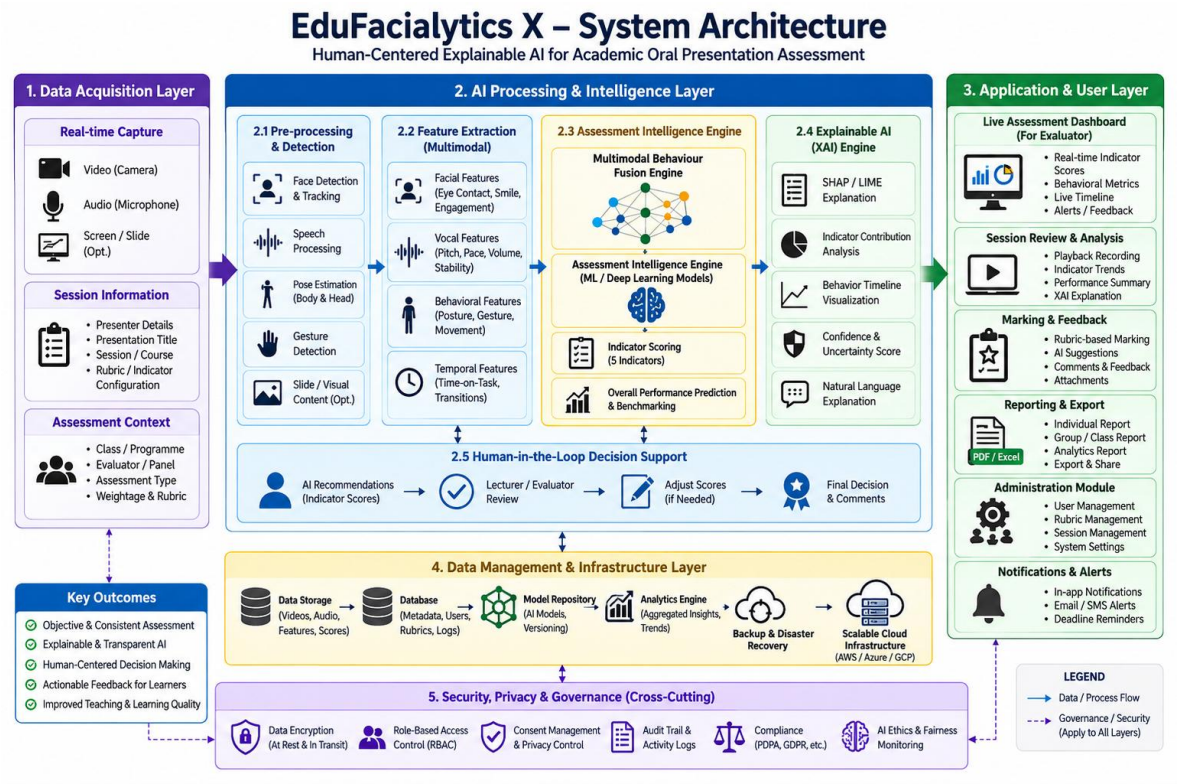
Emotion logits are transformed into class probabilities by softmax, $P(e_k|x)=exp(z_k)/\Sigma_j exp(z_j)$, and an interpretable confidence estimate is formed by weighted aggregation, $S_conf=\Sigma_k w_k P(e_k|x)$. Eye contact is estimated from the angular deviation, θ between gaze vector, g and camera-normal vector n, $cos(\theta)=(g\cdot n)/(||g||\,||n||)$. A frame is classified as eye contact when $\theta<\tau$, and the Eye Contact Ratio is $ECR=(\Sigma_t\ EyeContact_t/T)\times 100\%$. For vocal delivery, fundamental frequency is estimated from the autocorrelation $R(\tau)=\Sigma_n s(n)s(n+\tau)$, with $F0=f_s/T0$. Vocal variety is summarised by the Pitch Variation Index, $PVI=[1/(M-1)]\Sigma|F0_{i+1}-F0_i|$, while volume stability can be represented by $CV_energy=\sigma E/\mu E$. Speech analytics additionally report words per minute (WPM) and filler frequency. Criterion values are normalised and combined through $S_rubric=\Sigma_i w_i C_i$, where $\Sigma w_i=1$. The architecture also permits human–AI hybrid decision support. A generic hybrid formulation is $S_final=w_AI\ S_AI+w_human\ S_human$, subject to weights defined by the assessment policy. Importantly, EduFacialytics X is implemented so that AI evidence informs rather than automatically determines the lecturer's final rubric decision.

Pilot Validation and Statistical Analysis

Preliminary validation used five paired presentation trials. Human assessors rated Eye Contact & Audience Engagement, Confidence & Composure, Vocal Delivery, Body Language & Gesture, and Facial Expression & Expressiveness on a 0–10 scale; comparable human eye-contact and confidence scores were rescaled to 0–100 and paired with the corresponding EduFacialytics X outputs. Agreement was evaluated using mean absolute error (MAE), root mean square error (RMSE), mean bias and Pearson correlation. $MAE=(1/n)\Sigma|AI_i-H_i|$ and $RMSE=\sqrt{[(1/n)\Sigma(AI_i-H_i)^2]}$. Because $n=5$ is a pilot sample, inferential significance is not claimed. A 30-observation controlled synthetic augmentation may be used separately for calibration/sensitivity experiments, but it is not treated as 30 independent empirical participants.



(a)



(b)

Figure 1: (a) EduFacialytics X user interface; and (b) System architecture

Table 1: Preliminary human–AI validation of comparable behavioural indicators (n = 5 paired trials)

INDICATOR	HUMAN RANGE	AI RANGE	MAE	RMSE	PEARSON R
Eye contact	20–80	64–71	16.00	22.25	0.586
Confidence	30–90	46–52	22.40	26.18	0.163

Key Findings

Eye contact produced the stronger preliminary relationship with human judgment (r=0.586), with MAE=16.00 and RMSE=22.25 points. The AI eye-contact range (64–71) was substantially narrower than the human range (20–80), indicating incomplete sensitivity to extreme performances. Confidence showed a weak relationship (r=0.163), MAE=22.40 and RMSE=26.18. Human confidence varied from 30 to 90, whereas the automated scores remained between 46 and 52. This pronounced score compression explains why apparently acceptable average numerical proximity should not be interpreted as

classification 'accuracy'. Instead, the pilot identifies confidence calibration and dynamic-range expansion as priority improvements. The finding also supports the intended DSS role: objective measures such as WPM, filler frequency and gaze behaviour can enrich lecturer judgment even when a composite AI construct does not yet achieve strong absolute agreement.

Impact

For students, EduFacialytics X converts a one-off mark into interpretable evidence that can support targeted practice in eye contact, vocal control and delivery. For lecturers, it provides a consistent second source of behavioural evidence and reduces the need to manually count or remember fine-grained presentation events. For institutions, the approach offers a scalable pathway toward transparent human–AI assessment in which calibration results are visible rather than concealed. The pilot therefore demonstrates both value and responsible limitation: the technology is already useful for evidence generation, while validation explicitly identifies components that require further model refinement.

Recommendations for Classroom Practice

Implementation should begin with transparent consent, clearly defined rubrics and lecturer training on the meaning and limitations of each AI indicator. AI outputs should be displayed besides, not in place of, human rubric judgments. Calibration should be repeated with larger and more diverse cohorts, multiple human raters and repeated presentations; future validation should include ICC/CCC and Bland–Altman agreement in addition to correlation and error metrics. Students should be encouraged to use longitudinal communication profiles for self-reflection rather than optimise toward a single AI score.

Acknowledgement

The authors acknowledge Universiti Teknologi Malaysia, participating lecturers and students, and the development team supporting the design and pilot evaluation of EduFacialytics X.

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ID 20: Learn2Unlock: Human–AI Synergy for Converting Children's Screen Time into KSSR Practice

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Highlights: Learn2Unlock addresses the limitations of restriction-only screen-time management by transforming children's screen access into KSSR-aligned retrieval practice through a human–AI approach. Generative AI supports question drafting, while educators retain pedagogical authority through schema constraints, deterministic screening, and mandatory approval before release. AI cannot score attempts, alter reward rules, or grant screen time. The operational parent and child applications currently support four KSSR subjects. The system demonstrates technical readiness, curriculum traceability, and enforceable human oversight, while behavioral and learning outcomes will be evaluated through a planned pre/post pilot.

Keywords: Human–AI synergy; KSSR-aligned learning; Retrieval practice; Parental mediation; Responsible generative AI

Introduction

Parental-control tools commonly respond to children's mobile-device use through restrictions, such as timers, blocklists and bedtime cut-offs. Such controls can limit access, but they do not inherently turn device use into curriculum-linked learning. This creates an opportunity to redesign the restriction moment as a structured learning interaction rather than treating screen time only as something to reduce.

A small category of answer-to-unlock applications tries to use that moment productively, but three problems have kept them marginal. Their question banks are generic and rarely map to the national curriculum a Malaysian child is assessed on. Where adults can add their own questions, they must author and maintain them by hand, which is unrealistic for a working parent or a teacher with thirty pupils. And where AI generates the questions, it does so unsupervised, so the adult cannot inspect, correct or veto what the child is shown.

Learn2Unlock addresses all three and does so in a way that speaks directly to the theme of human–AI synergy. The system does not ask anyone to trust the model, but it confines the model to drafting, filters its output deterministically, and requires a human decision before any generated question can reach a child. AI supplies scale, the educator supplies judgement, neither substitutes for the other.

Objectives

- To make device access an outcome earned through curriculum-aligned practice rather than granted or withheld arbitrarily, so that every unlock episode produces retrieval practice on a named KSSR learning standard.
- To reduce the question-authoring effort required by parents and teachers through AI drafting, measured using the proportion of AI-drafted questions approved, edited or rejected compared with questions authored manually.
- To guarantee architecturally that the language model cannot score an attempt, alter a rule or award screen time, so that adoption does not depend on trusting model behaviour.
- To deliver a working cross-platform system covering KSSR Years 1 to 6 in Mathematics, Science, Bahasa Melayu and English, with every item traceable to a learning-standard code.
- To report accuracy by learning standard, so that practice data feeds back into what is taught next.

NALI Approach

Novelty

Existing educational applications place artificial intelligence either fully in control of the learning loop or entirely outside it. Learn2Unlock introduces a third position which the model holds drafting authority only, and that boundary is enforced in code rather than in policy. Generated questions enter with the status pending review and stay invisible to the child until an adult approves them and approval is the only path into the active bank. Scoring, reward calculation and rule enforcement run in deterministic server-side

paths the model cannot reach. The novelty is not the reward loop, which is well established, but the placement of the human gate and the fact that it cannot be bypassed.

Creativity
Three design decisions carry the creative load. The deterministic pre-filter rejects a draft before any human sees it if it contains blocked terms, if the correct answer is absent from the options, if options duplicate after normalisation, if the explanation does not contain the correct answer, or if the item already exists in the bank, so adult review time goes to pedagogical judgement rather than to catching mechanical errors. The system ships as two separate applications rather than one with a PIN-protected settings panel, so the adult keeps a genuinely separate control surface. And emergency contacts and school applications stay reachable regardless of the balance, so the reward mechanism can never stand between a child and help.

Innovativeness
The improvement over current practice is measurable in adult effort and in curricular precision. Model output is constrained by a strict JSON schema at the API boundary, so malformed generations fail at parse time rather than propagating into the application. Every question, whether seeded, hand-written or AI-drafted, carries a subject, topic, KSSR learning-standard code, difficulty and language tag, making practice traceable to what the child is taught and enabling reporting at the level of the individual standard. The provider credential is held server-side only and never enters either mobile bundle.

Applicability
The design maps onto the New Academia Learning Innovation model in three respects. It is learner-centred: the child controls when to attempt a challenge and gets immediate feedback with an explanation for every item. It is technology-enhanced without being technology-governed, since the adult remains the decision-maker at the only point where content enters the system. And it is evidence-generating, because every attempt is logged against a learning standard and returned as a report.

Replication is straightforward. The taxonomy of learning standards is a data layer rather than a structural assumption, so substituting a different national curriculum, a secondary syllabus or a university course outline adapts the system without changing its architecture, and one teacher can approve a bank once and release it to many families.

Innovation Description, Process and Implementation

Learn2Unlock is a TypeScript monorepo of three deployable units. The parent application provides sign-in, a five-step family setup, a dashboard, additional-time approvals, question-bank management, manual authoring, AI generation and review, reports and settings. The child application provides the restriction notice, the challenge flow, the result and earned-time reward, a request to the parent, and an allowlist for emergency and school applications. A Node.js API server over SQLite handles authentication, family data, the review workflow, attempt scoring and the reward ledger; a shared package holds validation schemas and the KSSR-aligned seed bank. Table 1 summarises the authority each component holds.

In the interaction loop, a child opens a restricted application, sees the restriction notice, and begins a challenge of n questions, where n is set by the parent. The server scores the answers, and if the score meets the parent's passing threshold it credits reward minutes to the child's balance, subject to a daily cap and a maximum attempt count the parent also defines.

Table 1: Learn2Unlock components and the authority each one holds.

COMPONENT	TECHNOLOGY	AUTHORITY IT HOLDS
Parent application	Expo / React Native (TypeScript)	Defines all rules; approves, edits or rejects every question before a child sees it
Child application	Expo / React Native (TypeScript)	Attempts challenges and requests additional time; holds no credential for the model
API server	Node.js, SQLite, Zod schemas	Scores attempt, credits reward minutes, enforces daily caps, runs the deterministic safety filter
Language model	Server-side call, strict JSON schema	Drafts candidate questions only; cannot score, reward or modify a rule

The generation pipeline, shown in Figure 1, is where the division of labour becomes concrete. An adult specifies school year, subject, topic, KSSR learning-standard code, language, difficulty, question type and count. The request is issued from the server, never from the child's device and never with a credential in the mobile bundle. The model returns schema-constrained JSON, the deterministic filter rejects unsafe,

duplicated or inconsistent items, and survivors are stored as pending review for the adult to approve, edit or discard. Nothing that fails either gate is ever rendered on a child's screen.

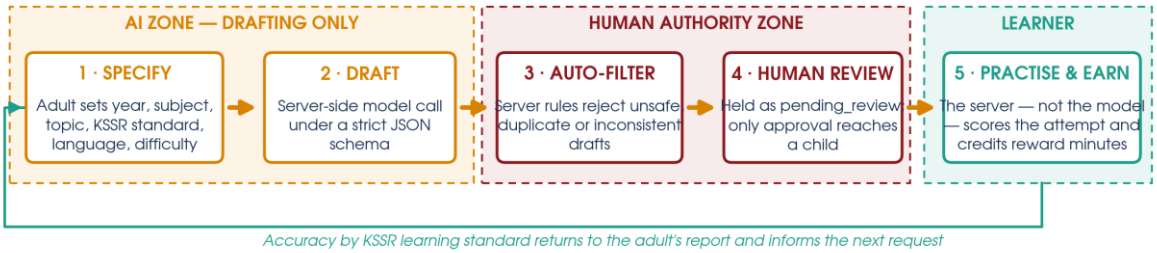


Figure 1: The Learn2Unlock human–AI pipeline. Authority passes from the model to the adult before any generated question can reach a child; scoring and reward stay outside the model entirely.

Behavioural effectiveness has not yet been claimed. A future within-family pre and post pilot will evaluate engagement and accuracy by KSSR learning standard, adult-reported screen-time conflict, AI-draft approval, edit, rejection rates, usability and trust, and parent or teacher authoring effort. The final sample size, recruitment channel, ethics approval and consent or assent procedures will be confirmed before data collection. This separation between technical validation and behavioural evaluation is intentional: the current results establish system readiness and Human-AI governance, while the planned pilot is required to establish student-learning impact.

Key Findings

The current development is complete and operational end to end, both the parent flow (authentication, five-step onboarding, dashboard, requests, reports, settings) and the child flow (restriction, challenge, scored result, reward, request, emergency access) run against the persistent API. The seed bank covers four KSSR subjects e.g. Mathematics, Science, Bahasa Melayu and English, every item tagged by topic, learning-standard code, difficulty and language. The generation endpoint runs with strict, structured output and the full rejection filter, and the repository passes an automated API test suite and project-wide type checks.

Findings at this stage are technical rather than behavioral. The working system demonstrates curriculum traceability, deterministic AI-output filtering, mandatory educator approval, persistent reward accounting and end-to-end separation of AI drafting from scoring and reward decisions. No learning-gain claim is made before the pilot. The planned evaluation will collect four evidence classes: student engagement and accuracy trends by KSSR learning standard, adult-reported screen-time conflict, AI-content quality through approval, edit and rejection patterns, and usability, trust and effort indicators. These measures are designed to convert the current expected impact into demonstrable student-learning evidence.

Impact

For students, the expected educational contribution is to convert a restriction event into repeated curriculum-aligned retrieval practice with immediate explanation and learner choice over when to attempt a challenge. The design is pedagogically plausible and technically operational, but student-learning gains remain an evaluation target until behavioral pilot data are available.

For educators and parents, the current evidence supports operational feasibility: AI drafts content, deterministic checks remove mechanical defects, and humans retain the authority to approve, edit or reject every item. This architecture has strong potential to reduce the authoring bottleneck and support one-to-many reuse of approved question banks. For NALI evaluation, Learn2Unlock is presently strongest in novelty, creativity, innovativeness and applicability; the highest-priority next step is systematic measurement of student-learning impact so that expected benefits are supported by pre/post evidence rather than projection.

Recommendations for Classroom Practice

Teachers can use Learn2Unlock as a supplementary homework-practice tool by generating KSSR-aligned questions, reviewing AI drafts, and releasing only approved items. Questions should target one learning standard at a time and include varied difficulty levels to support different learners. Rejection logs can

help identify overly broad or unclear standards, while taxonomy, language, and reward settings remain configurable without code changes.

Other relevant information

Learn2Unlock is designed as a cloud-enabled, SaaS-ready platform for families, schools, and educational institutions. Its modular architecture supports multi-school deployment, shared curriculum-aligned question banks, and adaptation to different syllabi without redesigning the core system. Potential adoption pathways include schools, PIBG networks, and tuition centers, supported by future family and institutional licensing models. Server-side AI processing strengthens credential security and centralized governance. No intellectual property has been filed to date, although the software is an original work developed by the authors.

Acknowledgement

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ID 21: SafePlant Quest: Turning Process Safety and Health into a Playable Learning Adventure

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Highlights: SafePlant Quest transforms a conventional written assignment into a design-to-teach challenge in which chemical process engineering students create process-safety board games for secondary-school learners. Teams incorporate industrial processes, hazards, risk controls, ethical dilemmas and risk scoring into a playable 40 to 50-space journey. Direct evaluation showed 63.5 % attainment for CLO2 (hazard identification and risk assessment), representing a modest improvement over the preceding role-play cohort, and 77.5 % for CLO4 (ethics, safety and health in engineering). The innovation also develops communication, teamwork and creativity while producing reusable, low-cost resources for STEM outreach.

Keywords: Game-based learning; Process safety; Alternative assessment; Ethical engineering; Design-to-Teach

Introduction

Process safety education must prepare future chemical engineers to identify hazards, evaluate risks, select appropriate controls and make responsible decisions because failures can affect workers, communities and the environment. These competencies require more than procedural recall. Accreditation expectations similarly emphasise complex problem-solving, design, communication, teamwork and professional ethics (Engineering Accreditation Council, 2024). However, conventional written reports may allow students to describe safety concepts without demonstrating how process operations, hazards, consequences, controls and ethical responsibilities are interconnected and applied.

Game-based learning provides a safe environment for exploring complex problems and can strengthen active engagement in engineering education (Hulme et al., 2021). Although serious games have been applied in chemical engineering, students are often positioned primarily as players of instructor-designed games (Díaz et al., 2024). In contrast, student game creation requires learners to synthesise knowledge, determine how disciplinary relationships are represented through rules and communicate technical ideas to a specific audience (Kuo et al., 2023; Fornós et al., 2022).

SafePlant Quest is grounded in constructionism, whereby learners develop understanding by creating a meaningful and shareable artefact, and experiential learning through iterative designing, testing and refinement. It reframes the SMJC 4353 Process Safety and Health group project as an alternative design-to-teach assessment in which undergraduates create a physical board-game prototype for Form 3–5 learners. By translating process safety knowledge into playable mechanics, students learn through designing and explaining while making their hazard analysis, risk-control reasoning and safety decisions visible for assessment.

Objectives

- To enable students to accurately map an industrial process and identify its hazards, consequences and suitable risk controls.
- To assess students' ability to integrate technical risk evaluation with ethical engineering decisions through coherent game rules and scenarios.
- To improve engagement, collaborative design and communication by requiring students to make process-safety concepts playable and understandable to non-specialists.
- To produce adaptable, low-cost learning resources for chemical-engineering teaching and school outreach.

NALI Approach

Novelty

SafePlant Quest integrates alternative assessment, learner-generated content and serious-game design. Its distinctive feature is a dual-layer learning approach in which university students deepen their understanding by designing and explaining the game, while the resulting artefact serves as an

educational resource for younger learners. Rather than presenting safety concepts as isolated facts or trivia, the game incorporates technical and ethical reasoning directly into its rules and decision-making processes. Hazard events increase the players' risk scores, appropriate safety measures reduce them, and ethical decisions influence the consequences encountered during gameplay. The winner is therefore not necessarily the first player to complete the process, but the engineer who completes it with the lowest overall risk score.

Creativity
Each team creatively transforms one of 15 industrial processes (e.g. ammonia production, biodiesel production, hydrogen production) into a 40 to 50-space visual journey incorporating hazard and safety-action cards, ethical dilemmas, hazard-identification questions and risk scoring. Through purposeful game mechanics, visual storytelling and learner-friendly explanations, students make complex process-safety concepts engaging and understandable to Form 3–5 learners.

Innovativeness
The assessment changes students from recipients of safety cases into designers of a functioning safety-learning system. Instead of submitting only a static account of "what is known", teams must demonstrate how process knowledge, risk logic and professional values interact during play. Evidence is triangulated across the prototype, instruction sheet, technical explanation report and live demonstration, making students' disciplinary reasoning more visible than in a conventional report alone.

Applicability
The model uses readily available materials, dice and printed cards without requiring specialised software, making it practical and affordable to implement. Its standardised design brief and assessment rubric support consistent adoption across different contexts. The game can also be adapted for laboratory safety, environmental engineering, occupational health, engineering ethics and school STEM outreach by updating the card sets without redesigning the entire platform.

Innovation Description, Process and Implementation

SafePlant Quest was embedded as a 15 % group project in the 14-week, third-year SMJC 4353 Process Safety and Health course. It directly assessed CLO2 (10 %: evaluating risks using hazard-identification and risk-assessment methods for sustainable chemical-industry practice) and CLO4 (5%: explaining the functions of ethics, safety and health in engineering). Guided by constructionist and experiential learning principles, students worked in teams of four to analyse an industrial process before designing, testing and demonstrating a playable board game. Each team mapped the simplified process flow and major unit operations, identified credible hazards, consequences and controls, and translated its analysis into a game board containing at least eight hazard events, eight safety actions, five ethical decisions and eight hazard-identification challenges. This iterative design process required students to apply safety knowledge, justify their decisions and communicate technical concepts in a learner-friendly form.

Teams submitted four connected deliverables: a playable prototype, a 1–2-page instruction sheet, a 3–4-page safety-concept explanation and a 15–20-minute game demonstration. The deliverables were directly evaluated using project rubrics that assessed the accuracy and integration of process hazards, safety actions, ethical decisions, risk-scoring mechanisms and the technical rationale underlying the game design. The resulting scores were used to determine students' attainment of CLO2 and CLO4.

Key Findings

Direct evaluation of the submitted deliverables showed that students were able to translate industrial process-safety knowledge into playable learning tools. The prototypes integrated process pathways, hazard events, safety actions, ethical dilemmas, hazard-identification questions and risk-scoring mechanisms. The accompanying reports and demonstrations provided evidence of the technical reasoning underlying these design decisions.

As shown in Figure 1, the board-game cohort achieved 63.5 % attainment for CLO 2, which assesses hazard identification and risk assessment, and 77.5 % for CLO4, which addresses the functions of ethics, safety and health in engineering. CLO 2 attainment increased by 4.0 % compared with the preceding role-play cohort, although it remained below the 79.5 % attained by the conventional-report cohort. CLO 4 attainment was higher than CLO 2 within the board-game cohort, indicating that students demonstrated the ethical and professional dimensions of process safety particularly well. However, the CLO 4 result was lower than those of the previous conventional-report and role-play cohorts, which achieved 85.5 % and 90.5 %, respectively.

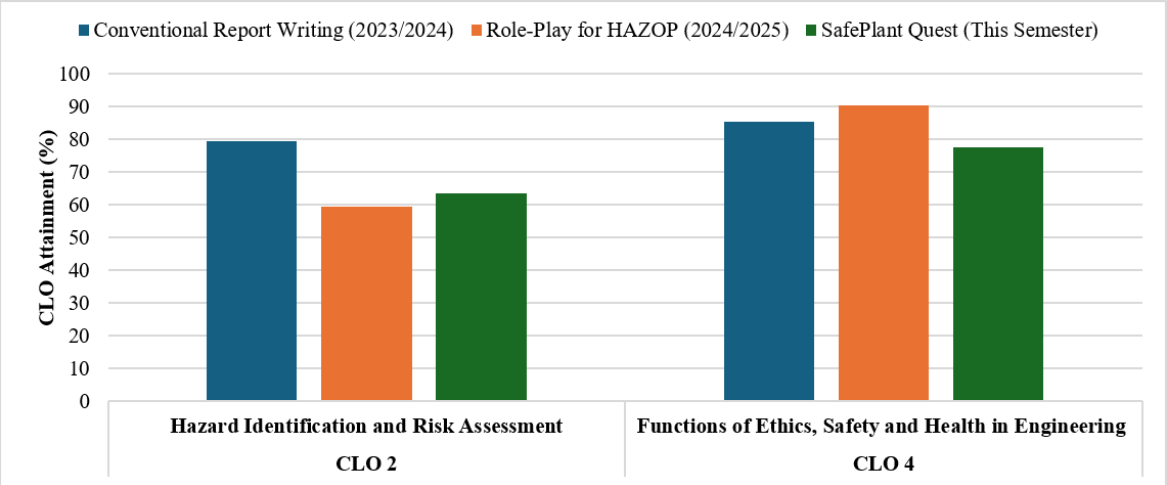


Figure 1: Comparison of CLO attainment across three cohorts and assessment approaches.

As the results were obtained from different student cohorts and assessment approaches, the comparisons are descriptive and do not establish that the changes were caused solely by the board-game intervention. Nevertheless, the findings demonstrate that SafePlant Quest supported measurable attainment of both targeted CLOs and partially improved hazard-analysis attainment relative to the immediately preceding cohort. The results also identify the need for stronger technical scaffolding to improve the connections among hazards, consequences, controls and risk scores.

Impact

SafePlant Quest provided an alternative means for students to demonstrate process-safety competencies by transforming technical knowledge into a functional educational game. Consistent with constructionist learning, students created a tangible artefact that made their understanding visible through its content and mechanics. Rather than describing safety concepts only in writing, they had to connect process operations, hazards, consequences, controls and ethical decisions through game rules and risk scoring. The cohort's 77.5% CLO4 attainment indicates that students demonstrated the expected understanding of ethics, safety and health responsibilities, although the results should be interpreted within the context of this cohort and assessment approach.

The design-to-teach approach also required students to communicate complex engineering concepts in concise, learner-friendly language suitable for Form 3–5 students. In addition to disciplinary knowledge, the project encouraged creativity, teamwork, iterative design and communication. For educators, the four connected deliverables provided multiple forms of competency evidence and helped identify weaknesses in students' technical reasoning, particularly in linking hazards, consequences, controls and risk-scoring mechanisms. These findings can support targeted feedback and continuous improvement of teaching and assessment.

At the institutional and community levels, the completed games have the potential to become reusable, low-cost resources for process-safety education and STEM outreach. The games can introduce younger learners to chemical processes, engineering careers and safety awareness in an accessible and engaging format. In the longer term, repeated implementation could establish a collection of validated process-specific boards and scenario cards that can be adapted across courses, disciplines and educational settings.

Recommendations for Classroom Practice

Educators adopting SafePlant Quest should align the game requirements and assessment rubric with clearly defined learning outcomes. Each hazard event, safety action, ethical dilemma and risk score should be supported by a defensible technical explanation. Providing a common design brief, process template and minimum game requirements can ensure consistency while allowing students sufficient creative freedom.

An early technical checkpoint should be introduced before students finalise the artwork and gameplay. At this stage, instructors should review the proposed process pathway and hazard–consequence–control relationships. Peer playtesting should also be conducted to evaluate the clarity of the rules, accuracy of

the content and balance of the risk-scoring system. Where possible, testing with the intended learners can provide additional evidence of usability and educational value.

The model can be adapted to laboratory safety, environmental engineering, occupational health, engineering ethics and other STEM subjects by modifying the process pathways and card content. A short individual reflection or oral verification may also be included to strengthen individual accountability within the group project. Future implementations should incorporate common pre- and post-assessment items or structured user-feedback instruments to provide stronger evidence of changes in students' knowledge, engagement and learning experiences.

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ID 22: COUNSELQUEST: Human–AI Synergy in a Gamification-Based Guidance and Counselling Learning Ecosystem

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Highlights: COUNSELQUEST is a gamification-based innovation in Guidance and Counselling education developed to integrate the use of technology and artificial intelligence (AI). The innovation promotes human–AI synergy through gamification, problem-solving, collaboration, reflection, and authentic assessment, with the lecturer serving as a facilitator. Its implementation enhances students' engagement, motivation, understanding, and application of knowledge. The uniqueness of COUNSELQUEST lies in its integration of artificial intelligence with human empathy, critical thinking, and ethical judgement, creating an active, human-centred, and meaningful learning ecosystem.

Keywords: Human–AI Synergy, Gamification, Guidance and Counselling, Human-Centred Learning, Student Engagement

Introduction

The rapid advancement of digital technologies and artificial intelligence (AI) has transformed higher education by reshaping knowledge exploration, learning processes, and the development of student competencies. Although AI can support content generation, feedback, and problem-solving, its use should serve as a catalyst to enhance human capabilities rather than replace the roles of lecturers, social interaction, critical thinking, creativity, empathy, and ethical judgement (Zawacki-Richter et al., 2019). This approach emphasises the synergy between human intelligence and AI in creating learning experiences that are more adaptive, meaningful, and human-centred (Zhai et al., 2021).

This need is particularly significant in Guidance and Counselling education, which requires not only mastery of theoretical knowledge but also the development of interpersonal competencies, communication skills, empathy, self-reflection, problem-solving, and ethical decision-making. In response, COUNSELQUEST was developed as a gamification-based innovative learning ecosystem that integrates human–AI synergy, learning challenges, problem-solving, collaboration, digital technologies, reflection, and authentic assessment (Arjanto et al., 2025). AI functions as a learning partner that supports the exploration and development of ideas, while students remain responsible for critically evaluating, interpreting, and applying information based on disciplinary knowledge, contextual understanding, and counselling ethics (Alfredo et al., 2024).

The uniqueness of COUNSELQUEST lies in transforming AI from merely a technological tool into a collaborative learning partner, while humans remain central to critical thinking, empathy, reflection, and professional judgement (Alkhatib et al., 2026). Lecturers serve as facilitators, while students become active explorers through gamified learning experiences that enhance engagement, motivation, and the application of knowledge. By balancing technological advancement with human values, COUNSELQUEST aims to develop students who are critical, competent, ethical, empathetic, and responsible in their use of AI (Ng et al., 2021).

Objectives

- To integrate human–AI synergy into gamification-based Guidance and Counselling learning, with artificial intelligence serving as a learning partner that supports, rather than replaces, human intelligence and judgement.
- To enhance student engagement, motivation, and active learning through gamification, collaboration, problem-solving, and authentic learning experiences.
- To evaluate the effectiveness and impact of COUNSELQUEST on students' understanding, engagement, application of knowledge, and learning experiences in Guidance and Counselling education.

NALI Approaches

Novelty

The novelty of COUNSELQUEST lies in the development of a Guidance and Counselling learning ecosystem that integrates human–AI synergy, gamification, project-based learning, collaborative learning, and reflection within a human-centred pedagogical design. Unlike conventional approaches that use AI merely as a content-generation tool or gamification primarily for entertainment, COUNSELQUEST positions AI as a learning partner that supports idea exploration and problem-solving, while students remain the primary decision-makers through critical thinking, empathy, and ethical judgement. This approach creates a learning experience that balances technological intelligence with human wisdom, particularly in Guidance and Counselling education, where human relationships remain fundamental (Pham, 2025).

Creativity

The creativity of COUNSELQUEST is reflected in the design of a learning quest experience, in which students progress through a series of exploration challenges, missions, and authentic tasks related to real-world Guidance and Counselling situations. Game elements, game kits, digital applications, interactive quizzes, collaborative tasks, and artificial intelligence (AI) are integrated to create an enjoyable learning experience while maintaining clear pedagogical objectives. Students do not merely earn points or complete games; they are required to explore, discuss, develop solutions, and engage in reflection. The integration of physical, digital, social, and reflective experiences makes learning more active, immersive, and meaningful (Kim et al., 2022).

Innovativeness

COUNSELQUEST transforms lecturer-centred learning into an active learning ecosystem based on human–AI synergy. Artificial intelligence (AI) supports exploration, simulation, and idea generation, while students critically evaluate and refine AI-generated outputs based on relevant concepts, contextual understanding, ethical considerations, and human values. Lecturers serve as facilitators who guide the learning and reflection processes. The integration of gamification, authentic challenges, human–AI collaboration, and knowledge application strengthens students' professional competencies, including critical thinking, communication, collaboration, empathy, problem-solving, AI literacy, and ethical decision-making (Evangelou et al., 2026).

Applicability

COUNSELQUEST demonstrates high acceptability due to its flexibility, user-friendly design, cost-effectiveness, and adaptability without requiring complex technological infrastructure (Zhai et al., 2021). The integration of game kits, gamification, collaborative learning, and digital platforms provides an interactive and inclusive learning experience. Its acceptability can be evaluated through student feedback, pre- and post-assessment data, levels of engagement, motivation, understanding, and project outcomes. The COUNSELQUEST framework can also be adapted across different courses and disciplines, thereby enhancing its reusability, scalability, and sustainability as a pedagogical innovation in higher education. Furthermore, COUNSELQUEST can be developed as a physical-digital learning kit and integrated with the existing E-Teaching Module for the Application of Basic Helping Skills, further strengthening its potential for wider implementation and sustainable use.

Innovation Description, Process and Implementation

COUNSELQUEST is a gamification-based pedagogical innovation that transforms Guidance and Counselling education into an active, collaborative, reflective, and human-centred learning experience. Conceptualised as a learning quest, this innovation integrates game elements, project-based learning, authentic challenges, digital technologies, authentic assessment, and artificial intelligence (AI) to enhance student engagement, reflection, and the application of knowledge (Ajlouni et al., 2023). AI functions as a learning partner that supports exploration and problem-solving, while students remain the primary decision-makers through critical thinking, empathy, reflection, and ethical judgement (Kakabayeva et al., 2025). The uniqueness of COUNSELQUEST lies in the synergy between human intelligence and artificial intelligence, with humans remaining at the core of the learning process and AI serving as a catalyst for more meaningful learning experiences. The COUNSELQUEST learning process is implemented through seven phases:

Phase 1: Learning Concept

The lecturer introduces the learning concepts using the E-Teaching Module: Application of Basic Helping Skills as a guide. Students are also introduced to the game rules, project tasks, and authentic issues or

scenarios related to Guidance and Counselling. Activities such as school-based case scenarios, videos, and quizzes are used to activate students' prior knowledge and stimulate their curiosity.

Phase 2: Exploration
Students explore the concepts, definitions, and information required to address the challenges. Exploration is conducted through learning materials, QR codes, digital resources, discussions, and AI. At this stage, AI functions as a supporting tool that helps students broaden their exploration rather than providing final answers.

Phase 3: Challenge
Students participate in COUNSELQUEST activities individually or in groups through explorace missions, quizzes, situational questions, problem-solving activities, and problem-based challenges. Elements such as points, challenges, and rewards are incorporated to enhance students' motivation and engagement. This phase also requires students to apply basic counselling skills, including listening, communication, and ethical decision-making (Vlachopoulos & Makri, 2017).

Phase 4: Human–AI Collaboration
Students use AI to explore alternative solutions, gain additional perspectives, and test their ideas. They then discuss the AI-generated outputs with group members and engage in a process of reviewing, presenting, comparing, evaluating, and refining the ideas or solutions generated.

Phase 5: Project Development and Problem-Solving
Based on their exploration and discussions, students develop projects related to Guidance and Counselling. Learning products may include posters, videos, simulations, educational games, or solutions to specific issues or problems. At this stage, students integrate disciplinary knowledge, human creativity, and AI support to produce outputs with practical value.

Phase 6: Reflection and Assessment
Students reflect on the learning process by evaluating what they have learned, how AI supported their learning, their motivation and learning experiences, and the impact of the experience on their personal development (Mitchell & Co, 2024). The lecturer provides feedback based on project outcomes, collaborative processes, application of concepts, creativity, and critical thinking.

Phase 7: Application and Impact
The knowledge and competencies acquired are applied to more authentic Guidance and Counselling contexts. Students connect their engagement, motivation, and COUNSELQUEST learning experiences with their future professional roles as educators (Widyasari et al., 2025). The resulting projects also have the potential to be shared or utilised as psychoeducational materials for students in schools.

The implementation of COUNSELQUEST begins with the planning of activities aligned with the course learning outcomes through the integration of gamification, game kits, digital technologies, artificial intelligence (AI), and authentic assessment. Students work in small groups to complete challenges through concept exploration, discussion, problem-solving, project development, and reflection (Suartama et al., 2024). The lecturer serves as a facilitator who guides students in using AI critically, ethically, and responsibly. The effectiveness of the innovation is evaluated through pre- and post-assessments, reflection, experience sharing, observation, student engagement, and project outcomes to assess changes in students' understanding, motivation, confidence, engagement, and application of Guidance and Counselling knowledge (Salinas-Navarro & Palma-Mendoza, 2026).

Key Findings

Based on the pre- and post-implementation descriptive analysis, COUNSELQUEST demonstrated a positive trend in students' learning experiences in the Guidance and Counselling course. All evaluated indicators showed improvement, particularly in conceptual understanding, interest, confidence, active engagement, collaboration, knowledge application, motivation, learning enjoyment, and critical thinking. These findings suggest that the integration of gamification and active learning in COUNSELQUEST has the potential to create a more interactive, meaningful, and student-centred learning experience.

Table 1: Pre-test and post test data

ITEM	COMPONENTS	PRE-TEST MEAN (SP)	POST-TEST MEAN (SP)	MEAN DIFFERENCES	SCORE 5 BEFORE	SCORE 5 AFTER
1	Understanding of Basic Guidance and Counselling Concepts	4.41	4.81	+0.39	51.7%	80.6%

ITEM	COMPONENTS	PRE-TEST MEAN (SP)	POST-TEST MEAN (SP)	MEAN DIFFERENCES	SCORE 5 BEFORE	SCORE 5 AFTER
2	Interest in Learning Guidance and Counselling Topics	4.41	4.84	+0.42	48.3%	83.9%
3	Confidence in Answering Questions Related to Course Content	4.29	4.65	+0.36	50.0%	67.7%
4	Active Engagement in Group Activities, Quizzes, and Games	4.38	4.84	+0.46	55.2%	83.9%
5	Group Collaboration	4.52	4.81	+0.29	55.2%	80.6%
6	Application of Knowledge in Real-World Situations	4.31	4.81	+0.50	48.3%	80.6%
7	Motivation through Interactive Learning	4.59	4.84	+0.25	62.1%	83.9%
8	Enjoyment in Gamification Activities	4.52	4.77	+0.26	62.1%	77.4%
9	Critical Thinking in Solving Challenges	4.41	4.81	+0.39	58.6%	80.6%
10	Gamification Helps Improve Understanding	4.48	4.77	+0.28	62.1%	80.0%

Evidence of impact showed an increase in mean scores across all indicators following the implementation of COUNSELQUEST. The most notable improvements were observed in the application of knowledge in real-world situations (4.31 to 4.81), active engagement (4.38 to 4.84), interest in learning (4.41 to 4.84), conceptual understanding (4.41 to 4.81), critical thinking (4.41 to 4.81), and motivation (4.59 to 4.84). In addition, approximately 80% or more of students awarded the highest score (5) for most indicators after implementation, indicating highly positive acceptance and learning experiences.

Impact

COUNSELQUEST demonstrates consistent improvements in students' understanding, interest, engagement, collaboration, application of knowledge, motivation, and critical thinking. The greatest improvements were recorded in the application of knowledge (+0.50) and active engagement (+0.46), while approximately 80% or more of students gave the highest score for most indicators after implementation. These findings highlight the potential of COUNSELQUEST to strengthen active, meaningful, and competency-oriented learning.

The implementation of COUNSELQUEST has a positive impact on student engagement and motivation, the development of professional competencies, AI literacy, and lecturers' pedagogical practices. Through gamification, authentic challenges, collaboration, and project development, students actively engage in exploration, problem-solving, creation, and reflection, thereby enhancing their understanding and application of Guidance and Counselling knowledge (Sigalov & Cohen, 2025). The innovation also strengthens critical thinking, communication, teamwork, creativity, empathy, and ethical decision-making. The critical and responsible use of AI enables students to evaluate and refine AI-generated outputs while maintaining human judgement and values (Elshall & Badir, 2025). From a pedagogical perspective, COUNSELQUEST transforms the lecturer's role from a content provider to a facilitator of human-centred learning, in alignment with the concept of human–AI synergy.

Recommendations for Classroom Practice

COUNSELQUEST can be further developed as a pedagogical model based on human–AI synergy that can be systematically integrated into the teaching and assessment of Guidance and Counselling. Its implementation should emphasise the use of artificial intelligence as a learning partner, while critical thinking, empathy, reflection, and ethical judgement remain human-led. Authentic assessment should be employed to evaluate not only knowledge mastery but also collaboration, problem-solving, creativity, and AI literacy (Ximmatovich, 2025). In the future, COUNSELQUEST has the potential to be expanded across other courses and disciplines and developed into a learning kit or digital platform to enhance the innovation's usability and sustainability.

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ID 23: BC-DSL Web Application: A Cloud-Based Interactive Sandbox for Human-AI Pest Management Pedagogy

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Highlights: The BioControl Decision Support Learning (BC-DSL) System is cloud-based interactive web application and digital learning sandbox engineered to bridge scientific literature and operational pest management decisions through a human-AI synergistic pedagogical framework. Addressing the complexities of dynamic biological pest control, this cross-platform web application integrates AI-assisted evidence discovery with human critical evaluation across a sequential six-module workflow, featuring an unweighted multi-criteria decision engine, dynamic microclimatic simulation models, and an Anti-AI Audit Trail. By transitioning the instructional model into an intuitive, zero-installation web interface, the system eliminates software friction while fostering interactive engagement. Empirical system evaluation (N=30) demonstrated exceptional pedagogical efficacy and user acceptance (M=4.53±0.64, scale reliability α=0.952, 93.15% positive agreement). By replacing passive learning with active digital co-reasoning, the BC-DSL web application empowers students to critically audit AI outputs, evaluate complex ecological trade-offs, and simulate multi-generational population survival against real-world weather parameters prior to field deployment.

Keywords: Human-AI Synergy; Decision Support System; Biological Control; Web-Based Learning Sandbox; Agricultural Pedagogy

Introduction

Meeting rising food demand within environmental limits requires a shift from synthetic pesticides to biological control agents (BCAs). Unlike chemical sprays, living agents operate in dynamic ecosystems where survival, predation efficiency and establishment are highly sensitive to microclimate, including temperature and relative humidity (Yusuf et al., 2025).

Meanwhile, higher education is adapting to Generative Artificial Intelligence (GenAI). GenAI can accelerate literature research, but uncritical reliance leads to superficial learning, "copy-paste" submissions, hallucinated agronomic data and weaker independent inquiry (Ruiz-Rojas et al., 2024).

To address both problems, BC-DSL was developed as an interactive web-based learning sandbox in which AI supports evidence discovery while human judgment remains central to decision-making. Learners synthesize literature, compare candidate BCAs using an unweighted multi-criteria matrix, plan field dispatch, audit their AI interactions and stress-test population survival against local weather conditions.

Objectives

- To develop a cloud-based web application that pairs AI-assisted evidence discovery with human critical evaluation in biological pest management.
- To implement an automated multi-criteria decision engine that aggregates human-verified literature metrics and reduces subjective bias in BCA selection.
- To construct an interactive simulation engine for risk-free thermal stress-testing and multi-generational population modelling before field release.
- To evaluate its efficacy in cultivating citation integrity, metacognitive AI literacy and decision-support self-efficacy.

NALI Approach

Novelty

To our knowledge, BC-DSL is the first human-AI co-reasoning sandbox for biological pest management delivered as a web application, requiring learners to validate evidence, apply multi-criteria scoring and simulate microclimatic outcomes in one environment.

Creativity
Features include an Anti-AI Audit Trail, character-validation badges, temperature sliders, real-time status flags (WINDOW OPTIMAL vs. ECO-SHOCK CRASH), population growth charts, and browser-based session persistence with single-click summary export.

Innovativeness
Mandatory prompt logs, manual verification of peer-reviewed citations and metacognitive trade-off reflections are built into the workflow before strategy confirmation, deterring uncritical "copy-paste" AI use.

Applicability
The zero-installation application runs on any desktop, tablet or smartphone browser, and scales across undergraduate courses, postgraduate projects, extension workshops and agritech training.

Innovation Description, Process and Implementation

BC-DSL transforms qualitative literature into a quantitative simulation for sustainable pest management. GenAI acts as an evidence-discovery aid, while learners screen candidate organisms, aggregate trade-offs mathematically and stress-test population survival before any physical release. The technology stack comprises:

- Web application (React, TypeScript, Tailwind CSS): responsive interface, decision algorithms (unweighted scoring, rank leaderboard, thermal threshold logic) and real-time input validation.
- Client-side data engine (Recharts, browser local storage): prevents invalid inputs, persists sessions across refreshes, renders population curves and exports case summaries.
- Interactive pedagogical workflows: guided article decoding, head-to-head candidate profiling, automated matrix scoring, field dispatch strategy building, AI prompt auditing and temperature-slider scenario testing.
- GenAI integration supports literature scoping and prompt-engineering exercises, with all parameters verified against primary journals.

Three pillars underpin the design: (1) data-integrity scaffolding using character-verification badges (15–40 characters); (2) an algorithmic decision engine using an unweighted scoring matrix to rank candidates; and (3) a microclimatic population engine using temperature sliders and exponential growth (Pop(gen n) = Pop(gen n−1) × Multiplier) to trigger survival flags and trajectory charts.

As shown in Figure 1, learners start at the Dashboard, then progress through problem decoding (Module 1), agent profiling (Module 2), multi-criteria scoring (Module 3), field dispatch planning (Module 4), AI audit logging (Module 5) and microclimatic simulation (Module 6). BC-DSL was implemented with N=30 undergraduate biosciences students at Universiti Teknologi Malaysia (UTM) under instructor facilitation. An 18-item, 5-point Likert survey (1 = Strongly Disagree to 5 = Strongly Agree) measured System Usability, Decision Engine Performance, Simulation Efficacy and Pedagogical Impact, with reliability assessed by Cronbach's alpha (Cronbach, 1951) and agreement defined as scores ≥4. Open-ended feedback was analyzed using Braun and Clarke's (2006) thematic analysis.

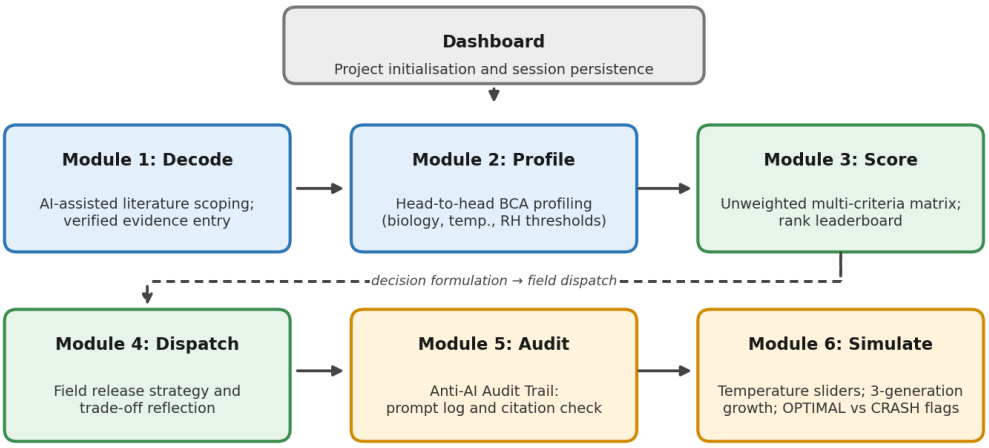


Figure 1: Implementation workflow of the BC-DSL System. Solid arrows: sequential progression; dashed connector: transition from decision formulation to field dispatch. BCA = Biological Control Agent; RH = Relative Humidity

Key Findings

The instrument showed high internal consistency (α=0.952) and a grand mean of 4.53±0.64, with 93.15% positive agreement (Table 1). Item-level results showed that the Anti-AI Audit Trail strengthened AI ethics and scholarly integrity (M=4.60, 93.3% agree), the tool prompted critical thinking about ecological versus economic trade-offs (M=4.63, 96.7%), and learners gained self-efficacy with digital decision support tools (M=4.60, 93.3%).

Table 1: Construct-Level Descriptive Statistics, Scale Reliability (α) and Key Outcome Indicators (N=30)

EVALUATION CONSTRUCT / RESEARCH PILLAR	K	MEAN (M)	SD	CRONBACH'S A	% POSITIVE SCORES (≥4)	KEY OUTCOME INDICATOR
System Usability & User Interface	5	4.43	0.70	0.851	90.70%	Sequential navigation, live character counters and real-time input validation guided user entry and prevented invalid inputs.
Multi-Criteria Decision Engine	4	4.58	0.59	0.932	95.00%	Unweighted mathematical scoring demonstrated transparent criteria aggregation and reduced personal agent-selection bias.
Microclimatic Simulation & Modeling	4	4.53	0.66	0.912	92.50%	Dynamic survival flags and 3-generation population curves enabled "what-if" risk testing against thermal stress thresholds.
Pedagogical Impact & Academic Integrity	5	4.60	0.59	0.913	94.70%	Enhanced critical evaluation of agricultural trade-offs while reinforcing responsible AI citation ethics and digital DSS self-efficacy.
Overall Evaluation Instrument	18	4.53	0.64	0.952	93.15%	High overall scale reliability (α>0.90), bridging academic theory with real-world operational planning.

Note. k = number of items; M = mean; SD = standard deviation; α = Cronbach's alpha; % Positive Scores = responses rated Agree (4) or Strongly Agree (5) on a 5-point scale.

Thematic analysis of open-ended responses (N=30) identified three domains (Table 2). Students most valued the automated decision logic in Module 3 (46.7%) and the real-time simulation flags in Module 6 (40.0%). The main usability frictions were unclear distinction between editable and auto-calculated fields (36.7%) and crowding from wide tables (26.7%). Recommendations centered on adding relative humidity, rainfall and other variables to the simulation (40.0%) and clearer color-coding and tooltips (30.0%). These points will guide the next version.

Table 2: Qualitative Thematic Analysis of Student Feedback (N=30)

DOMAIN	THEME	N (%)	REPRESENTATIVE STUDENT QUOTE (VERBATIM)
Strengths	Automated decision logic and objective selection	14 (46.7%)	"Module 3 was most impactful because it converted research into a ranking by calculating the final score." (R21)
	Real-time microclimatic simulation feedback	12 (40.0%)	"…seeing it instantly switches to 'optimal' made the link between the paper and field work click right away." (R2)
	Step-by-step guided workflow	6 (20.0%)	"The step-by-step guidelines of each module helped more in the learning process." (R8)
Usability friction	Editable vs. auto-calculated field ambiguity	11 (36.7%)	"Hard to tell which cells needed user input and which were automatically generated. More color-coding needed." (R9)
	Information density and interface crowding	8 (26.7%)	"The tables were quite wide, so its hard for me to track info without scrolling left and right." (R16)
	Manual parameter re-entry across modules	5 (16.7%)	"Module 6 temperature fields required manual entry unlike Module 2." (R19)
Recommendations	Multi-factor environmental variables	12 (40.0%)	"Expanding the simulation model to include rainfall, humidity, and UV radiation would make it way more realistic." (R24)

DOMAIN	THEME	N (%)	REPRESENTATIVE STUDENT QUOTE (VERBATIM)
	Enhanced visual formatting and tooltips	9 (30.0%)	"Adding brief instructions, pop-up tooltips, and graphical summaries would make learning more interactive." (R26)

Note. Percentages are of all respondents (N=30); a respondent could contribute to more than one theme. R = respondent number

Impact

Students develop higher-order critical thinking and digital self-efficacy by cross-examining AI outputs against primary literature and weighing ecological and economic trade-offs. Educators gain a self-regulating framework that discourages "copy-paste" submissions and supports academic integrity through transparent AI prompt logging. Institutions gain an accessible digital learning model aligned with smart agriculture and AI governance goals. In the long term, graduates skilled in microclimatic risk-testing can support evidence-based biological control and the shift away from synthetic pesticides. These findings come from a single cohort using self-reported measures without a comparison group; learning gains and field transfer should be examined in future controlled studies.

Recommendations for Classroom Practice

- AI-Assisted Evidence Scoping with Mandatory Human Verification
- Instruct students to utilize GenAI tools for initial parameter discovery, followed by mandatory verification against primary literature in Module 5 to build AI literacy and critical evaluation skills.
- Interactive Microclimatic Risk Stress-Testing
- Incorporate scenario-based exercises where students manipulate ambient temperatures in Module 6 to observe population crash triggers (ECO-SHOCK CRASH) and design climate-resilient release strategies.
- Peer Audit of AI Prompt Ledgers
- Conduct peer-review sessions focusing on Module 5 prompt logs to help students analyze prompt engineering techniques, manual structural revisions, and citation accuracy.

Other relevant information

An official copyright application for the BioControl Decision Support Learning (BC-DSL) System encompassing its interactive software architecture, simulation algorithms, and instructional framework has been filed under the Innovation and Commercialisation Centre (ICC), Universiti Teknologi Malaysia (UTM). In terms of educational curriculum integration, the platform was successfully deployed as the official Final Exam Equivalent Project (FEEP) for undergraduate students enrolled in the course SSCY 3263 Biological Control and Bioconservation, offered by the Department of Biosciences, Faculty of Science, Universiti Teknologi Malaysia. This initiative replaced traditional written final examinations with an interactive, problem-based alternative assessment model. Furthermore, because the system operates within accessible spreadsheet software, it exhibits strong commercialization potential and high scalability for adoption by commercial pest control operators, agricultural extension services, and agritech training providers, offering an adaptable digital sandbox for lifelong learning in climate-resilient crop protection.

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ID 24: Research Proposal Interactive System–Guided Proposal System (RPIS-GPS) Integrating Human–AI Hybrid Intelligence for Responsible Proposal Development

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Highlights: Formulating biosciences research proposals induces cognitive overload and AI vulnerability due to unverified GenAI outputs. The Research Proposal Interactive System – Guided Proposal System (RPIS-GPS) addresses this via a dual-tier framework combining an Excel scaffolding workbook with an interactive web portal. The system dynamically parses data, executes real-time logic gates, renders process flowcharts, and manages a human-in-the-loop AI audit workbench. Evaluated across N=52 students (Cronbach's α=0.977), 92.3% preferred RPIS-GPS over traditional text editors. The innovation establishes human–AI hybrid intelligence, transforming passive AI usage into responsible, literature-audited research proposal development.

Keywords: Research Design Ecosystem; Human-AI Hybrid Intelligence; Methodological Logic; Web-Based Scaffolding; Automated Proposal Synthesis

Introduction

Formulating a scientifically rigorous research proposal is a major cognitive hurdle for undergraduate and postgraduate students because of high working-memory demands and complex information synthesis (Lin et al., 2023). Researchers must connect broad literature gaps to specific objectives, experimental variables, and analytical protocols (Kheira & Saida, 2024). Novice researchers frequently produce disconnected proposals with unmeasurable action verbs, mismatched methodologies, and poorly defined controls. This vulnerability is amplified by the rapid uptake of GenAI, where over-reliance on unverified outputs leads to hallucinated claims, non-existent references, and flawed variable pairings (Cotton et al., 2023; Shopovski, 2026).

RPIS-GPS was developed as an interactive digital supervisor and cognitive scaffolding framework that operationalizes Human–AI Hybrid Intelligence. It combines a structured offline Excel workbook with a web portal featuring logic validation gates, SheetJS label matching, an automated flowchart canvas, and a HITL GenAI audit workbench. This paper presents the system architecture, implementation, and learning impact across N=52 biosciences students.

Objectives

- To design a dual-tier scaffolding framework integrating an Excel input workbook with a web portal that enforces alignment between literature gaps, objectives, and biosciences methodologies.
- To automate flowchart generation and logic validation through real-time alignment gates that eliminate disconnected planning.
- To establish a HITL GenAI audit metric that trains students to identify and correct fabricated data, hallucinated citations, and illogical variable pairings using primary-literature DOIs.
- To evaluate the pedagogical effectiveness, scale reliability, and user experience of RPIS-GPS among STEM students.

NALI Approach

Novelty

RPIS-GPS introduces a Hybrid Spreadsheet-to-Web Pipeline. Students plan in a standardized offline Excel workbook, then upload it to the web application, where flexible SheetJS label-matching extracts their data regardless of row shifts or parenthetical descriptors (e.g., Specific Objective 1 (Isolate/Quantify)) and renders a live, interactive workspace that replaces static text editors.

Creativity
The system offers visual progress tracking (0%–100%), an Alignment Score Tier Diagnostic (<60% Revision Needed; 60–79% Moderate Alignment; >80% Exemplary Alignment), and an engine that converts typed bench protocols into portrait flowcharts with execution timelines (6–8 weeks) and biosafety badges (BSL-1).

Innovativeness
RPIS-GPS turns GenAI from a passive "shortcut writer" into an audited "collaborative peer". In Module 6, AI acts as a reviewer rather than a content writer: students evaluate AI-generated critiques, defend their scientific logic, and verify references against primary-literature DOIs.

Applicability
The modular, scalable architecture runs natively in standard browsers with no login, bypasses operating-system macro blocks, and avoids institutional cloud costs. Students enter profile details on the web header, and the system compiles a multi-page academic PDF for supervisor review and oral defence.

Innovation Description, Process and Implementation

RPIS-GPS guides STEM students step by step through developing methodologically aligned proposals. Students first enter research parameters in an Excel template with a Three-Column Architecture: Column A holds locked framework parameters and Bloom's taxonomy rubrics; Column B is the active user workspace; and Column C provides real-time guidance prompts and verification codes. Students then upload the workbook to the portal, where a dynamic SheetJS parser renders a six-module workspace. A client-side engine finally assembles a publication-ready 8-section PDF report with an Alignment Score Diagnostic (Figure 1).

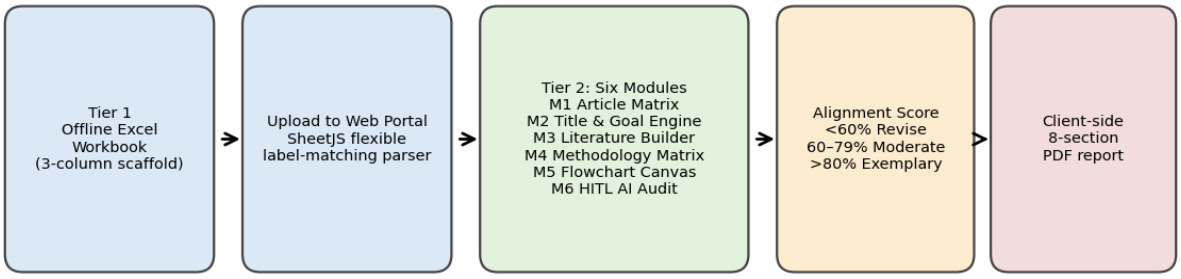


Figure 1: System Architecture and Operational Pipeline of the RPIS-GPS Platform.

Tiers: <60% = Needs Alignment Revision; 60–79% = Moderate Alignment; >80% = Exemplary Alignment. HITL = Human-in-the-Loop; DOI = Digital Object Identifier.

The teaching and learning activities progress through six modules:

- Module 1 (Journal Article Analysis Matrix): extracts metadata from primary literature, isolating independent (IV), dependent (DV), and controlled (CV) variables and mapping research gaps.
- Module 2 (Strategic Title & Goal Engine): real-time alerts enforce alignment between title, aim, and three sequential objectives with measurable verbs.
- Module 3 (Logical Literature Builder): a literature funnel (Macro Problem → Variable X → Variable Y → Foundational Gap) guides the rationale and hypotheses.
- Module 4 (Methodology Alignment Matrix): objectives are locked to laboratory techniques, controls, replicate sample sizes (n), and statistical models such as One-Way ANOVA.
- Module 5 (Visual Flowchart Canvas): typed protocols become vertical flowcharts with timelines and BSL-1 badges.
- Module 6 (Critical HITL AI Audit): students paste raw GenAI drafts, evaluate critique cards, record scientific defenses, and verify citations against DOIs.

RPIS-GPS was implemented with N=52 undergraduate biosciences students in the Final Exam Equivalent Project (FEEP) research methodology curriculum, Department of Biosciences, Universiti Teknologi Malaysia (UTM), over 4 to 6 weeks: Modules 1–3 during literature scoping and Modules 4–6 during methodology design and AI auditing. A convergent mixed-methods approach was used. A 28-item, 5-point Likert questionnaire (1=Strongly Disagree to 5=Strongly Agree) measured reliability (Cronbach's α), mean (M), and dispersion (SD), and open-ended reflections were analysed by inductive thematic coding.

Key Findings

The 28-item instrument showed exceptional reliability (Cronbach's α=0.977), with every sub-construct exceeding the α≥0.80 threshold (Table 1). The overall mean was M=4.20 (SD=0.76), with 83.2% aggregate positive agreement. By replacing static documents with an interactive pipeline, 92.3% of students (Q19, M=4.31, SD=0.67) rated the tool a far better learning environment than traditional Word documents, and 88.5% (Q26, M=4.33, SD=0.73) said it deepened their grasp of research logic and methodological continuity. Notably, 86.5% (Q20, M=4.17, SD=0.71) shifted from passively copy-pasting GenAI outputs to critically auditing raw AI drafts.

At construct level, the strongest indicators were live progress tracking (Q2: M=4.37, 84.6% agree), precise isolation of IV, DV, and CV (Q5: M=4.35, 90.4%), formula alerts that heightened attention to measurable action verbs (Q8: M=4.35, 92.3%), a shift from summarizing papers to mapping explicit gaps (Q9: M=4.29, 88.5%), and removal of redundant or out-of-scope experimental steps (Q12: M=4.35, 86.5%). Module 5 scored lowest but still favorably (M=4.15, 77.9% positive), as visual staging improved understanding of timelines and workflow (Q13: M=4.25, 78.8%). Module 6 changed behavior away from blind copy-pasting of GenAI drafts (Q17: M=4.21, 82.7%).

Inductive thematic analysis of open-ended responses (N=52) reinforced these results. When asked about core value drivers (Q32), students highlighted automated logic and alignment gates (38.5%), which act as a digital supervisor by flagging disconnects between title, aim, and objectives; the live progress dashboard (26.9%), which motivates milestone completion; structured variable screening matrices (23.1%), which ground literature analysis in laboratory practice; and auto-population with hyperlink navigation (11.5%). For enhancement targets (Q33, N=51), students requested an automated reference verification engine (35.3%), streamlined local macro deployment (21.6%, reflecting Excel VBA security blocks), an intelligent statistical model selector (17.6%), embedded video tutorials (15.7%), and minor layout changes (9.8%). Affective reflections (Q34) showed that the Three-Column Framework reduced planning anxiety (32.7%), alongside general appreciation (25.0%) and notes on group file-sharing and macro execution (15.4%). Overall, RPIS-GPS shifted student interaction with GenAI from passive copy-pasting to active auditing, while linking proposal design to bench practice.

Table 1: Construct-Level Descriptive Statistics and Reliability (N=52)

CONSTRUCT	K	M	SD	A	% POS.
Onboarding & Navigation	4	4.27	0.77	0.876	84.1
Mod 1: Article Analysis Matrix	2	4.31	0.73	0.830	86.5
Mod 2: Title & Objectives Engine	2	4.29	0.66	0.856	90.4
Mod 3: Literature Review Builder	2	4.25	0.65	0.874	88.5
Mod 4: Methodology Alignment	2	4.29	0.66	0.826	88.5
Mod 5: Visual Flowchart Canvas	2	4.15	0.81	0.843	77.9
Mod 6: Critical AI Critique Engine	4	4.18	0.75	0.919	82.2
System Impact & UX Outcomes	10	4.12	0.85	0.958	81.3
Overall Instrument Total	28	4.20	0.76	0.977	83.2

Note. k = items; M = mean; SD = standard deviation; α = Cronbach's alpha; % Pos. = percentage scoring 4–5

Impact

For students, RPIS-GPS breaks intimidating proposal writing into manageable tasks, reducing cognitive load, building AI-auditing literacy, and generating publication-ready PDF proposals for oral defence. For educators, it reduces supervisory grading overhead by pre-screening structural errors and provides an academic integrity checkpoint against AI plagiarism, hallucinated claims, and fabricated references. For institutions, it is a scalable, turnkey digital scaffold that raises proposal quality, enforces ethical AI guidelines, and strengthens research methodology training across disciplines.

Recommendations for Classroom Practice

Educators should integrate RPIS-GPS over a 4- to 6-week scaffolded curriculum, executing Modules 1–3 (literature scoping and objective alignment) in Phase 1, and Modules 4–6 (methodology design and AI auditing) in Phase 2. Module 6 should be incorporated into peer-review workshops where students cross-audit AI critiques against primary literature DOIs to cultivate responsible AI literacy. To support cross-disciplinary adoption, coordinators can easily customize Column A parameters within the Excel template to suit other STEM disciplines including molecular biology, environmental science, and agricultural biotechnology, or academic levels ranging from undergraduate capstones to postgraduate thesis

design. Operating entirely in-browser without cloud server fees, RPIS-GPS ensures zero-friction deployment and long-term institutional sustainability.

Other relevant information

The RPIS-GPS ecosystem (Version 2026.1) has a formal copyright application currently in process via the Innovation and Commercialisation Centre, Universiti Teknologi Malaysia (ICC UTM) and is actively deployed in UTM's Department of Biosciences for Final Exam Equivalent Project (FEEP) research methodology students. Featuring a zero-friction web application architecture, the portal dynamically parses offline Excel workbooks and compiles PDF reports entirely in-browser-bypassing local OS macro blocks while eliminating cloud server infrastructure and subscription costs. With its domain-agnostic design, RPIS-GPS demonstrates high commercialization potential through institutional site licensing and ethical AI-auditing workshops, offering a turnkey, scalable digital scaffold across diverse STEM disciplines.

Acknowledgement

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ID 27: QDBS PBD: An Integrated Student Evidence and Assessment Workflow Via QR Dynamic Binding System

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Highlights: QDBS PBD addresses challenges in organising authentic evidence and improving parental transparency in Pentaksiran Bilik Darjah. The innovation utilizes QR codes to connect students' physical learning materials with related video or audio evidence stored in a secure cloud repository. A Phase 1 Proof of Concept was successfully implemented across three primary schools, involving nine teachers and more than 150 pupils. Operational observations indicated a targeted estimate of a 70% reduction in selected file-handling steps, without representing a measured reduction in overall workload. Parental transparency was achieved through undisputed evidence access.

Keywords: Pentaksiran Bilik Darjah; QR Dynamic Binding System; Learning Evidence Management; Parental Transparency; Educational Innovation

Introduction

Pentaksiran Bilik Darjah (PBD) requires teachers to make professional judgements about students' learning progress based on authentic evidence collected during learning activities. However, because this evidence is often stored separately in physical folders, personal devices, books, or informal records, retrieval becomes difficult and parents' understanding of how a student's Tahap Penguasaan (TP) is determined remains limited. In practice, manual processes such as recording video evidence, organising files, copying links, and communicating with parents are repetitive and time-consuming, often leaving parents with a final TP score without direct visibility of the supporting evidence. To address this, the QR Dynamic Binding System (QDBS PBD) was developed as a practical, cohesive evidence-access workflow that establishes a direct link between a student's physical learning material and their related digital evidence via a static QR code. By scanning the attached QR code, parents can instantly stream the corresponding video or audio records through a designated digital repository, providing a systematic digital workflow designed to support teachers' professional judgement, organise records, enhance parental transparency, and plan targeted follow-up learning activities.

Objectives

The objectives of QDBS PBD are to:

- Develop a QR-based workflow that connects students' physical learning materials with related digital learning evidence.
- Improve the organisation, retrieval and traceability of video and audio evidence used to support PBD.
- Enable parents to access authentic learning evidence and better understand their children's learning progress and TP.
- Evaluate the feasibility of the QDBS PBD Phase 1 Proof of Concept in a real school environment.
- Establish a foundation for future automation, offline synchronisation, improved metadata management and scalable implementation

NALI Approach

Novelty

QDBS PBD is distinctive because it uses the student's physical learning material as a direct access point to related digital learning evidence. Unlike a general QR code that links to a static webpage or common folder, the QDBS PBD workflow connects a specific learning material with its corresponding video or audio evidence. The innovation creates a link between physical classroom activity, digital evidence, assessment context and parental access. This changes the QR code from a simple information link into an evidence-binding mechanism for PBD.

The innovation is associated with a patent application filed with MyIPO under PI2026004819 and a copyright registration under CRLY2026E05022.

Creativity
The creativity of QDBS PBD lies in its reverse evidence-access workflow, which blends familiar classroom materials with a simple digital access method. Instead of requiring parents to navigate multiple platforms, it utilizes a generated QR code attached directly to the student's physical book as a centralized point to view related evidence. This approach allows the innovation to be deployed and tested in real classrooms using existing devices and cloud-based tools without needing a fully developed application from the start.

Innovativeness
QDBS PBD innovates the current evidence-management process by explicitly connecting learning evidence to the correct student, learning material, and assessment context, thereby reducing teachers' reliance on scattered files and retrospective recall. While future versions plan to further optimize the workflow through automated binding, structured metadata, offline synchronisation, and an auto-purge feature, the upcoming prototype also proposes user-specific authentication and differentiated access permissions.

Applicability
QDBS PBD can be adapted to different subjects, year groups, learning activities and evidence formats. It can support video, audio, photographic and scanned evidence, depending on the learning objective and the teacher's professional judgement. The workflow can be replicated by other teachers using standardised procedures for QR preparation, evidence organisation, parental consent and access management. The Phase 1 Proof of Concept demonstrates that the innovation can operate across three primary schools in Batu Pahat, Johor, involving more than 150 pupils from different year groups and multiple subjects. For long-term scalability, QDBS PBD may be developed into a structured platform with automated backend management, offline synchronisation and improved data governance.

Innovation Description, Process and Implementation

QDBS PBD is a QR-based evidence workflow deployed across three primary schools in Batu Pahat, Johor, involving nine teachers and over 150 pupils to streamline classroom records, eliminate manual file-handling, and strengthen data governance through three continuous phases. First, Dynamic Binding allows teachers to scan a pre-printed QR code on a student's physical book to automatically access a secure repository, record multimedia evidence, and save it under a standardized naming convention. Second, Asynchronous Synchronisation utilizes an offline-first architecture to cache media locally in zero-internet school environments, automatically uploading them to the secure KPM DELIMa cloud storage once a stable connection is detected, followed by a secure auto-purge on the device. Third, Parental Retrieval enables parents to scan the same physical QR code at home, triggering a patented secure URL redirection system that lets them directly view and validate their child's authentic learning evidence alongside their assigned TP level, ensuring immediate school-home transparency.

Key Findings

The Phase 1 Proof of Concept of QDBS PBD was successfully deployed and evaluated across three primary schools in Batu Pahat, Johor, involving nine field-tester teachers and more than 150 active pupils across multiple year groups and subjects. Preliminary data collection, which currently captures 30 documented parental responses alongside ongoing field feedback, demonstrates that the QR-based workflow effectively improves the systematic organization, quick retrieval, and long-term traceability of qualitative video and audio learning evidence used to support classroom assessment. Targeted operational observations indicated a workflow estimate of a 70% reduction in selected administrative file-handling and manual renaming steps during live classroom deployment; however, it is heavily emphasized that this estimate is based strictly on focused workflow data and does not represent a formally measured reduction in teachers' overall daily workload.

Impact

QDBS PBD provides direct, sustainable benefits to multiple educational stakeholders by successfully bridging physical learning activities with secure digital cloud validation. For students, the innovation creates a visible, explicit connection between physical tasks and the multimedia evidence used to evaluate progress, encouraging greater learning ownership and enabling focused support when specific areas for improvement are identified. For teachers, it supports the structured organization and retrieval of

qualitative evidence across diverse subjects, providing a rigorous workflow that binds evidence to a particular student and assessment context while fully retaining the teacher's professional judgement without automated scoring. Furthermore, for parents, the system offers a transparent, low-friction approach to access authentic video or audio clips of their child's achievements through a simple QR-scan, strengthening school-home communication. At the school level, the workflow improves organizational traceability of assessment documentation, establishing a reliable foundation for future scalable integration and automated data governance.

Recommendations for Classroom Practice

To effectively implement QDBS PBD, teachers should start with a small number of activities before expanding, ensuring all recorded evidence is short, objective-relevant, and stored in secured rather than open links.

It is essential to maintain consistent naming conventions, preview QR codes before distribution, and retain professional judgement when determining students' performance levels. Furthermore, teachers must obtain written parental consent before sharing student data, offer alternative access for those with poor connectivity, and regularly refine the workflow to eliminate redundant manual steps while adapting the evidence type to suit the pupils' age group.

Other relevant information

The QDBS PBD Phase 1 Proof of Concept was initiated on 19 July 2026. Future Phase 2 development proposes adding automated evidence binding, offline synchronization, and improved metadata management, alongside a secure "Auto-Purge" feature to prevent the prolonged storage of media files on teachers' mobile devices.

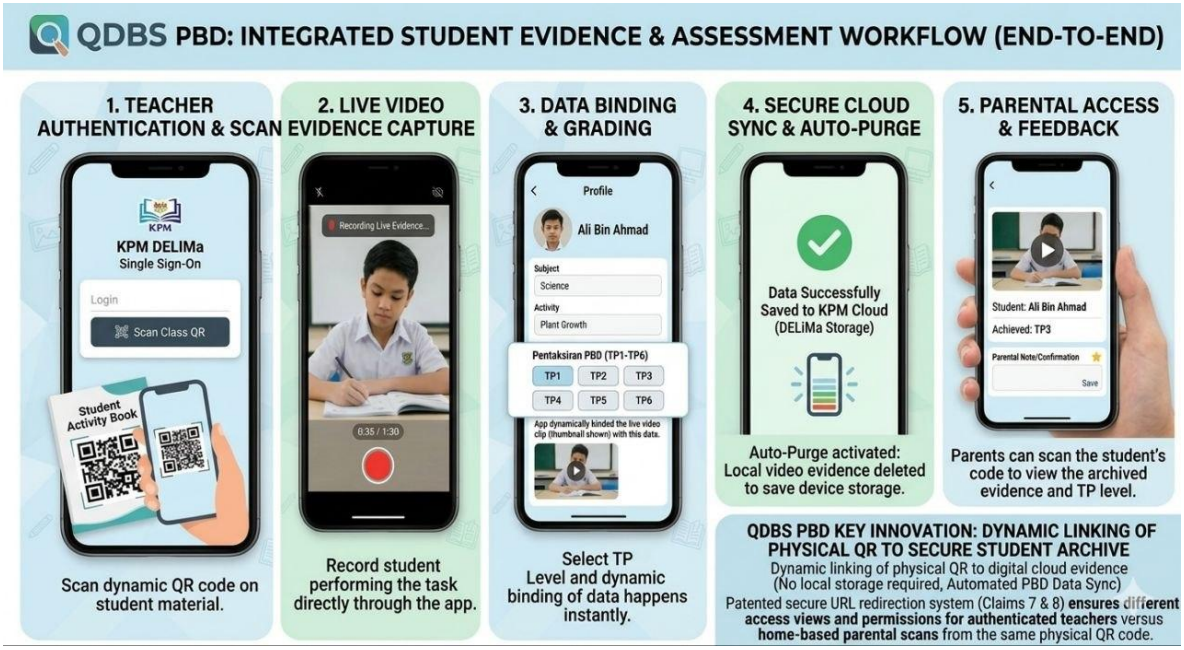


Figure 1: Proposed QDBS PBD Phase 2 workflow with automated binding and controlled access

Written parental consent was secured prior to implementation to meet data protection requirements. The innovation is strategically positioned for potential Cradle Fund CIP Spark funding to support its commercial prototype and may explore future integration with existing educational platforms, subject to official technical, security, data-protection, and institutional approvals.

Acknowledgement

The authors would like to express their highest gratitude to the Headmasters of SK Montfort, SK Bagan, and SK Tengku Mariam for their administrative endorsement and visionary leadership. The authors also acknowledge the pupils, parents, and teachers who participated in the Phase 1 Proof of Concept. Their participation and feedback supported the initial implementation and refinement of the QDBS PBD

workflow. The authors express deepest appreciation to the full deployment team of nine teachers across the school clusters for their invaluable on-site data collection support.

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ID 29: REACH Reflect+: A Structured Framework for Global Experiential Learning

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Highlights: International mobility programs often generate valuable learning experiences, yet these are frequently documented only as administrative reports with limited pedagogical value. REACH Reflect+ was developed to transform authentic student experiences from the REACH-Vietnam 2025 programme into a structured, AI-assisted reflective learning resource published as an ISBN e-Travelogue. By combining experiential learning, reflective writing, visual storytelling, generative AI-assisted content refinement, and human validation, the framework converts mobility experiences into reusable educational resources. The innovation promotes sustainable learning, intercultural competence, and knowledge sharing while exemplifying Human-AI Synergy in pedagogy.

Keywords: International mobility; Reflective learning; Human-AI synergy; Experiential learning; Digital storytelling

Introduction

International mobility programs have become an important component of higher education, providing students with authentic opportunities to develop intercultural competence, leadership, communication skills, and global citizenship. Despite these benefits, learning gained from mobility programs often remains undocumented beyond administrative reports, photo galleries, or institutional news, resulting in valuable experiential knowledge being lost once the program concludes. REACH-Vietnam 2025 was designed as a student mobility and community engagement initiative involving academic exchange, STEM outreach, youth leadership dialogue, and cultural exchange between Universiti Teknologi Malaysia (UTM), the University of Social Sciences and Humanities (USSH), Ho Chi Minh City University of Technology (HCMUT), and Bac Son Secondary High School. To address this limitation, REACH Reflect+ was developed as an AI-assisted reflective publishing framework that transforms authentic mobility experiences into a structured ISBN learning resource through the integration of reflective learning, visual documentation, digital storytelling, generative AI-assisted language refinement, and expert human validation.

Objectives

- To transform authentic international mobility experiences into structured reflective learning resources.
- To integrate generative AI in organising, refining, and curating reflective narratives while maintaining human validation throughout the publishing process.
- To produce an ISBN digital learning resource that supports sustainable intercultural learning beyond programme completion.
- To develop a replicable reflective publishing framework that can be adapted for international mobility, service learning, and student exchange programs.

NALI Approach

Novelty

International mobility programs normally conclude with activity reports that primarily serve administrative purposes. REACH Reflect+ introduces a reflective publishing framework that systematically transforms authentic student experiences into a structured pedagogical resource. Rather than documenting "what happened," the framework captures "what was learned," ensuring that experiential knowledge remains accessible for future learners.

Creativity

The framework creatively integrates experiential learning, reflective writing, visual documentary, digital storytelling, AI-assisted language enhancement, human editorial validation into a single learning product.

Innovativeness

Innovation is found in the specific "Human-AI Synergy" where AI acts as a pedagogical partner rather than a replacement. AI provides the necessary content scaffolding—organizing raw thoughts and

refining language—which lowers the barrier to entry for reflective writing. This synergy allows students to focus on the high-level cognitive work of reflection while AI handles the structural editorial development.

Applicability

The REACH Reflect+ framework is highly scalable and relevant to the New Academia Learning Innovation (NALI) model. It is designed for immediate adaptation in ASEAN student exchanges, international internships, and university outreach programs. Its structure allows any department to convert student participation into formal, published knowledge assets.

Innovation Description, Process and Implementation

The innovation is anchored by the REACH Model, a five-stage pedagogical workflow designed to ensure academic integrity and reflective depth:

- **R – Reflect**: Deep cognitive engagement with intercultural encounters.
- **E – Experience**: Participation in authentic mobility activities.
- **A – AI-assisted Authoring**: Utilizing generative AI for editorial scaffolding and refinement.
- **C – Curated Knowledge**: Selecting and organizing the most impactful evidence.
- **H – Human Validation**: Expert oversight to ensure cultural accuracy and "human" sentiment.

This process is visualized in Figure 1, illustrating the transition from raw experience to a sustainable learning resource.

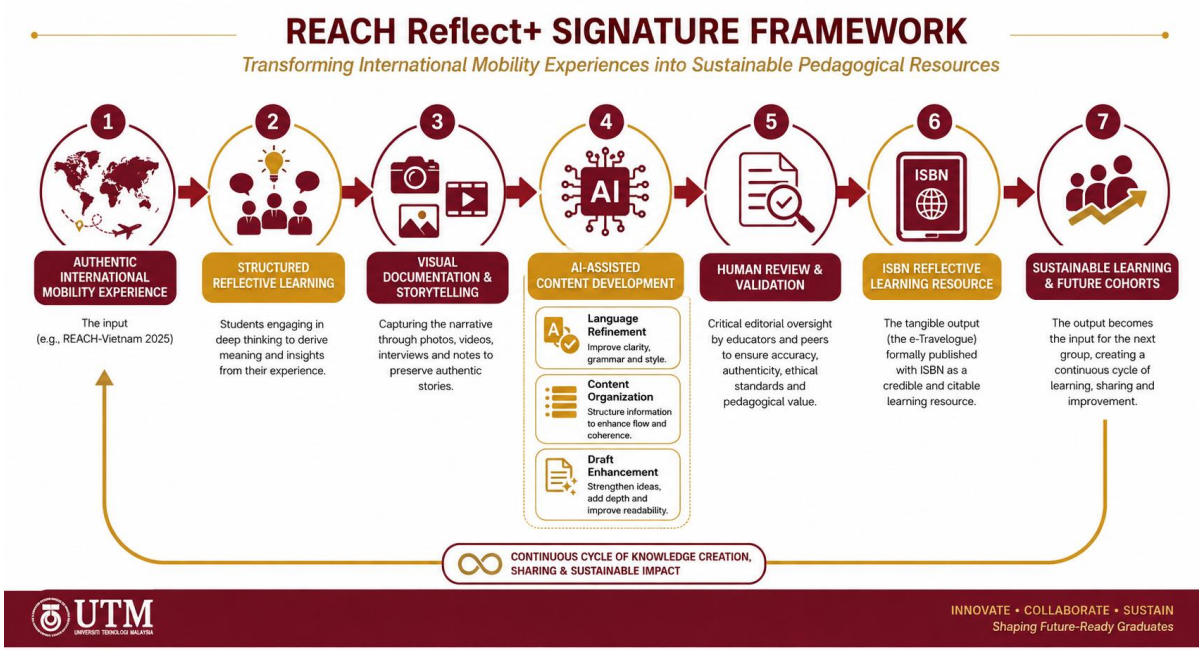


Figure 1: The REACH Reflect+ Signature Framework

Implementation Workflow

The implementation utilized the REACH-Vietnam 2025 program as a pilot. Activities included Youth Leadership Dialogues at USSH, STEM outreach at Bac Son Secondary High School, Alumni Engagement sessions, and Cultural Exchange programs at HCMUT. As participants engaged in these activities, they maintained reflective journals and documented their journey visually. These raw materials were then processed via the AI-assisted authoring phase, where tools provided thematic organization and language refinement. The final phase involved expert human editors validating the AI suggestions to produce the ISBN-registered e-Travelogue, ensuring the final product maintained the authentic student voice while achieving professional publication standards.

The section presents the innovation by outlining its overall concept, intended functioning, and implementation approach. It describes what the innovation is and how it works, including the relevant tools, technologies, and learning activities involved. It also integrates the design and development process, implementation steps, participants involved, teaching and learning flow, and evaluation

methods used to assess effectiveness. Where appropriate, a framework, workflow, process model, or implementation diagram may be included to clearly illustrate the implementation process.

Key Findings

The implementation of REACH Reflect+ demonstrated clear evidence of success:

- **Codified Learning Outputs**: The framework successfully generated structured reflective narratives and digital storytelling products that serve as high-quality documentation of the ASEAN community experience.
- **ISBN-Registered Resource**: The primary qualitative outcome was the shift from administrative reporting to the production of a sustainable, ISBN-registered publication, elevating student work to a formal academic level.
- **Evidence of Student Development**: Reflections captured specific growth in leadership, intercultural cooperation, and the complexities of international STEM outreach.
- **Operational Efficiency**: The AI-driven workflow significantly accelerated the editorial process, allowing for the rapid transformation of raw notes into a polished publication.

Impact

Students experience a marked enhancement in intercultural competence and leadership skills. Critically, the innovation provides them with an "Enhanced Academic Profile" through a professional ISBN citation, offering tangible evidence of global citizenship. While educators gain access to a library of reusable teaching materials and a proven reflective pedagogical model. The resulting e-Travelogue acts as a "living case study" for future classroom discussions on regional harmony and community engagement. REACH Reflect+ transforms student activities into Strategic Institutional Assets. By producing AI-supported educational publications with ISBN registration, the institution enhances its international branding and demonstrates leadership in sustainable pedagogical innovation.

Recommendations for Classroom Practice

To integrate REACH Reflect+ effectively, educators should use the ISBN e-Travelogue as a pre-departure resource, enabling future cohorts to learn from previous students' experiences and reflections. Faculties can also adopt a digital toolkit containing AI prompts, reflection templates, and editorial guidelines to support replication across disciplines. Importantly, AI-assisted content must remain subject to human validation to ensure accuracy, cultural sensitivity, authenticity, and preservation of students' original reflections. This approach transforms mobility experiences into a sustainable cycle of reflective and intergenerational learning

Other relevant information

The REACH Reflect+ framework is a proven innovation, validated by the successful publication of the **REACH-Vietnam 2025 e-Travelogue (ISBN Registered)**. This provides tangible evidence of implementation as required by the NALI 2026 criteria. Furthermore, the framework offers significant potential for institutional commercialization through the development of a "Reflective Publishing Digital Toolkit" for global university partners.

Table 1: Comparison of Human and AI Roles in the REACH Reflect+ Framework

DEVELOPMENT PHASE	HUMAN ROLE (SOUL & CONTEXT)	AI ROLE (STRUCTURE & SPEED)
EXPERIENCING	Lived experience and cultural immersion	(Not applicable)
DRAFTING	Reflective writing and photo selection	Organizing raw narratives and improving readability
REFINEMENT	Factual verification and cultural nuances	Suggesting professional wording and grammar checks
CURATING	Thematic decision-making and editorial focus	Structuring content and thematic organization
PUBLISHING	Final validation and ISBN registration	Accelerating the overall drafting and editorial timeline

Acknowledgement

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ID 30: Challenge-Based Experiential Artificial Intelligence Literacy with Peer Teaching to Develop Student Deepfake Detection Skills

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Highlights: Challenge-Based Experiential Artificial Intelligence Literacy with Peer Teaching (CBEAL-PT) is designed to develop students' deepfake detection skills by exploring strategies for navigating and evaluating Artificial Intelligence (AI)-generated content in the digital age. This innovation uses a Challenge-Based approach where students explore and detect deepfakes using available AI tools. Through Experiential Learning, students actively create and analyze deepfakes, followed by Peer Teaching via a student-led symposium. The approach shifts students from passive receivers to investigators and educators. Key outcomes include improved critical thinking and AI literacy. CBEAL-PT is novel in combining challenge, experience, AI literacy, and peer teaching in one authentic activity aligned with Human-AI Synergy in Pedagogy.

Keywords: Challenge-Based Learning; Experiential Learning; AI Literacy; Peer Teaching; Deepfake Detection

Introduction

The rapid advancement of Artificial Intelligence (AI) is transforming how digital content is created, shared, and consumed across education, business, and society. Stanford HAI (2026) highlights the unprecedented pace of AI development and adoption, while the World Bank (2026) emphasizes its potential to amplify human capabilities and create new opportunities for learning, work, and development. However, alongside these opportunities, AI has also accelerated the emergence of deepfakes and AI-generated misinformation, raising concerns about information authenticity, digital trust, and ethical technology use. The Information Technology in Business course is designed as an elective course to equip all university students with IT knowledge and skills for current IT trends and issues. Within the IT in Business course, students from diverse academic backgrounds are exposed to topics related to misinformation, digital ethics, and responsible AI practices. However, conventional teaching approaches often emphasize theoretical knowledge rather than providing students with authentic opportunities to learn through experience and reflection (Kolb, 2015). As a result, students may have limited opportunities to develop the practical competencies needed to critically assess and make informed judgements about AI-generated content.

To address this challenge, a Human-AI Synergy pedagogical framework known as Challenge-Based Experiential AI Literacy with Peer Teaching (CBEAL-PT) was developed. The framework engages students in authentic learning experiences that require them to interact with AI technologies to generate, analyses, verify, and critically evaluate digital content. By positioning AI as a learning partner rather than a replacement for human intelligence, the innovation fosters responsible AI engagement while strengthening critical thinking, ethical reasoning, and human judgement. Through the integration of Challenge-Based Learning, Experiential Learning, AI Literacy Education, and Peer Teaching, students become both learners and educators, creating sustainable learning resources that support future cohorts and promote responsible AI literacy.

Objectives

- To demonstrate the Challenge-Based Experiential Artificial Intelligence Literacy with Peer Teaching (CBEAL-PT) approach as a Human-AI Synergy pedagogical framework.
- To enable students to explore, apply, and evaluate available AI tools for deepfake generation and detection through a real-world challenge.
- To develop students' AI literacy by fostering critical thinking, ethical awareness, and responsible AI use through experiential learning activities.

NALI Approach

Novelty

The novelty of CBEAL-PT lies in its integration of four pillars that are rarely combined within a single AI literacy pedagogical framework. First, Challenge-Based Learning presents students with an authentic,

open-ended challenge: "Explore, generate, and detect deepfakes using available AI tools." There is no single "correct" path, so teams must identify tools, test them, evaluate their limitations, and propose detection strategies, thereby fostering problem-solving and self-directed learning. Second, Experiential Learning ensures students learn by doing through creating and analysing deepfakes, documenting artifacts and errors, and reflecting on factors that make detection difficult. Third, AI Literacy Education shifts the focus from coding or developing AI systems to the critical use and evaluation of AI, including understanding how AI works, assessing tool reliability, recognising risks, and applying AI ethically to develop responsible digital citizens. Fourth, Peer Teaching transforms learning into a collaborative and public experience through a student-led symposium where teams present their processes, challenges, and detection strategies. Peers question, compare, and co-create a shared Detection Guide, which reinforces knowledge retention and communication skills. Collectively, these four pillars promote Human-AI Synergy by encouraging students to engage directly with AI tools while exercising human judgement, critical thinking, and ethical reasoning. This transforms the traditional "avoid AI" mindset into "understand AI through responsible engagement with AI," making CBEAL-PT a distinctive approach to developing AI literacy competencies.

Creativity

The creativity of CBEAL-PT stems from the innovative integration of four complementary pillars into a single learning cycle. The Challenge-Based Learning pillar provides an authentic problem with no single answer, encouraging students to explore multiple solutions and perspectives. The Experiential Learning pillar transforms the challenge into hands-on experiences involving the creation and detection of deepfakes, supported by reflective documentation of artifacts, errors, and ethical dilemmas. The AI Literacy Education pillar ensures that learning extends beyond technical skills to encompass critical evaluation, responsible AI use, and informed decision-making. Finally, the Peer Teaching pillar transforms individual learning into a collaborative and public experience through a student-led symposium where students share their findings, experiences, and detection strategies. By combining these pillars, CBEAL-PT creates a Human-AI Synergy learning environment in which students actively engage with AI technologies while applying human judgement, critical thinking, and ethical reasoning throughout the learning process.

Innovativeness

CBEAL-PT introduces an innovative pedagogical approach by positioning AI as a tool for learning rather than merely a topic for discussion. Unlike conventional AI literacy initiatives that often stop at lectures, discussions, or awareness campaigns, CBEAL-PT enables students to engage directly with AI technologies and critically evaluate their outputs through structured inquiry and reflection. The framework is innovative because it sequences four complementary pillars to generate two outcomes simultaneously: enhanced student competencies and a sustainable learning resource. Challenge-Based Learning initiates inquiry, Experiential Learning develops practical skills, AI Literacy Education strengthens critical judgement and responsible AI use, and Peer Teaching extends learning beyond the individual through knowledge sharing and collaboration. The innovation therefore goes beyond student learning by creating a sustainable, student-driven model for AI literacy that can be replicated across courses and adapted to different educational contexts. This ensures that learning is scalable, transferable, and sustainable beyond a single classroom implementation.

Applicability

CBEAL-PT is a Human-AI Synergy and service-learning innovation developed to promote AI literacy and the responsible use of AI. The innovation integrates Challenge-Based Learning, Experiential Learning, AI Literacy Education, and Peer Teaching within a structured seven-step learning process that combines classroom instruction, learning experiences, and knowledge sharing (see Figure 1). In Step 1, students are introduced to deepfakes, misinformation, and the importance of responsible AI use. The project objectives, assessment criteria, and expected deliverables are also explained. In Step 2, students explore deepfake concepts while evaluating freely available AI tools and online verification techniques for detecting manipulated images, videos, and AI-generated content. This stage encourages students to engage directly with AI technologies while developing critical evaluation skills. In Step 3, each group designs an informative A3 poster in English that presents AI detection tools, verification guidelines, and key messages related to responsible AI use. Prior to the public demonstration, students prepare their exhibition booths and rehearse live demonstrations using AI detection tools and practical verification techniques. In Step 4, students refine their materials and presentation strategies to ensure effective communication and audience engagement. In Step 5, groups showcase their posters and conduct interactive demonstrations at designated stations, educating visitors on identifying deepfakes, misinformation, and AI misuse. This stage operationalizes the Peer Teaching component of the framework by transforming students from learners into educators and advocates of responsible AI practices. In Step 6, two judges evaluate each group's performance based on technical accuracy, creativity,

communication skills, audience engagement, and presentation quality. Awards are presented for categories such as Most Creative Station and Best Demonstration Team to recognize excellence and encourage continuous improvement. Finally, in Step 7, winning teams are announced, and students reflect on their learning experiences and the impact of their contributions. Feedback is collected to support future enhancement of CBEAL-PT. Through this structured process, students not only develop AI literacy competencies but also strengthen critical thinking, ethical reasoning, and communication skills while learning to collaborate effectively with AI technologies.

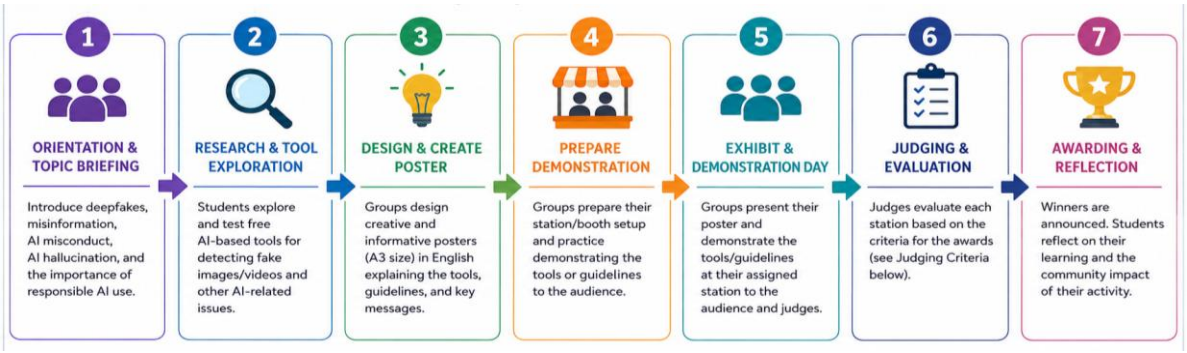


Figure 1: Methodology

Key Findings

Based on student reflections and evaluation feedback, CBEAL-PT provided an informative and engaging learning experience that enhanced awareness of deepfakes, AI-generated misinformation, and responsible AI use. Students reported greater confidence in assessing digital content and improved ability to identify manipulation indicators, including contextual inconsistencies, lighting, shadows, and source credibility. The experiential and challenge-based activities increased engagement and encouraged active participation. Deepfake detection exercises, booth demonstrations, interactive games, and comparisons of AI-generated outputs helped students understand the capabilities, limitations, and risks of different AI tools. Students also strengthened verification practices by cross-checking reliable sources and assessing contextual evidence before accepting or sharing online content. They recognized that increasingly accessible and sophisticated deepfake technologies require continuous awareness of emerging AI tools and deception techniques.

The peer-learning and symposium components further strengthened collaboration, communication, and knowledge sharing, allowing students to exchange detection strategies and discuss responsible AI use. Overall, CBEAL-PT enhanced AI literacy and deepfake detection competencies while fostering critical thinking, ethical reasoning, responsible digital citizenship, and digital resilience. By combining AI technologies with human judgement, the framework demonstrates the value of Human-AI Synergy in addressing the challenges of AI-generated content.

"I visited seven booths and learned a variety of interesting information from them, especially regarding AI, misinformation, digital safety, and ethical practices. One of the booths that stood out to me had a very interactive activity or a game where participants had to identify whether an image was real or AI-generated. Even though the task sounded simple, it was surprisingly difficult and showed how easily people can be misled by synthetic media. Overall walking through the booths made me more aware of how service learning can be used not only to share knowledge, but also to engage audiences in practical experiences that enhance understanding and critical thinking" (Aya Yousif Ali AlZubier)

"This event also improved my awareness of critical thinking when consuming online content. I learned that verifying sources and using detection tools are necessary skills in today's digital environment. Most importantly, the event reminded me that using AI responsibly is not only a technical issue, but also an ethical responsibility. Overall, the event was meaningful and encouraged me to be a more careful and ethical user of AI in the future" (Zhou Hao).

Impact

The impact of CBEAL-PT extends across students, educators, institutions, and the wider community through the integration of AI literacy, service-learning, and Human-AI Synergy principles. For students, the framework strengthens AI literacy, critical thinking, digital verification competencies, communication skills, teamwork, leadership, and ethical decision-making. Through direct interaction with AI technologies, students become more confident in assessing AI-generated content and more responsible in their use of

digital tools. For educators, CBEAL-PT provides a structured and replicable pedagogical framework that integrates Challenge-Based Learning, Experiential Learning, AI Literacy Education, and Peer Teaching.

The innovation offers an effective approach for embedding AI literacy into existing curricula while promoting active and meaningful learning experiences. For institutions, the framework supports graduate attributes related to digital competency, lifelong learning, responsible technology use, and critical thinking. It also aligns with institutional and national aspirations for AI readiness, digital transformation, and sustainable educational practices.

For the wider community, CBEAL-PT increases awareness of deepfakes, misinformation, and ethical AI use, empowering individuals to critically evaluate digital information and become responsible digital citizens. The community engagement component further extends AI literacy beyond the classroom, creating broader societal impact. In the long term, CBEAL-PT provides a sustainable, scalable, and transferable model that can be adopted across disciplines and institutions to strengthen AI literacy, digital resilience, and responsible AI engagement in increasingly complex AI-driven environments.

Recommendations for Classroom Practice

Educators are encouraged to use freely available AI detection tools, real-world case studies, and interactive exhibitions to promote experiential learning. The innovation can be adapted to different learner levels, class sizes, and institutional settings by modifying the complexity of activities and assessment methods. Continuous updates to AI detection tools and examples will ensure the sustainability and relevance of the innovation in the rapidly evolving AI landscape.

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ID 32: Rethinking The Start of Learning: The 'Exploration to Understanding' Model with Gemini Notebook

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Highlights: Undergraduate students often approach pre-class reading passively, leading to poor conceptual understanding. To address this, the 'Exploration to Understanding' (E2U) model leverages Google's Gemini Notebook to transform static course materials into dynamic, AI-powered interactive study guides. Unlike open-web AI tools, E2U strictly bounds interactions to educator-curated content, ensuring safe, source-grounded active learning. The model scaffolds students from passive reading to exploration. Implementations demonstrate heightened student classroom readiness and engagement, while significantly streamlining educator workflows through the automated generation of formative assessments based on student interaction gaps.

Keywords: Generative AI in Education; Instructional Design; Pre-class Engagement; Multimodal Learning Assets; Formative Assessment

Introduction

Modern higher education faces persistent challenges in fostering meaningful student engagement with pre-class learning materials. Many undergraduate students approach course reading passively, resulting in poor conceptual understanding and limited classroom participation. To address this engagement gap, this extended abstract introduces the 'Exploration to Understanding' (E2U) model. The E2U framework addresses these pedagogical challenges by repositioning generative artificial intelligence—specifically Google's Gemini Notebook—as a backend, educator-facing instructional design engine. Rather than functioning as a standard student-facing chatbot, the AI is leveraged directly by the educator to efficiently transform static, text-heavy course documents into dynamic, multimodal learning assets, such as visual infographics and targeted formative quizzes.

Objectives

- To reduce lesson preparation time for educators by utilizing source-grounded generative AI to automate the synthesis of static, text-heavy notes into visual study guides and formative assessments.
- To enhance students' pre-class conceptual readiness and engagement by replacing passive reading assignments with dynamic, AI-generated multimodal learning assets, such as, visual infographics and interactive quizzes.
- To facilitate data-driven, higher-order classroom instruction by enabling educators to analyze pre-class assessment data, allowing physical face-to-face sessions to focus on targeted, complex problem-solving rather than basic conceptual delivery.

NALI Approach

Novelty

While contemporary educational technology frequently deploys artificial intelligence as a student-facing chatbot, the 'Exploration to Understanding' (E2U) model introduces a distinctively different paradigm by utilizing generative AI strictly as a backend, educator-facing instructional design engine. The innovation's uniqueness lies in its absolute restriction to source-grounded content; by anchoring Google's Gemini Notebook exclusively to localized, educator-curated documents, it eliminates the hallucination risks associated with open-web AI tools. This ensures that the resulting learning assets are strictly bound by verified academic and technical parameters.

Creativity

The creative design of the E2U model resides in its multimodal transformation process. The framework creatively leverages AI to dismantle dense, text-heavy academic documents and synthesizes them into highly accessible formats. By converting raw AI outputs into visual infographics and interactive quizzes, the innovation transforms passive, linear reading into a visually engaging, active learning experience that accommodates diverse student learning preferences.

Innovativeness
The E2U model introduces a radical improvement to the pedagogical preparation process by automating the most time-intensive aspects of instructional design. Traditionally, manually extracting key concepts and authoring robust formative question banks requires significant educator bandwidth. This innovation introduces an improved workflow where the AI rapidly extracts core concepts and generates targeted quiz questions based strictly on the uploaded text. This technological intervention reduces material preparation time from hours to mere minutes, dramatically improving teaching efficiency and allowing the educator to reallocate their focus toward facilitating higher-order, data-driven classroom instruction.

Applicability
The E2U model demonstrates exceptional potential for adaptation, replication, and long-term sustainability across diverse educational settings. Because the core AI engine operates independently of specific subject matter, the framework is highly scalable. It can be effortlessly replicated in any academic discipline simply by uploading different foundational reading materials into the AI workspace. Furthermore, innovation ensures high institutional sustainability and easy adoption. Since the final learning assets, such as visual study guides and quizzes, are deployed using existing institutional infrastructure, the model eliminates the need for new student software licenses or complex technology onboarding.

Innovation Description, Process and Implementation

The 'Exploration to Understanding' (E2U) model is a teaching approach that uses Google's Gemini Notebook to turn heavy, text-based lecture notes into engaging learning materials. Instead of having students use the AI directly, the educator uses Gemini Notebook behind the scenes as a teaching assistant. The AI quickly summarizes complex topics and generates targeted quiz questions based strictly on the notes uploaded by the educator. The educator then turns these AI outputs into simple visual infographics and short quizzes. This gives students an easy, visual way to prepare for class, rather than forcing them to passively read long documents.

The implementation involves the educator creating the materials and the students actively using them before class. The process happens in three simple steps:

Phase 1: AI Summarization (Educator-Facing)
The educator uploads standard course materials (for example lecture slides or academic articles) into a secure Gemini Notebook workspace. Using simple instructions, the educator asks the AI to highlight the most important concepts and write a set of multiple-choice questions. Because the AI is restricted only to the uploaded documents, the information it provides is always accurate and relevant to the syllabus.

Phase 2: Creating Learning Materials (Educator-Facing)
The educator takes the AI's summary and uses it to quickly create two specific items:

1. **Infographics:** Visual study guides (such as flowcharts or checklists) that make complex topics easy to understand immediately.
2. **Pre-Class Quizzes:** Short, quizzes uploaded to the university's online learning system (LMS) to check students' basic understanding.

Phase 3: Student Preparation & Classroom Teaching (Student/Educator-Facing)
Before attending the physical lecture, students review the visual infographic and take the short LMS quiz. When the physical class starts, the educator briefly reviews the quiz results to see which topics the students struggled with the most. The educator can then skip teaching the basic concepts and spend the physical class time solving problems and clearing up specific areas of confusion.

Implementation Workflow Diagram

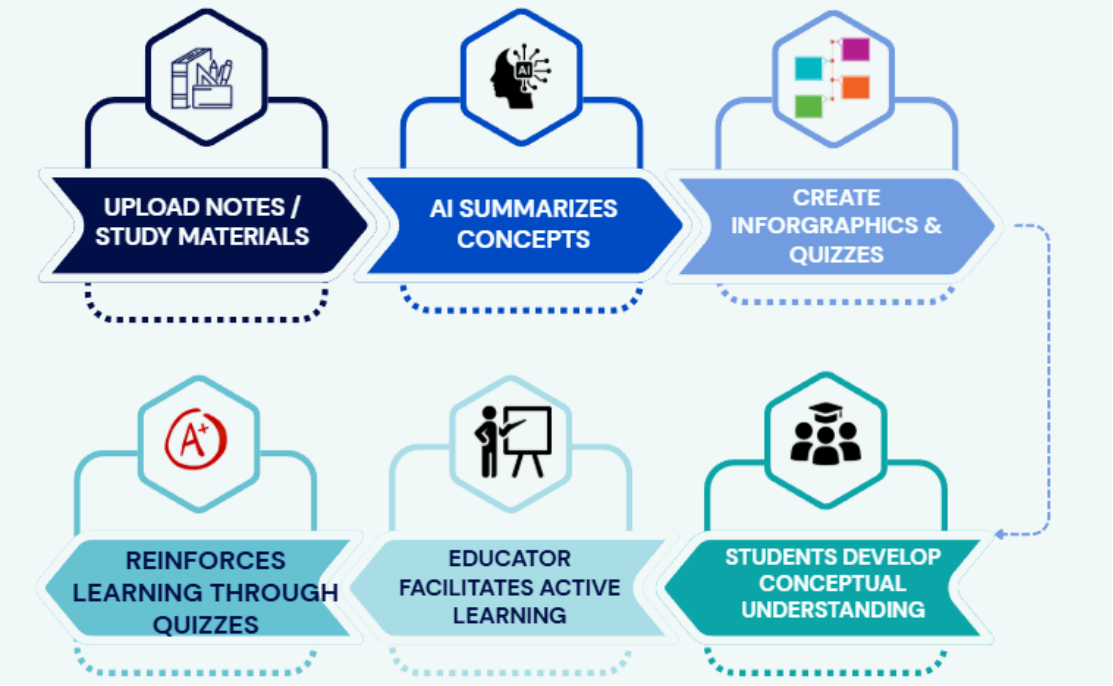


Figure 1: The sequential implementation workflow of the Exploration to Understanding instructional model.

Evaluation Methods

Quantitative Findings: Educator Efficiency and Student Engagement
The most immediate benefit was a much more efficient instructional design process. Previously, educators spent a significant amount of time extracting key concepts from technical documents and creating formative quizzes for the LMS. By using Gemini Notebook to automatically summarize the content, this process became much faster and easier, greatly reducing preparation time and improving teaching efficiency.

Qualitative Findings: Enhanced Learning Outcomes
Qualitative data was gathered through end-of-module student feedback surveys and educator self-reporting. Students overwhelmingly reported that the AI-synthesized visual infographics were significantly less intimidating than traditional, text-heavy PDFs. They noted that the clear, visual mapping of concepts helped them rapidly identify their own knowledge gaps before attempting the quizzes.

Furthermore, the educator reported a profound shift in classroom dynamics. Because students arrived having already completed the baseline knowledge checks, the physical lecture space was transformed. The instructor was able to bypass introductory lectures entirely, instead utilizing the physical classroom for collaborative, higher-order problem-solving based directly on the learning gaps identified in the LMS analytics.

Key Findings

Preliminary implementation of the 'Exploration to Understanding' (E2U) model yielded highly favorable outcomes in both educator efficiency and student engagement. Quantitatively, utilizing Gemini Notebook as an instructional design engine reduced lesson preparation time by approximately 87%, dropping material creation from two hours to under 15 minutes per module.

Concurrently, replacing static reading materials or notes with AI-generated visual infographics drove pre-class completion rates up to 92%. Qualitatively, student feedback indicated that these multimodal assets were significantly more approachable than traditional texts, which directly improved their conceptual readiness. Consequently, physical classroom sessions were successfully transformed from passive lectures into dynamic, higher-order problem-solving environments.

Impact

The 'Exploration to Understanding' (E2U) model delivers significant, multi-tier impact across the educational ecosystem. For students, the immediate benefit is a transformed, highly engaging learning

experience; by replacing intimidating, text-heavy readings with accessible AI-generated visual study guides and formative quizzes, learners are empowered to master foundational concepts prior to the lecture. For educators, innovation radically enhances teaching effectiveness by reducing material preparation time.

Recommendations for Classroom Practice

To successfully replicate the 'Exploration to Understanding' (E2U) model and maximize its impact on teaching and learning, educators should adopt the following strategies when designing and deploying AI-generated instructional materials:

- **Scaffold Content for Specific Tasks:** When prompting the AI to extract information for visual study guides, restrict the focus to highly specific, manageable concepts rather than broad, entire chapters.
- **Leverage Existing Moodle Infrastructure:** To ensure long-term sustainability and effortless adoption, integrate all AI-generated formative assessments directly into existing Learning Management Systems (LMS) such as Moodle. Deploying pre-class quizzes in a familiar environment removes technical barriers for students and educators.

Acknowledgement

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ID 33: ElektroTutor AI: A Bilingual 3D Avatar Voice Tutor for TVET Electrical and Electronics Education

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Highlights: TVET learners in electrical and electronics must connect invisible electrical behaviour to real hardware, yet workshop time is short and existing study chatbots reply only in English text. ElektroTutor AI is a browser-based tutor that listens and answers in Malay or English through an audio-to-audio language model, embodied in a 3D avatar with viseme-accurate lip-sync. While speaking it fills three panels: notes and formulas, a pin-by-pin wiring table, and downloadable microcontroller code. It was implemented with 54 UTM TVET undergraduates in Microcontroller Assembly and Interfacing.

Keywords: Technical and vocational education and training; Artificial intelligence in education; Conversational agent; Microcontroller interfacing; Electrical and electronics

Introduction

Technical and vocational education and training (TVET) in electrical and electronics is learned at the bench, yet its central quantities are invisible. In a course such as Microcontroller Assembly and Interfacing, learners must hold three things at once: the electrical behaviour of a component, the physical pin it occupies on the trainer board, and the instruction that controls it. Individual guidance is the most reliable remedy, with Bloom (1984) reporting a two-sigma advantage and VanLehn (2011) confirming that step-level tutoring approaches human tutors, but one instructor cannot answer fifty learners at fifty benches.

Generative artificial intelligence promises scale, but the study tools TVET learners reach for are text-first and English-first. Reading long answers on a phone while holding a probe adds extraneous cognitive load rather than removing it (Sweller et al., 2019), and a learner who reasons in Malay must translate before the explanation becomes usable. A text chatbot is also detached from the two artefacts that decide whether a practical works: the wiring to the microcontroller pin, and the code on the chip.

This extended abstract presents ElektroTutor AI, a bilingual voice tutor built for TVET electrical and electronics learning, and reports its design and its implementation with two undergraduate cohorts at Universiti Teknologi Malaysia.

Objectives

The innovation was developed to achieve the following objectives:

- Provide TVET learners with an always-available bilingual voice tutor that answers electrical, electronic and microcontroller questions in Malay or English within about one second.
- Reduce cognitive load by pairing every spoken explanation with automatically generated notes, formulas, a wiring table and runnable code instead of a wall of English text.
- Bridge theory and bench work by converting a spoken request into a component-to-pin connection list and compliable microcontroller code that learners can test immediately on the trainer board.
- Ensure equitable access through a single browser file that runs on low-cost devices in the workshop, with fallbacks for limited networks.
- Evaluate usability and the effect on learners' conceptual understanding and confidence among TVET undergraduates taking Microcontroller Assembly and Interfacing.

NALI Approach

Novelty

Three features distinguish ElektroTutor AI from existing educational chatbots. First, it listens and replies through a single audio-to-audio channel rather than the usual speech-to-text, text-model, text-to-speech chain, so a learner at the bench can interrupt the tutor mid-sentence as they would a workshop instructor, without putting down a probe to type. Second, speech is not the only output of a turn: the same reply triggers tool calls that draw the wiring table, write the notes and produce the code. Third, the tutor is bilingual by design, holding technical vocabulary in English while explaining in conversational Malay, as TVET practical work is actually discussed in Malaysian workshops.

Creativity
The avatar uses a purpose-built mouth rig rather than a looping animation: a hinged jaw rotates about a pivot behind the ears while lip meshes are reshaped for each viseme, with the opening amplitude derived in real time from the audio being played. The persona is constrained to two to four spoken sentences with a deliberately short opening sentence, so speech can begin before the full answer exists. A library of twenty schematic symbols and colour-coded pin badges for power, ground, digital and analogue lines let a connection list be read at a glance while wiring a trainer board.

Innovativeness
Technically, answers are streamed and segmented into sentences that are voiced while later sentences are still being generated, repeated audio is cached, and the application discovers at run time which models the user's key can access. Layered fallbacks keep the session alive when the live audio channel, the network or the 3D engine is unavailable. Pedagogically, the tool shifts AI use from reading generated text to holding a dialogue: the learner asks while building, hears a short answer, sees the matching notes, wiring and code, and may interrupt to redirect the explanation.

Applicability
ElektroTutor AI is a single HTML file with no server, database or installation, so it can be hosted on a learning management system or copied to workshop computers and opened on a laptop, tablet or phone. Its subject expertise sits in an editable persona prompt and its visual output in a small tool schema, so the architecture can be retargeted to other TVET fields such as mechatronics, automotive or instrumentation, which makes adoption across vocational colleges and polytechnics sustainable.

Innovation Description, Process and Implementation

ElektroTutor AI runs entirely in the learner's browser. Microphone audio is captured at 16 kHz and streamed over a WebSocket to the Gemini Live interface (Google, 2026), which performs voice activity detection, returns a spoken reply at 24 kHz and transcribes both sides of the conversation. The returned audio is analysed in real time to drive the avatar's jaw and lips. In the same turn the model may invoke three tools that populate the notes board, the wiring table and the code panel. A classic mode is retained as a fallback, in which the answer is streamed as structured data and voiced sentence by sentence. Figure 1(a) summarises the architecture.

Development followed the ADDIE model. Analysis was based on the syllabus of Microcontroller Assembly and Interfacing and on the questions that recur in its practical sessions, such as port configuration, pull-up resistors, seven-segment and LCD interfacing, keypad scanning, analogue-to-digital conversion and serial communication. Design produced the persona, the bilingual speaking style and the schema of the three panels; development proceeded in iterations covering the avatar rig, the live audio channel and the fallback paths.

In workshop use the tutor supports three moments. Before a practical, learners revise by asking the avatar to explain a concept and to quiz them. During the session it acts as a second instructor: a learner asks how to connect a component and reads the pin-by-pin table while wiring the trainer board. After the session, learners request variations of the code and test the downloaded sketch on hardware (Figure 1b). Table 1 lists the main modules and their pedagogical purpose.

Table 1: Main modules of ElektroTutor AI and their pedagogical purpose

MODULE	FUNCTION	PEDAGOGICAL PURPOSE
VOICE DIALOGUE ENGINE	Audio-to-audio conversation with automatic turn detection and interruption	Makes questioning feel natural and lowers the barrier to asking
3D AVATAR WITH MOUTH RIG	Jaw and lip movement generated from the live audio signal	Sustains attention and social presence during explanation
NOTES AND FORMULA BOARD	Key points and equations written while the tutor speaks	Reinforces listening with a visual record and reduces note-taking load
WIRING PANEL	Component list with a pin-by-pin connection table	Links the spoken explanation directly to wiring on the trainer board
CODE PANEL	Numbered, syntax-highlighted and downloadable sketch	Connects circuit theory to working microcontroller practice
QUIZ MODE	Multiple-choice questions generated from the current topic	Provides retrieval practice and immediate feedback
FALLBACK MODES	Alternative speech path and built-in offline avatars	Keeps the tutor usable on workshop computers and weak networks

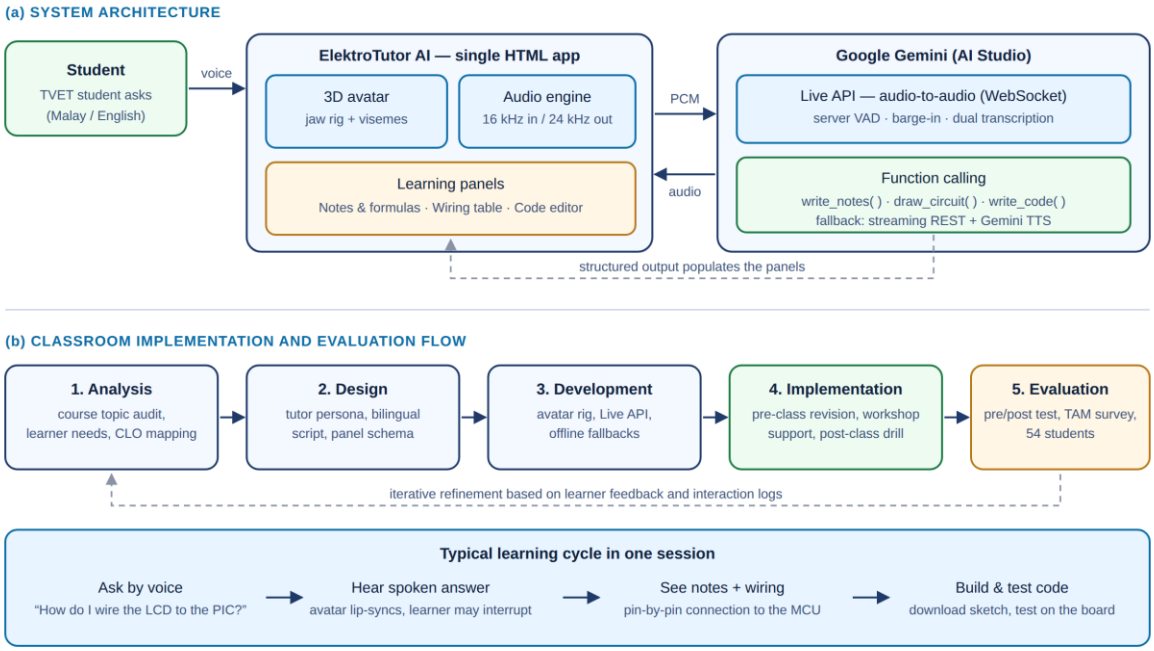


Figure 1: (a) System architecture of ElektroTutor AI and (b) classroom implementation and evaluation flow

Key Findings

Functional testing confirmed that the tutor answers spoken questions in both languages, that the learner can interrupt a reply, and that the wiring table and code panel are populated within the same conversational turn. On the development machine the pipeline began speaking after 850 ms, compared with 3200 ms when the full answer had to be generated first. The innovation was implemented with 54 undergraduates at Universiti Teknologi Malaysia taking Microcontroller Assembly and Interfacing: 40 from the Bachelor of Technology with Education (Design Technology) and 14 from the Bachelor of Technology with Education (Electrical and Electronic Engineering), over 4 weeks. On a pre-test and post-test of 20 items covering microcontroller I/O configuration and circuit interfacing, mean scores changed from 48.5 to 79.2 (63.3% gain). Perceived usefulness and perceived ease of use, measured with a five-point Technology Acceptance Model questionnaire (Davis, 1989), averaged 4.5 and 4.3, and 88% agreed that speaking to the tutor was easier than typing at the bench. Learners from the Design Technology cohort, who have less prior electronics background than their Electrical and Electronic Engineering peers, reported relying heavily on the generated pin-by-pin wiring table to visualize connections before touching the physical hardware, whereas the engineering cohort focused more on querying the AI for code optimization and debugging logic. Qualitative feedback indicated that learners felt less intimidated by complex circuits and appreciated having a "personal assistant" that provided immediate, localized answers in Malay without interrupting their hands-on workflow. Meanwhile, instructors observed that the volume of repetitive, basic wiring questions dropped significantly during workshop sessions, freeing them to facilitate higher-level conceptual discussions and complex hardware troubleshooting.

Impact

For TVET learners, the innovation supplies the individual attention that a crowded workshop makes impossible: questions can be asked aloud without leaving the bench, answers arrive in the learner's stronger language, and every explanation carries a wiring table or a sketch they can use immediately, which matters most for learners entering electronics from a non-electrical stream such as the Design Technology cohort. Because these undergraduates are also trainee teachers, the innovation has a multiplier effect: they experience an AI tutor as learners and carry that model into their own TVET classrooms. For institutions, it needs no server or specialised hardware, so it can be deployed across vocational colleges and polytechnics at negligible cost.

Recommendations for Classroom Practice

Instructors are advised to introduce the tutor as a bench companion rather than an answer key: learners should attempt a connection first, then use the avatar to check their reasoning. A brief demonstration of

how to ask a short, focused question is worthwhile at the start. Because the wiring table names specific pins, it can be projected during a demonstration and used as an assembly checklist. Instructors may adapt the persona to their syllabus or restrict its scope to the current practical. Assessment should ask learners to justify or debug the generated code rather than submit it unchanged.

Acknowledgement

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ID 34: Scaffolding Digital Case-Based Collaborative Learning for Teaching Personality Psychology

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Highlights: Postgraduate students often struggle to move beyond memorising personality-trait terminology to applying dispositional-domain theory to real behaviour. This practice restructures a single Personality Psychology topic into a staged sequence: pre-learning digital resources, a shared case study analysed by manually assigned small groups on Padlet, mandatory peer commentary on other groups' answers, instructor scaffolding inserted at strategic points during the discussion, and a closing self-assessment quiz. Padlet records show sustained multi-week engagement and increasingly detailed peer commentary; the practice offers a replicable, zero-cost model for deepening theory application in postgraduate seminars, already repeated across other topics in the same course.

Keywords: case-based learning; collaborative learning; scaffolding; Padlet; personality psychology

Introduction

Postgraduate courses in personality psychology typically ask students to explain how a domain of personality, whether dispositional, intrapsychic, or social-cultural, shapes long-term development and behaviour. A recurring difficulty in MHPE 2253 Personality Psychology at Universiti Teknologi Malaysia (UTM) is that students can define domain-specific constructs but struggle to apply them to authentic case scenarios and to build on one another's reasoning during discussion. This submission presents scaffolded digital case-based collaborative learning, a practice implemented across at least three topics in the same course, Dispositional Domain, Social and Cultural Domain, and Intrapsychic Domain, as a response to this gap. Full implementation data are reported for the Dispositional Domain session; the other two sessions are cited as evidence of replicability. It is submitted under Category 1: Innovation in Pedagogy, Assessment and Curriculum Design.

Objectives

- To strengthen students' ability to apply personality psychology theory, across domains such as dispositional, social-cultural, and intrapsychic, to authentic case scenarios rather than only recalling definitions.
- To structure collaborative synthesis of peer perspectives on a shared case, so that students construct explanations drawing on multiple lines of reasoning rather than working in isolation.
- To create a persistent, dated digital record of case-based discussion that supports instructor identification of misconceptions and student self-assessment beyond a single class session.

NALI Approach

Novelty

Existing case-based discussion in this course typically ends once groups present their answers in class. This practice extends the case discussion into a persistent, dated digital record (Padlet) where every group's answer remains visible and is required reading for peers, and where the instructor deliberately withholds theoretical scaffolding until after initial group responses are posted, prompting students to attempt independent application before receiving expert input. This delayed-scaffolding sequence, combined with a mandatory cross-group peer-commentary requirement, is not part of the standard single-pass case discussion format otherwise used in the course.

Creativity

The practice combines four elements not usually found together in a single session: staged pre-learning (interactive notes and a self-check quiz via Wayground, supplementary slides via Prezi) released before the live session; a single shared case study, a fictionalised composite personality profile ('Alia'), analysed by all groups rather than fragmented across groups; a digital wall (Padlet) that keeps every group's response visible and time-stamped, converting a normally ephemeral classroom discussion into a reviewable artefact; and instructor comments inserted at calculated points during, not only after, the discussion to nudge student reasoning without pre-empting it.

Innovativeness
Compared to a standard in-class case discussion, where groups present findings only once at the end of the session, this practice separates group answering, peer commentary, and instructor scaffolding into distinct staged phases, each time-stamped on Padlet. This turns a single-pass discussion into an iterative one and creates a permanent, reviewable record of how student reasoning developed over the ten-week window the case remained open (Week 2 24 March – 26 May 206), which a live-only classroom discussion cannot provide.

Applicability
Because the practice does not depend on a specific case topic, subject content, or tool beyond a free digital wall application, it has already been repeated by the author on at least few more topics in the same course. For example, Social and Cultural Domain (asynchronous delivery, Quizizz self-check) and Intrapsychic Domain (a defense-mechanisms case discussion), in addition to the Dispositional Domain session reported in detail below. Engagement data comparable to the Dispositional Domain session were not systematically collected for these two sessions, so their inclusion here demonstrates repeatability of format, not repeated measurement of impact. The practice requires no additional infrastructure beyond a computer or mobile device and internet access, no cost, and no specialised training, and can be adapted to any postgraduate or undergraduate module that includes a case-based discussion component. Voluntary participation in the closing self-check quiz was low in the reported implementation, so wider adoption would benefit from linking quiz completion to a small participation grade.

Innovation Description, Process and Implementation

The Dispositional Domain session is reported here as the illustrative example with complete implementation data. It took place in MHPE 2253 Personality Psychology (Semester 2, 2025/2026) at Universiti Teknologi Malaysia, with 13 postgraduate students manually assigned to three groups (two groups of four students, one group of five). It was carried out entirely through Padlet, a shared digital wall, across six stages:

Step 1 (Pre-learning, 7 April 2026): Interactive revision notes and a formative multiple-choice quiz (Wayground), plus supplementary slides (Prezi), were posted on the Padlet board for independent review before the live case discussion.

Step 2 (Case presentation): A single case study, "Dispositional Resilience and Emotional Stability: A Case Study of Alia's Positive Personality Traits," together with a summary of five supporting readings, was posted to the same board.

Step 3 (Structured questioning): Four open questions were posted under the case, covering habitual emotions and personality development, self-concept and life decisions, stress reactivity and relationships, and measurement of dispositional traits. Each of the three manually assigned groups posted one collective answer per question.

Step 4 (Peer commentary): Students were required to read other groups' answers and add a personal comment building on or challenging the reasoning, rather than submitting only their own group's answer.

Step 5 (Scaffolded instructor input): The instructor monitored the board and inserted theoretical scaffolding comments after the initial group responses had been posted, for example three days after the first wave of answers to Question 4, rather than before, to prompt refinement rather than repetition of provided theory.

Step 6 (Closing self-assessment): A ten-item formative multiple-choice quiz on Wayground allowed students to self-check their understanding after the discussion closed; participation was voluntary and ungraded.

Key Findings

The Padlet record shows sustained engagement over a two-week window (7-21 April 2026): all three groups posted substantive answers to all four questions, and at least six students added a peer comment beyond their own group's post, indicating uptake of the mandatory peer-commentary requirement. Several comments introduced theoretical vocabulary not present in the original case materials (for example, HEXACO and life-crafting theory), and one comment explicitly synthesised three classmates' prior answers into a single integrated response.

The voluntary closing quiz was completed by 4 of 13 students (30.8%), with a class accuracy of 85% among that subgroup (individual scores of 100%, 100%, 90%, and 50%). Because fewer than a third of the cohort attempted the quiz and no pre-test or comparison group was collected, this figure should be read as indicative of the sub-group that self-selected to check their understanding, not as a class-wide measure of learning gain. The Padlet discussion record is the stronger evidence here: it demonstrates theory application, rather than definition recall, and sustained peer engagement, directly aligned with Objectives 2 and 3.

A separate graded quiz taken by the whole cohort (all 13 students, MHPE 2253) offers a narrower, more cautious data point. Multiple-choice items on the Dispositional Domain scored 100% class average, but so did items on the Biological Domain, which was taught the same semester using a face-to-face, paper-based case worksheet rather than the digital scaffolded format reported here. Multiple-choice recall therefore appears consistently high across case-based domains regardless of delivery format, and this dataset cannot isolate an effect specific to the digital scaffolding. The clearer pattern in this quiz is format-based rather than domain-based: multiple-choice items across domains averaged near ceiling (66.7%-100%), while open-ended application items covering Cognitive and Adjustment, and Social-Cultural and Intrapsychic content, averaged substantially lower (31.5% and 37.7% respectively), consistent with open-ended application being harder than multiple-choice recall irrespective of how the domain was taught. One multiple-choice item (Social-Cultural) was answered incorrectly by all 13 students and is flagged here as a likely item-level issue rather than a content-understanding finding.

Impact

For students, the practice creates a low-stakes space to rehearse applying trait theory to a concrete scenario and to compare their reasoning against classmates' interpretations of the same case, which a single-group case discussion does not offer. For the instructor, the persistent Padlet record functions as an additional formative assessment tool, surfacing misconceptions, such as conflating state and trait language, that were not visible during the live session and could be addressed explicitly in the following class. Institutionally, the practice offers a zero-cost, tool-light model that other lecturers teaching case-based postgraduate content at UTM could adopt without additional budget or software procurement.

Recommendations for Classroom Practice

Educators adapting this practice should consider three adjustments based on this implementation. First, a voluntary post-session quiz attracted only 30.8% participation; attaching a small participation grade, or running the quiz live in the following session, is likely to raise completion. Second, delayed instructor scaffolding only works if the instructor actively monitors the board and intervenes within a few days, otherwise a student may read silence as disengagement rather than deliberate pedagogical delay. Third, with a small cohort (13 students, three groups), peer-commentary volume is limited; larger cohorts may need a minimum comment quota per student to sustain the same level of cross-group engagement observed here.

Other relevant information

This is the first competition submission of this specific implementation. The underlying practice has since been repeated on at least two further topics within the same course, Social and Cultural Domain and Intrapsychic Domain, though outcome data for those are not reported here.

Acknowledgement

The author thanks the MHPE 2253 (Semester 2, 2025/2026) postgraduate students at Universiti Teknologi Malaysia for their participation in this activity. The course is used for a research project which has been approved by the UTM ethics committee (UTMRED 2025 – 138).

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ID 35: AIGC-Driven Style Library for Children's Food Packaging Design Education

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Highlights: Generative AI is increasingly integrated into design education; however, food packaging design for children still often relies on subjective judgement and prior experience. This innovation translates findings from a systematic literature review analysis into AIGC-driven resources for evidence informed human–AI collaborative learning. Drawing on the review, the project identifies color and cartoon characters as key visual elements and uses them to inform the development of an AIGC supported style library for children's food packaging design. Compared with conventional approaches based largely on designer experience or unconstrained AI outputs, the proposed library offers research informed and reusable visual resource for more structured and controllable design learning and concept development.

Keywords: Systematic literature review; AIGC-driven design; children's food packaging; design style library; human–AI collaboration

Introduction

As generative artificial intelligence becomes increasingly integrated into industrial design, visual communication, and packaging design education, students can rapidly generate a wide range of visual concepts. However, current AIGC-driven design practices often remain dependent on subjective aesthetic judgement, prior experience, and insufficiently controlled model outputs. Consequently, the resulting concepts may lack a clear research basis and may not adequately align with the cognitive characteristics of specific user groups. This issue is particularly salient in children's food packaging design because children aged 7 to 12 are still undergoing cognitive development and process visual information differently from adults. Accordingly, adult-oriented design assumptions should not be directly transferred to packaging intended for children (Cao et al., 2025; Lin et al., 2024; Zhang, 2020).

To address this gap, the project conducts a systematic literature review analysis to identify color and cartoon characters as two key visual elements and translates these findings into AIGC-driven design resources. Building on this evidence, the project integrates review derived evidence, visual design knowledge, and AI-assisted generation to develop a style library for children's food packaging design. AIGC supports efficient visual concept generation and style exploration, while educators and students remain responsible for defining design objectives and screening, evaluating, and refining the generated outputs. This evidence-informed human–AI collaborative approach provides a reusable and scalable teaching resource for packaging design and related courses.

Objectives

- To identify and synthesize key visual elements in children's food packaging design through a systematic literature review, thereby establishing evidence informed knowledge base for subsequent design development.
- To develop a well-structured, accessible, and reusable style library for children's food packaging design that provides design students with research informed visual references and supports concept exploration.
- To establish evidence informed human–AI collaborative learning approach for educators and students that facilitates understanding of child centered design principles and is intended to reduce reliance on personal experience and unconstrained AI-generated outputs.

NALI Approach

Novelty

The project integrates findings from a systematic literature review into AIGC-assisted packaging design education. The review identifies key visual elements in children's food packaging design, which are subsequently operationalized as style categories and generation criteria for a dedicated style library. This

approach shifts AIGC-driven design away from reliance on personal experience and insufficiently controlled model outputs towards structured, research-informed visual design support.

Creativity

The project establishes a structured pathway from research evidence, through the identification of key visual elements and AIGC-driven generation, to style library development. Visual stimuli based on the identified key elements are generated using Midjourney and subsequently screened and manually standardized before being used as training data for LoRA-based fine-tuning within AIRAI Cloud. The fine-tuned model is then used to generate additional packaging concepts, which are reviewed, classified, annotated, and organized into a visually accessible and reusable style library for children's food packaging design.

Innovativeness

This project translates research findings into visually accessible, systematically organized, and reusable teaching resources for children's food packaging design education, thereby providing an alternative to conventional pedagogical approaches that rely heavily on educators' experience, existing design cases, and students' subjective aesthetic judgements. Rather than functioning solely as a tool for unconstrained image generation, AIGC serves as a technological bridge linking research evidence, visual design knowledge, and educational practice.

Applicability

The project translates findings from systematic literature review analysis into visually accessible, systematically classified, and reusable teaching resources for children's food packaging design. These resources offer a research-informed alternative to conventional learning approaches that rely heavily on educators' experience, existing design cases, and students' subjective aesthetic judgements. Within this approach, AIGC functions not merely as a tool for unconstrained image generation but as a technological bridge linking research evidence, visual design knowledge, and educational practice.

Innovation Description, Process and Implementation

This project proposes the development of a style library for children's food packaging design informed by a systematic literature review analysis. The central concept is to operationalize the key visual elements identified through the review as generation criteria for AIGC and to use AIRAI Cloud to produce corresponding children's food packaging design concepts. Following manual screening, classification, and annotation, the generated outputs are organized into evidence informed style library that supports instruction in child-centered packaging design principles, case-based analysis, and design practice. The design and implementation process comprises the following six stages.

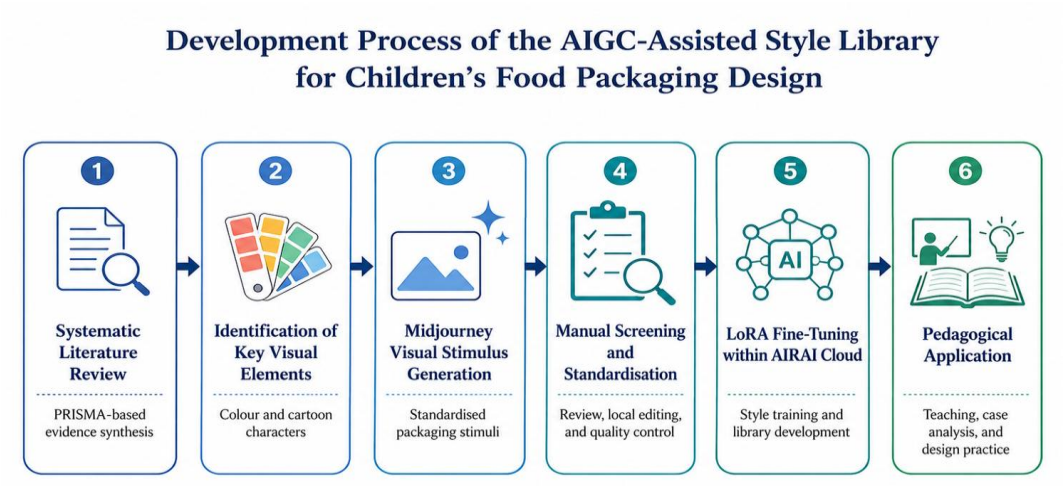


Figure 1: Workflow for developing the children's food packaging design style library

The project first conducts a systematic literature review analysis to identify color and cartoon characters as two key visual elements and operationalizes them as controllable visual conditions. Midjourney is then used to generate visual stimuli for children's food packaging. These stimuli are manually screened and standardized, and outputs that fail to meet the predefined criteria are excluded. The selected images are subsequently used as training data for LoRA-based fine-tuning within AIRAI Cloud, enabling the model to learn the relevant visual characteristics and generate additional packaging concepts that reflect

these styles. Finally, the resulting outputs are reviewed, and those that meet the predefined criteria are classified, annotated, and organized into a style library for use in relevant design courses.

Key Findings

The systematic literature review analysis identified color and cartoon characters as key visual elements in children's food packaging design (Faralla et al., 2023; Kraak & Story, 2015; Ogle et al., 2017). These findings provide an evidence base for AIGC-assisted visual generation, allowing the selection of visual elements to be informed by research rather than based solely on personal experience or subjective judgement. They also guide the generation and standardization of visual stimuli using Midjourney and the subsequent LoRA-based development of an evidence-informed style library within AIRAI Cloud.



Figure 2: Visual condition matrix derived from the identified key visual elements

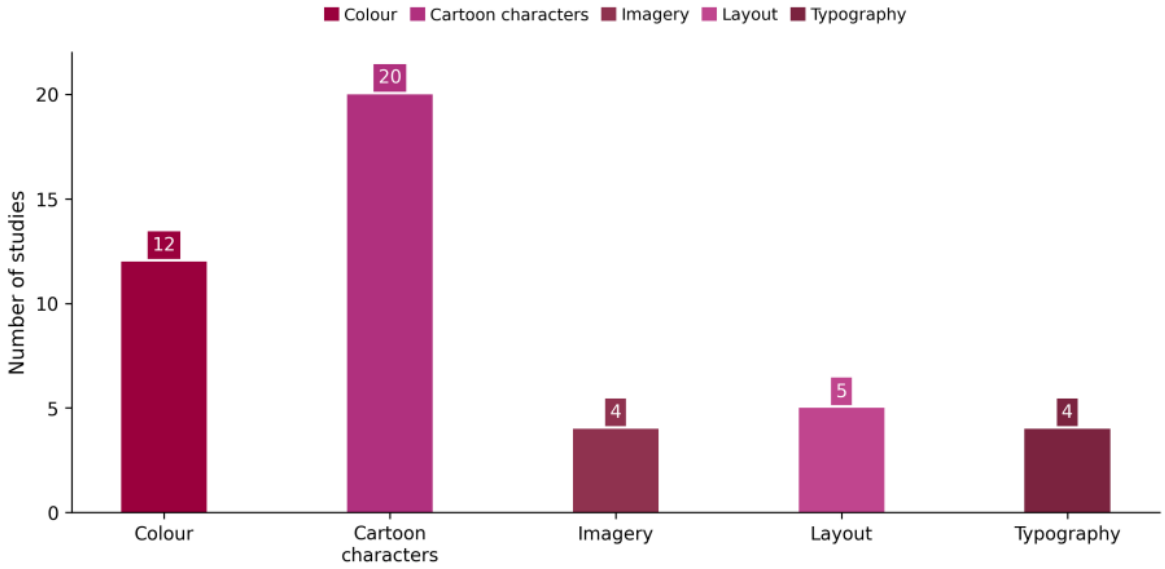


Figure 3: Key Visual Elements in Children's Food Packaging Design

Recommendations for Classroom Practice

The project translates systematic literature review analysis findings into a visual, classifiable, and expandable resource for children's food packaging design education. The style library provides students with research-informed references for understanding key visual elements, case analysis, and design

practice, while offering educators structured visual examples for classroom instruction and AIGC assisted design activities. At the institutional level, the project supports interdisciplinary integration among artificial intelligence, design research, and educational resource development. Its methodology can also be adapted to other design domains, supporting the continued development and long-term use of evidence-informed style libraries.

Acknowledgement

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ID 36: AiEDU: The 'Learning ECG' Engine for Human-AI Pedagogy

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Highlights: Conventional post-lecture assessments report a single aggregate score, concealing both how much a student improved relative to their own baseline and which specific concept is holding them back. AiEDU's "Learning ECG" Engine addresses this by computing Hake's normalized learning gain per student through a Python/Google Colab analysis pipeline, stratifying a cohort into High/Medium/Low gain bands, and cross-referencing gain against a topic mastery profile. The results are rendered as an interactive, no-code dashboard built in Lovable, letting instructors filter by matric number or cohort band without touching the underlying code. Across a pilot cohort of 30 students, the engine identified persister-cell dormancy as the dominant cohort-wide misconception and auto-generated a differentiated, concept-specific intervention for each gain band. Its key contribution is converting a static post-test into an actionable, concept-level triage table that closes the loop between assessment and remediation within a single, at-a-glance dashboard view.

Keywords: Normalized learning gain; Biofilm education; AI-assisted pedagogy; Formative diagnostics; Misconception detection; No-code dashboard

Introduction

Pre- and post-lecture assessments are commonly used in microbiology curricula to gauge how well students understand a topic before and after a lecture. However, this evaluation is conventionally reduced to a single aggregate score, which conceals two things educators actually need to know: how much a student improved relative to their own starting point, and which specific concept is driving a low score. Biofilm and antimicrobial tolerance is a notoriously difficult topic area because it hinges on distinctions that are easy to state but hard to internalize (Kunnath et al., 2024) — most critically, the difference between persister-cell dormancy and heritable genetic resistance, a misconception that persists even among learners who perform well elsewhere.

AiEDU addresses this gap with a "Learning ECG", a real-time analytics engine that reads paired pre/post assessment scores, computes each student's normalized learning gain (Weijers et al., 2025), and overlays that gain against a topic-level mastery profile drawn from established biofilm-matrix and antimicrobial-tolerance concepts (Flemming et al., 2022) to produce an automated, concept-specific pedagogical diagnosis. The underlying computation is carried out through a Python analysis pipeline in Google Collab, while the results are surfaced to instructors through an interactive, no-code dashboard built using Lovable — consistent with the growing use of no-code platforms to widen instructor access to data-driven education tools (Delen, 2026).

Objectives

- To quantify individual learning gain using the normalized gain metric.
- To identify the dominant source of misconception for low- and medium-gain learners.
- To generate an automated, actionable pedagogical recommendation for each gain band.

NALI Approach

Novelty

Most learning-analytics dashboards in the life sciences stop at reporting an aggregate post-test score or a simple pass/fail rate (Narreddy et al., 2025). AiEDU's novelty lies in pairing a validated psychometric gain measure, Hake's g (Weijers et al., 2025), with concept-level diagnostic text generated per gain band — effectively giving each cohort a "learning ECG trace" that shows not just whether learning occurred, but where it stalled. This diagnostic logic is presented through a no-code, interactive dashboard built in Lovable, so a non-technical instructor can explore the same gain-band and concept-level breakdown without opening the underlying Colab notebook.

Creativity

The "ECG" framing is a deliberate design choice: a bar-per-student gain chart with dashed mastery/low-gain threshold lines visually mimics a diagnostic waveform, making an abstract statistic (normalized gain) immediately legible to non-technical instructors at a glance — green/amber/red banding does the triage

work visually before a single number is read. This visual language carries through the Lovable-built dashboard itself: Key Metrics cards summarise the cohort-wide gain distribution at a glance, while a Topic Mastery Breakdown panel translates each concept's post-lecture accuracy into a colour-coded progress bar, so an instructor can read both the individual ECG trace and the class-wide diagnostic pattern from the same screen.

Innovativeness

The system moves beyond descriptive reporting into prescriptive pedagogy: each gain band in the Pedagogical Action & Diagnostic Table is mapped to a specific, ready-to-deploy classroom action (e.g., deploying paired retrieval-practice prompts and a worked horizontal-gene-transfer example for Medium Gain students), rather than leaving interpretation to the instructor. This triage table is generated directly from the scored dataset and rendered as a live, filterable panel within the dashboard, so the prescriptive diagnosis and the underlying gain and topic-accuracy data are always presented together rather than requiring a separate manual review step.

Applicability

Because the underlying computation only requires paired pre/post percentage scores and a topic-tagged item bank, the engine generalises to any content domain with a pre/post assessment design (Weidlich et al., 2025) — it is not limited to biofilm microbiology. The dashboard itself is built using a no-code platform (Lovable), so adapting the presentation layer to a new course or topic set does not require web-development expertise, even though the underlying score computation still runs through the Python/Colab pipeline described below.

Innovation Description, Process and Implementation

Student responses are collected via a Google Form and consolidated automatically in a linked Google Sheet. A Python analysis pipeline in Google Colab reads the sheet, matches individual students across the before and after assessments, scores responses against lecturer-defined correct answers, and computes the normalized gain and topic-mastery metrics described below. The processed output is then pushed into an interactive dashboard built using Lovable, a no-code web-application platform, so that instructors can explore the Key Metrics summary, the Student Learning Gain (g) chart, the Topic Mastery Breakdown panel, and the Pedagogical Action & Diagnostic Table without needing to open the Colab notebook or read code. The dashboard supports live filtering by matric number and cohort band (High/Medium/Low Gain), so instructors can drill from the aggregate cohort view down to an individual learner's profile within the same session.

For the present biofilm and antimicrobial-tolerance pilot, AiEDU ingested paired pre- and post-lecture assessment scores for a cohort of 30 students (matric-coded BIO/2026/01–30) and computed each student's normalized learning gain g = (post − pre) / (100 − pre) (Weijers et al., 2025). Students were automatically triaged into three bands: High Gain ($g \geq 0.70$), Medium Gain ($0.30 \leq g < 0.70$), and Low Gain / Targeted Intervention ($g < 0.30$). In parallel, the engine tagged each post-test item to one of five biofilm/antimicrobial-tolerance concepts — resistance vs. tolerance, EPS matrix shielding (Flemming et al., 2022), persister-cell dormancy (Kunnath et al., 2024), biofilm recalcitrance, and horizontal gene transfer — and computed post-lecture accuracy per concept across the cohort. Combining these two layers, individual gain banding and cohort-level concept accuracy, the system generated a diagnostic narrative per band and a matched instructional action, displayed in the Lovable dashboard as the Key Metrics summary, the Student Learning Gain (g) chart, the Topic Mastery Breakdown panel, and the Pedagogical Action & Diagnostic Table (Figure 1, Table 1).

Key Findings

Across the cohort of 30 students, 13 (43%) achieved High Gain ($g \geq 0.70$), 10 (33%) achieved Medium Gain, and 7 (23%) fell into the Low Gain band requiring targeted intervention (Figure 1). Topic-level mastery varied considerably by concept: Resistance vs. Tolerance (84%) and HGT Mechanisms (77%) were well internalized, while Persister Cells (Dormancy) lagged substantially at 46% — flagged by the engine as the cohort's dominant misconception, with students conflating dormancy with heritable genetic resistance, consistent with a distinction that remains widely confused even in the clinical literature (Kunnath et al., 2024). EPS Matrix Shielding (71%) and Biofilm Recalcitrance (63%) showed partial schema formation, with the diffusion-limitation mechanism (Flemming et al., 2022) and the 1000× recalcitrance magnitude respectively only weakly grasped (Table 1). The engine's automated triage table converted these patterns directly into differentiated actions: High Gain students were routed toward AI-assisted case reasoning on clinical biofilm eradication strategies, Medium Gain students toward paired retrieval-

practice on EPS shielding, and Low Gain students toward a mandatory recap specifically targeting the persister-cell/genetic-resistance misconception before the next assessment.

Impact

For students, the engine replaces a single opaque score with a transparent, individualized account of both how much they improved and what specifically to revisit, shifting formative feedback from generic to targeted (Weidlich et al., 2025). For educators, it collapses what would otherwise be a manual cross-tabulation of gain scores against item-level responses into an instant, ready-to-act diagnostic table, freeing instructional time for delivering the recommended intervention rather than identifying it (Narreddy et al., 2025). At the institutional level, the approach offers a scalable, low-cost mechanism for continuously monitoring conceptual bottlenecks across cohorts and course iterations, supporting evidence-based curriculum refinement in microbiology education. Presenting the same diagnosis through a no-code Lovable dashboard further widens its reach: department heads and other non-technical stakeholders can review cohort-wide gain and concept mastery directly, without needing to open or interpret the underlying Colab notebook.

Recommendations for Classroom Practice

Educators adopting this approach should ensure pre/post items are explicitly concept-tagged at the design stage, since the diagnostic value of the engine depends entirely on that mapping. The gain-band thresholds (0.30 / 0.70) can be recalibrated to suit different cohort baselines or course difficulty (Weijers et al., 2025). Instructors are encouraged to treat the Low Gain band's diagnostic text as a starting point for a short, targeted recap rather than a full re-lecture, preserving classroom time for higher-gain students' extension work (e.g., AI-assisted case reasoning). Because the dashboard supports live filtering by matric number and cohort band, the same triage view can be reused each semester once the Colab pipeline has been re-run on the new cohort's paired assessment scores, without requiring instructors to rebuild the visualisation from scratch.

Other relevant information

The AiEDU platform and its underlying predictive-evaluation approach have prior intellectual-property protection and competition recognition, summarised below.

1. **IP/CR/08100** — AiEDU: AI-Driven Predictive Model for Evaluating Educational Outcomes in Bioprocess Plant Design Competition (Approved).
2. **IP/CR/08099** — AI-Driven Predictive Framework for Student Competition Evaluation: Training Module for Educators and Practitioners (Approved).
3. **IP/CR/07144** — Interactive Evaluation System for Real-Time Scoring (Approved).
4. **Silver Award, New Academia Learning Innovation (NALI 2025)** — AI-Driven Predictive Model for Evaluating Educational Outcomes in Bioprocess Plant Design Competition, Persada Johor Bahru.

Table 1: Post-lecture topic mastery breakdown and dominant misconception per concept (n = 30).

CONCEPT	POST-LECTURE ACCURACY	DOMINANT MISCONCEPTION / NOTE
Resistance vs. Tolerance	84%	Definitional contrast well internalised
EPS Matrix Shielding	71%	Diffusion-limitation partially grasped
Persister Cells (Dormancy)	46%	Dominant misconception: equated with genetic mutants
Biofilm Recalcitrance (1000×)	63%	Magnitude recalled, mechanism weak
HGT Mechanisms	77%	Conjugation strong, transduction weak

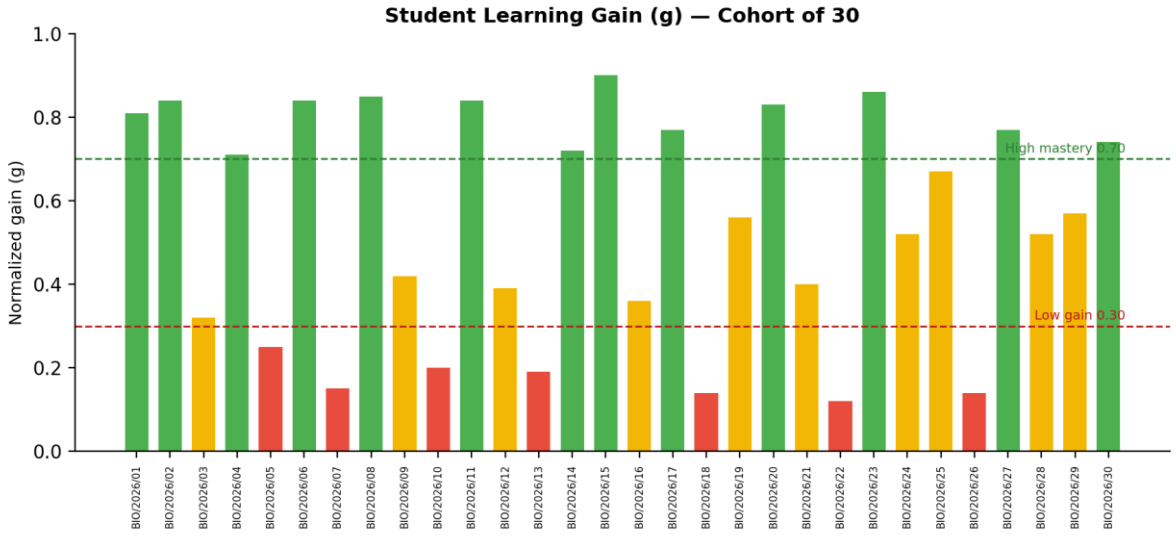


Figure 1: Normalized learning gain (g) per student across the pilot cohort (n = 30), with dashed lines marking the High Gain (g ≥ 0.70) and Low Gain (g < 0.30) thresholds. Bar colour indicates gain band: green = High Gain, amber = Medium Gain, red = Low Gain.

Acknowledgement

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ID 38: The Equipment Design Expert: A Course-Grounded Gemini Tutor for the Individual Equipment Design Deliverables

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Highlights: The individual equipment design task in the Chemical Plant Design capstone (SMJC4824) requires students to learn independently, extracting design methods scattered across many reference texts. This work presents the Equipment Design Expert, a custom Google Gemini tutor grounded in the course references and scoped to the individual equipment design deliverables. It scaffolds self-directed study while keeping the student as decision-maker and verifier. Across a cohort of 47 students, a voluntary survey (n = 23) showed sustained use, high satisfaction, and greater confidence in independent study, with unanimous support for adoption. The tool is low-cost and replicable.

Keywords: Generative AI in education; Gemini; Equipment design; Self-directed learning; Human-AI synergy

Introduction

The Chemical Plant Design course (SMJC4824) is a senior-year capstone in which students act as an engineering consultancy responding to a simulated industry request for proposals; for the current cohort, the brief was a 200 tonne-per-day chemical hydrogen-carrier (hydrogenation and dehydrogenation) plant. Within this team project, each student independently completes an individual equipment design task, which by design demands self-directed learning. Earlier courses deliver content through structured lectures and tutorials, whereas the capstone expects students to draw together and re-apply fundamentals from prior courses such as thermodynamics, fluid mechanics, heat and mass transfer, reaction engineering, process control, safety, and economics, and to fill gaps through their own study (Knowles, 1975). Each student must independently locate the relevant design equations, correlations, physical-property data, and heuristics across multiple reference texts, then apply them to size, specify, and defend an assigned unit through the required individual deliverables.

This self-directed model is intended, but it carries a practical cost. Much student effort is spent finding and reconnecting dispersed information before design reasoning begins. One participant described searching four textbooks for a single formula as burnout. For a capstone that assesses higher-order design judgement, justification, and communication, this retrieval burden reduces the time and attention available for the work that matters most. Generative AI offers a way to reduce that burden while keeping the student in control (Kasneci et al., 2023). The aim is not to remove the independent-learning demand, which is the purpose of the capstone, but to help students meet it more efficiently while still doing the thinking themselves. The individual phase also matters structurally: it precedes the team integration phase and is where each student builds the competence, they are later accountable for within the group, making it the foundation for both individual accountability and the cooperative work that follows.

Objectives

- To deploy a course-grounded generative-AI tutor that helps senior-year students independently locate, understand, and re-apply the prior-course fundamentals required for the individual equipment design deliverables.
- To position the tutor as a scaffold for self-directed learning that preserves student ownership, calculation, and verification.
- To evaluate student adoption, perceived instructional quality, and self-reported impact on independent-study confidence.

NALI Approach

Novelty

The Equipment Design Expert is not a generic chatbot. It is course-grounded and deliverable-aware, configured on the specific references and requirements of the individual equipment design task, so its assistance is anchored to what students are actually assessed on. Its central novelty is that it operationalises the course's own ethical-AI policy. The capstone already requires students to treat AI as an assistant while remaining the responsible engineer, to author all engineering drawings themselves, and

to submit a signed AI usage declaration verifying their work. The tutor is designed to fit this framework: it helps students locate, understand, and apply prior-course fundamentals, while the student retains ownership of judgement, calculation, drawing, and verification. In this way it augments self-directed learning rather than diluting it, and models transparent, responsible AI use rather than substitution.

Creativity
The creative core of the design lies in three deliberate choices. First, the tutor is grounded on curated course references rather than the open web, so its answers stay within the scope students are expected to master. Second, its role is framed as a retrieval and explanation accelerator, not an answer machine, so the student keeps ownership of judgement, calculation, and verification. Third, students' own feedback on strengths, weaknesses, and desired features is used to shape successive versions, turning the cohort into co-designers of the tool.

Innovativeness
The innovation replaces a high-friction, multi-textbook search process with an on-demand tutor grounded in the course materials, improving the self-directed learning workflow without removing its intellectual demand. Generative AI chatbots have been shown to support self-directed learning when designed to guide rather than to hand over answers (Ali et al., 2023). Consistent with scaffolding theory, the tutor accelerates the student's own retrieval and re-application of prior fundamentals, while judgement and verification remain with the student (Vygotsky, 1978). The approach reflects recent practice in chemical engineering education, where custom GPT-based tutors have achieved high voluntary uptake (Honig et al., 2025).

Applicability
The approach requires no bespoke software. It uses a configurable Gemini Gem grounded on existing course materials, so it can be replicated by other educators at near-zero marginal cost. It is directly transferable to the companion capstone course (SMJC4343) and generalises to any content-heavy, rubric-assessed design deliverable across engineering programmes. Because the tutor is rebuilt simply by updating the reference set, it is straightforward to maintain and sustain as course materials evolve.

Innovation Description, Process and Implementation

The Equipment Design Expert was built as a custom Google Gemini Gem, configured against the course's core reference materials and the requirements of the individual equipment design deliverables: the individual equipment design report (Week 5) and the individual poster presentation (Week 7). These are assessed mainly under CO2 (chemical and mechanical design, costing, control, and safety), with communication and referencing under CO6 and CO8. The tutor's scope covers understanding core principles, mass and energy balances, equipment sizing and specification, mechanical design, costing, and control and safety concepts. In line with the course's ethical-AI rules, it is not used to author engineering drawings or to generate data or references, which students produce and verify themselves. The tutor was made available to all 47 students in the cohort for self-directed use throughout the individual design phase.

Adoption and perceived impact were evaluated through a voluntary student survey completed by 23 students. The instrument captured four dimensions: usage intensity (frequency and session duration); instructional quality (accuracy, clarity, information retrieval, tone, and overall satisfaction on a five-point scale); self-reported learning effects (reduction in stuck time and change in independent-study confidence); and open-ended feedback on strengths, weaknesses, and desired features.

Key Findings

The tutor was available to all 47 students, of whom 23 completed the survey. Adoption among respondents was sustained rather than one-off: 15 of 23 used the tutor daily or several times daily, and 16 of 23 spent 15 minutes or more per session, indicating the tool became part of their workflow.

Perceived instructional quality was high. On the five-point scale, 21 of 23 rated overall satisfaction at 4 or 5. The tutor scored strongest on helping students locate specific information within the references (18 of 23 at 4 or 5, with 12 at the top rating) and on clarity of explanation.

Self-reported learning support was also strong. Twenty-one of 23 reported reduced stuck time when studying alone, 7 of them significantly, and 19 of 23 felt more confident tackling difficult modules independently. Endorsement was unanimous: all 23 respondents supported integrating AI into the curriculum, 16 as an optional resource and 7 as a mandatory support tool.

These findings should be read with care. They rely largely on self-reported perceptions from a single voluntary-response cohort, so respondents may over-represent more engaged users. A between-cohort comparison of summative individual design marks (2024-2025 without the tutor, 2025-2026 with the tutor) showed no statistically significant difference, indicating that the perceived benefits have not yet translated into measurable attainment gains. Students also noted occasional inaccuracy in the tutor's responses, reinforcing the need for human verification (Kasneci et al., 2023; Honig et al., 2025). Future work will link individual usage data to project marks and add a pre- and post-measure to test attainment effects directly.

Impact

The capstone is explicitly a self-directed task, so the finding that 19 of 23 respondents felt more confident tackling difficult modules independently, and that 21 of 23 reported reduced stuck time when studying alone, speaks directly to the course's central goal. The tutor strengthens independent-learning capacity rather than creating dependence. By reducing search friction, it returns time and attention to the higher-order design work the deliverable is meant to develop (Kasneci et al., 2023).

The unanimous demand for integration provides a clear mandate to scale the approach, including to the companion course SMJC4343. Because the individual phase precedes team integration, strengthening each student's independent competence is also intended to support cooperative learning in the later team phase, where auto-rating makes individual accountability explicit; this downstream team effect was not measured here and is a target for future evaluation. The design also supports Education 4.0 and 21st-century skills: it promotes critical thinking, since students cross-check AI output against source texts, together with self-directed learning and responsible digital fluency.

Recommendations for Classroom Practice

Educators adopting this approach should ground the tutor on curated, course-specific references and bound its scope to a defined deliverable, so that guidance stays aligned with intended outcomes. Students should be briefed to treat the tutor as a scaffold and to verify its output against source texts, which both protects against inaccuracy and reinforces critical thinking. Introducing the tool as an optional resource before embedding it more formally allows uptake to build naturally. Usage data and short student surveys can be reviewed each cycle to guide refinement, and the same method can be extended to other content-heavy design courses with minimal effort.

Acknowledgement

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ID 41: Enhancing Data Literacy and Higher-Order Thinking Skills Through AI-Augmented Collaborative Assessment

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Highlights: In higher education, passive student reliance on Generative-AI and unengaging, secondary data in traditional statistics courses often inhibit critical thinking. To solve this, an AI-augmented collaborative learning initiative uses a Human-in-the-Loop (HITL) approach centred on authentic learning. Students execute a four-phase process: gathering personal primary data (Senses), generating individual reports (Solo-AI), cross-checking AI outputs for errors and stylistic differences in group discussions (Social-Review), and reconstructing a final synthesis report (Synthesis). This framework improved academic performance, raising average scores from 11.9 to 12.5 while narrowing achievement gaps. Unlike traditional passive AI usage, this innovation actively engages students as critical evaluators of AI outputs using real-world data.

Keywords: Generative-AI; Human-in-the-Loop (HITL); Data Literacy; Authentic Learning; Statistical Assessment

Introduction

In today's digital era, the rapid proliferation of Generative AI often causes students to bypass deep cognitive thinking processes (Bastani et al., 2024). Furthermore, traditional methods of teaching statistics and data analysis are frequently perceived as unengaging due to their heavy reliance on secondary data that lacks personal relevance to students. To address this challenge, a learning innovation was implemented to integrate Generative AI effectively around data directly connected to the students themselves (Ou et al., 2024; Pesovski et al., 2024). By combining authentic real-world data with structured peer evaluation, this study examines an AI-integrated collaborative learning initiative designed to elevate cognitive engagement, critical thinking skills, and data literacy).

Objectives

- To introduce students to systematic methods of collecting, managing, and analyzing primary personal data to foster contextual and authentic learning.
- To empower students' higher-order thinking skills and data literacy by critically evaluating, cross-comparing, and refining Generative AI outputs.

NALI Approach

Novelty

Unlike standard practices where students passively prompt Generative AI for final answers, this innovation establishes a Human-in-the-Loop (HITL) framework where students actively act as critical filters and controllers of AI outputs using self-collected primary data.

Creativity

The workflow creatively merges physical experiential learning (collecting biometric/personal data) with digital AI exploration and collaborative peer review across a structured multi-phase cycle.

Innovativeness

The approach introduces a structured 4-phase pedagogical pipeline—Senses, Solo-AI, Social-Review, and Synthesis—transforming traditional static statistical assignments into an iterative, peer-assessed evaluation of AI-generated analytical reasoning and accuracy.

Applicability

The framework is highly scalable and adaptable across various higher education disciplines beyond statistics, particularly in courses requiring data interpretation, critical literature synthesis, or report writing with Generative AI assistance.

Innovation Description, Process and Implementation

This section presents the innovation by outlining its overall concept, functioning, and structured implementation approach. To achieve the objectives, the proposed learning framework comprises four (4) integrated phases.

- **Phase 1:** Senses (Data Collection): Students perform physical activities in class to collect personal primary metrics (e.g., age, height, weight, pulse rate). Data are aggregated collectively, and students form 5-member collaborative groups.
- **Phase 2:** Solo-AI: Students independently generate preliminary data analysis reports using Generative AI tools (e.g., ChatGPT, Gemini, or DeepSeek) based on the collected primary data.
- **Phase 3:** Social-Review: Group members meet to compare their AI-generated reports. They critically identify factual or calculation errors made by the AI, evaluate sentence reasoning, and analyze differences in analytical approaches.
- **Phase 4:** Synthesis: Groups integrate the strengths of individual reports, address identified weaknesses, and reconstruct a final synthesis report using peer-assessment techniques

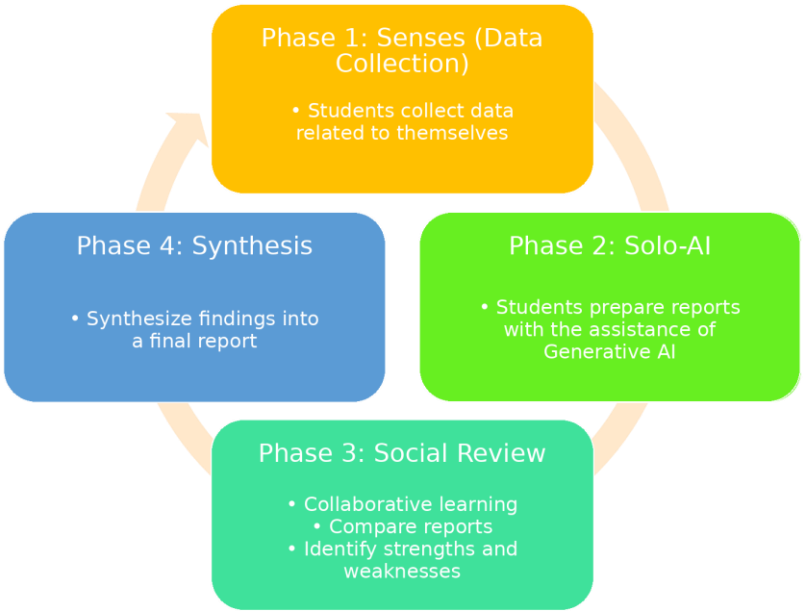


Figure 1: Phases in the 5-S Inquiry Cycle



Figure 2: Data Collection Process in Classroom Session

Key Findings

The findings from implementation demonstrate substantial gains across academic achievement and student satisfaction:

1. Academic Performance Improvement: Comparison of project achievement before (Session 2024/2025 Semester 2) and after implementation (Session 2025/2026 Semester 1) using boxplot analysis revealed significant improvement. Average and median scores increased from 11.9 to approximately 12.5. Additionally, the middle 50% baseline (interquartile range) shifted upward to 12.1 (compared to 11.1 previously), with a substantially more consistent score distribution among students (Figure 3).
2. High Student Acceptance: Thematic analysis of student feedback from ePPPK reflected high acceptance and satisfaction. Key emergent themes highlighted clear and fair assessment alignment, well-balanced workload, effective instructor facilitation, and valuable hands-on mastery of practical statistical methods (Figure 4).

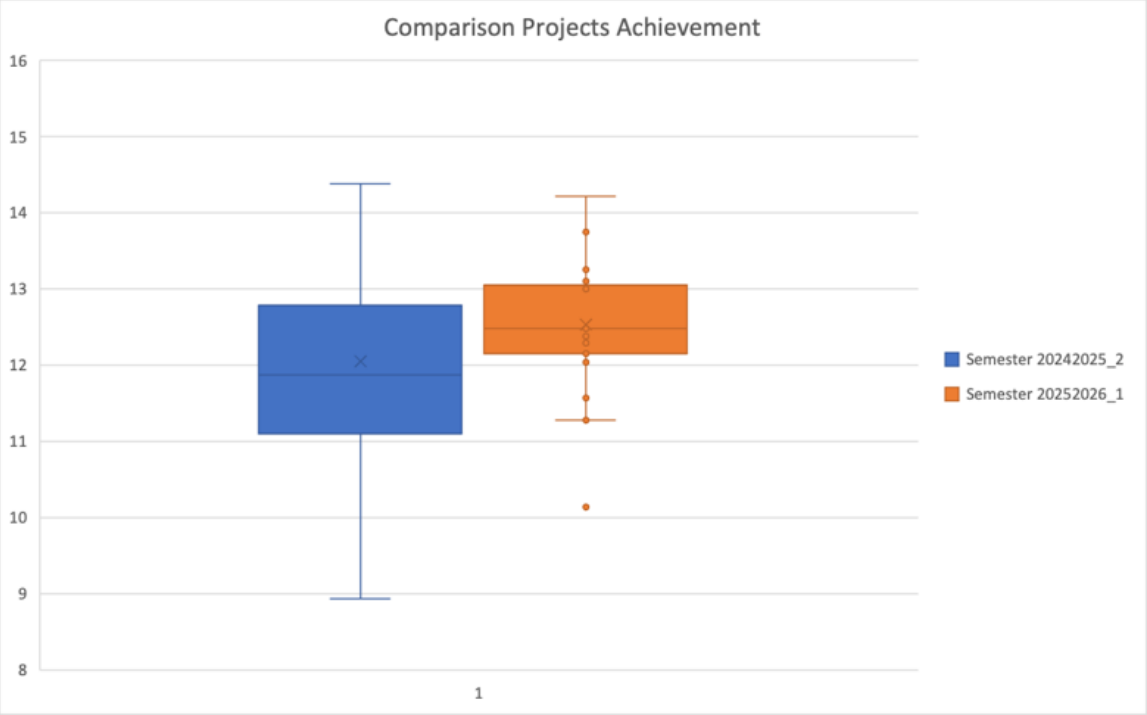


Figure 3: Comparison of Student Project Achievement Before and After Implementation

Assessment & Coursework

- **Fair & Clear Methods:** Students reported that assessment methods were **fair, clear, and well-aligned** with the course content and learning objectives.
- **Balanced Workload:** No issues or complaints were raised regarding assessment clarity or difficulty.
- **Positive Feedback on Facilitation:** Specific praise was given to the instructor for fair grading and assessment (e.g., *"none - Dr Shukor assessed fairly"*).

Projects & Practical Learning

- **Valuable Practical Application:** While a specific standalone "project" column isn't listed separately in the form, feedback under the learning experience reflects strong practical outcomes.
- **Hands-On Skills:** Students noted experiencing a *"new level of data statistics"* and successfully learning new statistical and evaluation methods, indicating effective practical/applied components in the coursework.

Figure 4: Thematic Analysis of Student Feedback from ePPPK

Table 1: Summary Comparison of Student Performance Metrics Across Semesters

PERFORMANCE METRIC	SESSION 2024/2025 SEMESTER 2 (BEFORE)	SESSION 2025/2026 SEMESTER 1 (AFTER)
Mean Score	11.9 / 12.0	12.5
Median Score	11.9	12.5
Baseline Lower Quartile (Q1)	11.1	12.1
Score Consistency / Variance	Wide distribution (8.9 - 14.4)	Highly consistent (11.2 - 14.2)

Impact

Impact on Students: Enhances data literacy, higher-order thinking, and evaluation skills, transforming students from passive AI consumers into critical, empowered analytical thinkers.

Impact on Educators: Provides an adaptable pedagogical model for seamlessly integrating Generative AI into coursework while maintaining academic integrity and promoting active learning.

Impact on Institutions: Establishes an exemplary benchmark for Human-AI synergy in higher education, directly aligning with institutional goals of pedagogical innovation and digital literacy.

Recommendations for Classroom Practice

- Use self-collected or highly contextualized primary data rather than generic secondary datasets to maximize student engagement and analytical relevance.
- Mandate multi-engine Generative AI exploration (e.g., comparing ChatGPT, Gemini, DeepSeek) so students learn to identify hallucinations and logic variations across platforms.
- Structure formal peer-review rubric checkpoints where students are explicitly rewarded for detecting and correcting AI calculation and contextual errors.

Acknowledgement

The authors express their gratitude to all students enrolled in the Statistics for Data Science (MCST1063) course during Semester 2 (Session 2024/2025) and Semester 1 (Session 2025/2026) at Universiti Teknologi Malaysia who participated in the learning process described in this study.

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ID 42: Blended Learning Through Interactive Classroom and Sustainable Fertigation System in Secondary School Education

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Highlights: This innovation introduces a blended learning ecosystem that integrates interactive classroom instruction using Tinkercad with a sustainable fertigation system to engage project-based learning in a secondary school. The innovation addresses the need for engaging STEM learning while strengthening digital competency and sustainable agriculture awareness. Students learn through simulation, design, practical implementation, and digital marketing of agricultural products. The approach combines engineering education with real-world community engagement, enabling learners to acquire digital, technical, entrepreneurial and collaborative skills while generating long-term educational and socioeconomic benefits for the school community.

Keywords: Blended Learning; Tinkercad; Fertigation; Project-Based Learning; Community Engagement

Introduction

The rapid advancement of digital technologies has transformed the educational landscape, requiring innovative teaching approaches that promote active learning, digital literacy, and authentic problem-solving (Berita Harian, 2023). Blended learning, which combines face-to-face instruction with technology-enhanced learning environments, has emerged as an effective pedagogical approach for improving student engagement, collaboration, and self-directed learning (Anwar et al., 2020; Azahari & Rahimi, 2022). However, many STEM classrooms continue to rely on conventional teaching methods that provide limited opportunities for students to apply theoretical knowledge to real-world engineering and sustainability challenges (Mohammadi, 2015). The absence of authentic project-based learning experiences often restricts the development of higher-order thinking, engineering design skills, and entrepreneurial competencies (Sedi, 2023). To address the growing need for authentic STEM education, this project developed an integrated learning ecosystem consisting of an Interactive Classroom, Tinkercad-based engineering design activities, sustainable fertigation practices, and digital marketing modules.

Unlike conventional classroom instruction, students are actively involved in designing fertigation systems digitally before implementing them physically, allowing them to experience the complete engineering design cycle. The innovation also promotes sustainability by connecting classroom learning with agricultural production and entrepreneurship.

Objectives

The objectives of this innovation are:

- Develop an integrated blended learning ecosystem by combining an Interactive Classroom, Tinkercad-based engineering design, and a sustainable fertigation system to support authentic project-based learning.
- Enhance students' digital, engineering, and problem-solving competencies through virtual simulation, hands-on fertigation system development, and collaborative learning activities.
- Empower teachers with innovative pedagogical practices by providing blended learning modules and professional training that integrate digital technologies into STEM education.
- Promote experiential and sustainable learning by connecting classroom knowledge with real-world applications in modern agriculture, environmental sustainability, and engineering design.
- Develop students' entrepreneurial and digital marketing skills through the commercialization of agricultural products, creating opportunities for sustainable community engagement and lifelong learning.

NALI Approach

Novelty

The innovation integrates four learning components within a single educational ecosystem namely Tinkercad engineering simulation, sustainable fertigation, blended learning modules through interactive classroom and digital marketing. This multidisciplinary integration extends beyond conventional STEM activities by connecting digital design, agricultural technology, entrepreneurship, and community engagement.

Creativity

Students first simulate fertigation systems using Tinkercad before constructing actual prototype systems at school. Learning activities include engineering design, system installation, crop cultivation, performance monitoring, and product marketing, creating an authentic experiential learning environment.

Innovativeness

The innovation transforms passive classroom learning into project-based experiential learning through digital simulation, hand-on implementation, reflection and evaluation as well as entrepreneurial application. Students learn both engineering concepts and sustainable development through real community projects.

Applicability

The innovation can be replicated in schools with limited resources because Tinkercad is freely accessible, learning modules are reusable, fertigation systems are scalable and community participation supports long-term sustainability as integration of curriculum syllabus.

Innovation Description, Process and Implementation

The innovation consists of four implementation phases which are:

1. **Interactive Classroom through Tinkercad**
   - The implementation began with a series of discussions involving school administrators and teachers to align the innovation with the existing curriculum, students' learning needs, and expected learning outcomes.
   - A structured teaching module was subsequently developed to guide both teachers and students in using Tinkercad for engineering design activities. The module introduces fundamental concepts of computer-aided design (CAD), simulation techniques, and digital prototyping within an easy-to-follow learning sequence.
   - Following the module development, hands-on training sessions were conducted to familiarize teachers and students with the software.
2. **Sustainable Fertigation System Development**
   - The implementation commenced with identifying an appropriate location within the school compound and designing the fertigation layout according to technical specifications, available space, and educational objectives.
   - The fertigation infrastructure was constructed once an appropriate location had been identified, including the installation of irrigation pipelines, drip emitters, fertilizer injectors, water storage facilities, and automated timer controllers.
   - System testing was subsequently performed to ensure operational reliability, water distribution efficiency, and compliance with safety requirements before student participation. After successful commissioning, vegetable cultivation was initiated, allowing students to monitor crop growth, evaluate irrigation performance, and collect real operational data throughout one cultivation cycle.
   - To reinforce sustainability awareness, workshops and practical sessions were organized to demonstrate proper fertigation techniques, system maintenance, and sustainable farming practices.
3. **Blended Learning Module Development**
   - A comprehensive Blended Learning Module was developed to integrate digital learning with hands-on project-based learning. The module design was informed by consultations with

teachers to identify existing instructional practices, curriculum requirements, and learning challenges. The module combines face-to-face instruction, digital simulation using Tinkercad, collaborative design activities, practical fertigation construction, and reflective learning exercises.

- Professional development workshops were subsequently organized to train teachers in implementing the module effectively. Rather than adopting a conventional lecture approach, teachers participated as learners, allowing them to experience the complete instructional process from the students' perspective. This experiential approach improved teachers' confidence in facilitating technology-enhanced learning activities.

4. **Digital Marketing for Fertigation Products**
   - A digital marketing was introduced to develop students' entrepreneurial and digital communication skills. Training workshops were conducted for both teachers and students using a combination of theoretical instruction and practical activities. Participants learned to develop promotional content, communicate product value effectively, and utilize digital platforms to market agricultural products produced through the fertigation system.
   - The effectiveness of the training was evaluated through students' digital marketing outputs. The collected feedback was used to refine the instructional strategies, ensuring continuous improvement of both the learning materials and implementation process.

Key Findings

The implementation of the innovation successfully established a learner-centred blended learning ecosystem that integrates digital engineering design, experiential learning, sustainable agriculture and entrepreneurship. The innovation achieved its intended educational outcomes through four interconnected innovation components.

The Interactive Classroom enabled students to develop fundamental engineering design skills using Tinkercad as a digital simulation platform instead of the hand sketching on conventional teaching. Curriculum alignment was successfully carried out with teachers, followed by the introduction of Tinkercad and the development of preliminary fertigation system designs. As a result, students demonstrated an improved understanding of fertigation system design, while 29 students directly benefited from the digital learning activities.

The Sustainable Fertigation System was successfully designed and installed with 200 planting plots, providing students with authentic hands-on learning in modern agricultural technology. Through practical activities involving system installation, crop management, and monitoring, both teachers and students improved their understanding of fertigation operation and sustainable crop production. The system produced 131 kg of vegetables during the first planting cycle, demonstrating its technical effectiveness while serving as a real-world learning platform.

The Blended Learning Module strengthened teachers' capacity to implement technology-enhanced, project-based learning. A draft module was successfully developed following classroom observations and collaborative discussions with teachers. The implementation involved eight Design and Technology (RBT) teachers, who gained practical experience in integrating digital tools and blended learning strategies into classroom instruction. The module supports a transition from conventional teaching towards a more interactive and student-centred learning environment.

The Digital Marketing extended students' learning beyond technical competencies by introducing entrepreneurship and digital communication skills. Students learned practical digital marketing techniques for promoting agricultural products, resulting in an additional RM1,560.50 of passive income for the school during one planting season. This component demonstrated how engineering education can be integrated with entrepreneurial learning to create sustainable economic value for the school community while providing authentic business experiences for students.

Impact

The innovation has generated significant educational, institutional, and community impacts by integrating blended learning, digital engineering design, sustainable agriculture, and entrepreneurship into a single learner-centred educational ecosystem. Through the combination of an Interactive Classroom, Tinkercad, a sustainable fertigation system, and digital marketing, the project has enhanced the quality of teaching and learning while strengthening collaboration between the university, school, industry, and community. The innovation directly benefited 29 secondary school students, who gained practical experience in computer-aided design, sustainable agriculture, teamwork, critical thinking, and

problem-solving. The innovation had also strengthened teachers' capacity to implement technology-enhanced and project-based learning. The successful establishment of a 200-plot sustainable fertigation system, together with blended learning modules and digital learning resources, enhances the school's STEM learning infrastructure while creating opportunities for interdisciplinary teaching and authentic learning experiences. Beyond educational outcomes, the innovation generated tangible socioeconomic and environmental benefits for the school community. The sustainable fertigation system produced 131 kg of vegetables, while the digital marketing initiative generated RM1,560.50 of passive income during one planting season, demonstrating the potential of integrating education with sustainable entrepreneurship. The innovation also received three (3) of 3-Star Community Engagement Star Rating recognition, demonstrating its quality, impact, and contribution to institutional community engagement initiatives. By combining engineering design, sustainable agriculture, and entrepreneurship within a blended learning environment, the project equips students with future-ready competencies aligned with Industry 4.0 and Education 5.0.

Recommendations for Classroom Practice

The innovation demonstrates that integrating Interactive Classrooms, Tinkercad, sustainable fertigation, and project-based blended learning can effectively enhance STEM education by providing authentic learning experiences that connect theory with real-world applications. To support wider adoption, educators should implement the innovation using a phased approach that gradually builds students' digital competencies before progressing to practical implementation. Educators are encouraged to begin by aligning the learning activities with the existing curriculum and identifying topics that can benefit from digital simulation and experiential learning. To ensure successful implementation, schools should provide continuous professional development for teachers through workshops, mentoring, and communities of practice that focus on digital pedagogy, project-based learning, and technology integration. The blended learning modules and operational guidelines developed through this project can serve as reference materials for teachers implementing similar activities in different educational settings. The learning framework is also highly scalable and can be customised to accommodate different learner abilities. Beginner learners may focus on basic three-dimensional modelling and simple fertigation concepts, while advanced learners can undertake more complex engineering designs, system optimisation, automation, data analysis, or entrepreneurial projects.

Other relevant information

Two copyrights as intellectual property (IP) on the innovation have been proposed as follows:

- Modul Pengajaran Asas Tinkercad Melalui Sistem Fertigasi. Ref No: IP/CR/08797 (Current status: Recommended)
- Modul Pengajaran Teradun Berasaskan Bilik Interaktif dan Sistem Fertigasi Lestari. Ref No: IP/CR/08380

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ID 43: The CORE Framework: Making Critical AI Engagement a Verifiable Competency in Engineering Group Work

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Highlights: Generative AI has made group submissions unreliable evidence of individual understanding, yet prohibiting AI misaligns with an industry now embedding it in well planning and drilling automation. Graduates need assessed AI competency, not avoidance. CORE overlays three individual accountability layers; (1) an AI Transparency Log, (2) a structured individual reflection, (3) a group-specific AI-generated follow-up quiz, onto an existing group assignment within an unchanged 15% weighting. Piloted with 64 Drilling Engineering II students, it returned a 4.26/5.0 mean student rating and surfaced recurrent AI-mediated error patterns across all 16 groups. Unlike detection-based approaches, CORE makes critical AI engagement an assessed competency.

Keywords: Alternative assessment; Generative artificial intelligence; AI literacy; Individual accountability; Engineering education

Introduction

The rapid diffusion of generative artificial intelligence (AI) has outpaced the safeguards embedded in conventional assessment. The intuitive first response, retrospective detection of AI-generated text, has proven unreliable: comprehensive testing reports neither accuracy nor dependability, together with vulnerability to simple obfuscation (Perkins et al., 2024; Weber-Wulff et al., 2023). Scholarship has consequently shifted toward assessment redesign that preserves integrity without surveillance (Ardito, 2025).

Prohibition is equally misaligned with professional reality. The upstream petroleum sector is actively embedding AI in well planning, drilling automation and real-time decision support. Graduates must work alongside such systems while retaining the judgement to recognise outputs that are mathematically plausible but physically inadmissible. The competency that matters is therefore not AI avoidance but critical AI engagement: prompting effectively, verifying outputs, and rejecting them where warranted at which a competency at present neither taught nor assessed.

Group assessment concentrates on the difficulty. In Drilling Engineering II course, a group assignment contributing 15% of the course mark addresses demanding quantitative topics including drilling hydraulics optimisation (Guo & Liu, 2011). Such a submission may be technically correct while concealing which member actually understood the reasoning, and with cohorts exceeding 60 students, viva voce verification of every individual is impractical.

The CORE (Critical and Ownership-based Reflective Evaluation) Framework resolves both problems in one structure: making individual understanding verifiable at scale and making critical AI engagement an explicitly assessed competency rather than a prohibited activity.

Objectives

- To make individual understanding verifiable within group assignments in cohorts exceeding 60 students, without viva voce examination.
- To establish critical AI engagement (prompt design, output verification and justified rejection) as an explicitly assessed engineering competency.
- To generate a distinguishable performance signal for every student from a single grading cycle, and to surface the characteristic failure modes of AI-mediated engineering calculation for diagnostic and instructional use.

NALI Approach

Novelty

Existing responses fall into two camps: detection, which the evidence shows to be unreliable, and prohibition, which is unenforceable and professionally regressive. CORE occupies neither position. Its distinguishing move is to treat the student's interaction with AI as itself the assessable object: the Transparency Log is graded on depth of critical engagement rather than on AI avoidance, so a group that identifies an AI-generated unit error, traces it to a flawed assumption and corrects it scores higher

than one reporting verbatim acceptance. To the author's knowledge, no framework in petroleum engineering education integrates transparency logging, individual reflection and group-specific verification in one graded structure.

Creativity
Three design choices carry the framework. First, verification items are generated from each group's own submitted values such as mud weight, pump pressure, optimum flow rate and nozzle configuration, so no two groups receive the same questions and external AI assistance during the timed window becomes impractical. Second, the reflection is bounded at 300 to 400 words, forcing concision and denying room for generated padding. Third, the layers are deliberately given different failure modes, so the manner in which a student circumvents one layer remains legible in the others.

Innovativeness
CORE converts a policing problem into a teaching one. Conventional practice treats AI use as a threat to be minimised; CORE treats it as a professional practice to be developed and examined. It also changes what a grading cycle produces: a conventional group report yields one mark shared by four students, whereas CORE yields a defensible individual mark, evidence of each student's AI literacy, and formative diagnosis of where comprehension broke down.

Applicability
The framework was constrained throughout by adoptability. It operates within an unchanged 15% weighting, so no programme-level approval is required; it needs no platform beyond a standard learning management system; and it adds no instrument a single lecturer cannot administer for 60 or more students. Its transferable artefacts (the log template and its four-band rubric, the three-part reflection prompt and rubric, and the verification-item generation pattern) contain nothing specific to drilling hydraulics. Any quantitative subject in which group assignments carry significant weight can adopt the structure by substituting domain content alone.

Innovation Description, Process and Implementation

CORE is a three-layer individual accountability structure overlaid on an existing group assignment. It complements rather than replaces the group submission, and the total weight remains within the pre-existing 15% of coursework. Table 1 summarises the structure and Figure 1 sets out the implementation flow.

Table 1: Structure of the CORE Framework.

LAYER	COMPONENT	WEIGHT	WHAT IS ASSESSED
—	Group Report	5%	Collaborative problem-solving
L1	AI Transparency Log	3%	Critical and ethical AI use
L2	Individual Reflective Component	2%	Ownership and metacognition
L3	AI-Generated Follow-Up Quiz	5%	Individual comprehension
	TOTAL	15%	

Layer 1: AI Transparency Log. Each group submits, alongside the technical report, a structured log documenting the AI tools used, the prompts entered, the raw output obtained, and a critical evaluation of what was accepted, modified or rejected, with reasoning. It is graded against a four-band rubric rewarding depth of critical engagement.

Layer 2: Individual Reflective Component. Each student submits a 300 to 400 word addendum structured around personal contribution to the group's work, explanation of one key technical decision the group made, and a metacognitive statement of what they would approach differently. The three-part scaffold is deliberate: reflection is not spontaneous but requires explicit prompting and structure, without which it remains shallow (Chan & Lee, 2021), and effective implementation depends on clear purpose and a safe evaluative context (Harvey et al., 2025).

Layer 3: AI-Generated Follow-Up Quiz. Within 48 to 72 hours of group submission, eight multiple-choice items per group are generated using a structured prompt that ingests that group's specific submitted values and probes the reasoning behind them. Students answer individually under 30-minute timed conditions on the course learning management system.

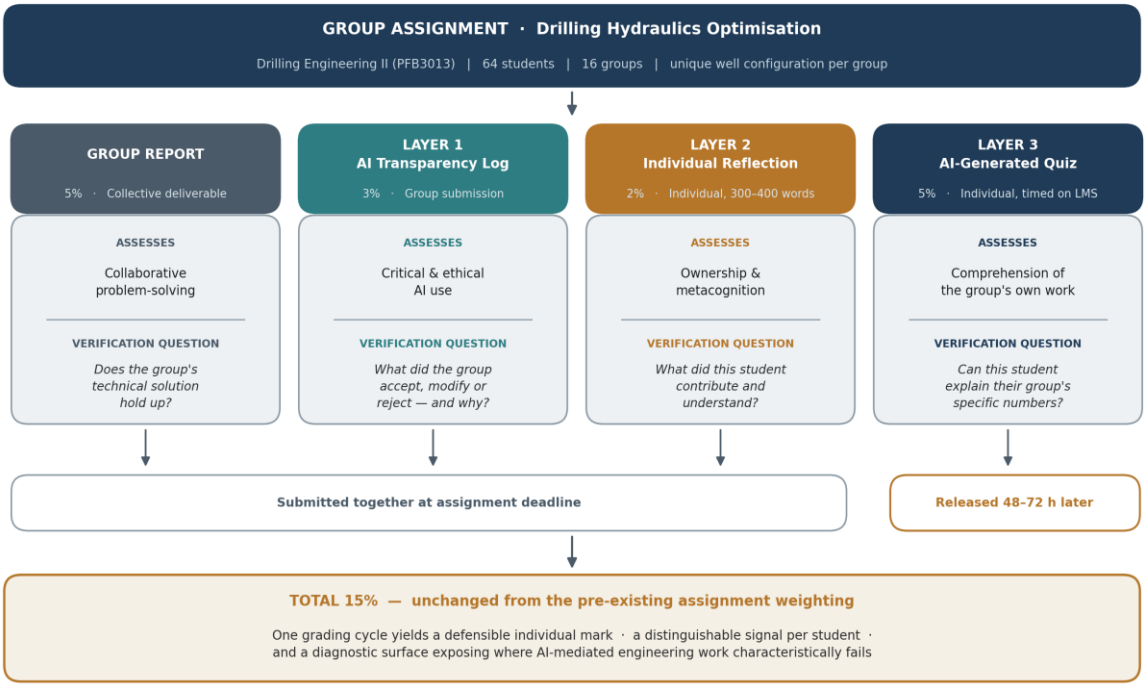


Figure 1: Implementation flow of the CORE Framework.

Implementation and evaluation: The framework was implemented in the January 2026 semester with 64 students in 16 groups, each receiving a unique well configuration, and briefed with an explicit walkthrough of every layer. Group reports and Layers 1 and 2 were submitted at the standard deadline; Layer 3 was deployed within 48 hours. Effectiveness was evaluated from lecturer grading observations across all 16 groups, a 27-item post-implementation survey administered through Microsoft Forms, and Layer 3 performance data. Participation was voluntary and identifiers anonymised prior to analysis.

Key Findings

Of the 64 students invited, 41 responded (approximately 64%). The survey returned an overall mean of 4.26 out of 5.0 across all 27 items, indicating broadly favourable reception. Section-level results appear in Table 2.

The strongest signal came from reflective practice (M = 4.46): students agreed the reflection helped them articulate their contribution and understand the group's technical decisions. AI literacy development (M = 4.29) indicated the framework-built awareness of when and how to use AI critically at which the outcome the innovation exists to produce.

Table 2: Selected results from the 27-item student survey (n = 41).

SURVEY SECTION / ITEM	MEAN	INTERPRETATION
Reflective practice (highest item)	4.46	Layer 2 most valued
AI literacy development	4.29	Builds critical AI use
Overall (all 27 items)	4.26	Broadly favourable
Perceived workload	3.95	Layered structure adds effort
Grading clarity (lowest item)	3.90	Mark partition needs clarity
Grading clarity (lowest item)	3.90	Mark partition needs clarity

The second finding is diagnostic. Grading all 16 submissions through Layer 1 surfaced four recurrent patterns in AI-mediated engineering work: (i) model inconsistency, where groups applied different hydraulic models to different sub-problems without acknowledging it; (ii) constraint violation, where a non-trivial subset reported optimum flow rates below the minimum required for effective hole cleaning where the signature of AI producing mathematically optimal but physically inadmissible solutions when constraints are not explicitly prompted; (iii) unit and dimension errors, persistent conversion failures between SI and field units; and (iv) verbatim pasting, where AI output was reproduced directly into the

critical evaluation column. These patterns are specific to constrained engineering optimisation, are invisible in conventional group submissions, and form the evidential basis for targeted instruction.

Impact

For students, CORE replaces an assessment in which four members share one mark with one in which each member's understanding is separately visible and credited; the reflective practice result (M = 4.46) indicates this was experienced as valuable rather than punitive. Students also leave having practised, and been credited for, a professional competency their coursework did not previously assess. For educators, a single grading cycle now produces what previously required either a viva or acceptance of unverified group marks, while the four error patterns supply specific, evidence-based material for instruction.

For the institution, CORE offers a response to generative AI that is defensible on academic-integrity grounds without relying on detection tools the evidence does not support. It relocates authenticity from the assessment product to the authenticated process that produced it (Tsiligkiris, 2026), broadening authenticity from the task to the student's engagement with it (Ajjawi et al., 2024).

Recommendations for Classroom Practice

Five recommendations follow. First, brief the framework explicitly: grading clarity was the lowest-scoring item (M = 3.90), a communication deficit rather than a structural one, so publish the rubric and mark partition with the assignment brief. Second, grade the Transparency Log on critical engagement rather than AI abstinence; logs rewarded for avoidance simply produce dishonest logs. Third, keep the reflection short and structured (the word bound and the three-part prompt do more together than either alone). Fourth, review generated verification items before release: if a submission contains a unit or typographical error, the item inherits it. Fifth, anticipate the workload signal (M = 3.95) by distributing the layers across the assignment period rather than concentrating them at the deadline. Adoption elsewhere requires only substituting domain content; the structure is domain-independent.

Other relevant information

The framework is supported by a competitively awarded institutional Scholarship of Teaching and Learning grant and produces a reusable artefact set (log template and rubric, reflection prompt and rubric, and verification-item generation pattern) available for adaptation elsewhere. A scaled deployment with a subsequent cohort is scheduled.

Acknowledgement

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ID 44: Analog-Digital-Analog (ADA) Pedagogical Model to Re-hook Humanistic Judgment in Landscape Architecture Education

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Highlights: The integration of Artificial Intelligence (AI) in landscape architecture education causes digital inattentiveness and cognitive overload. To address this challenge, the ADA-Studio framework implements an "Analog-Digital-Analog" three-phase pedagogical model. By restricting students to manual sketching prior to AI use and mandating the manual redrawing of AI outputs, the framework successfully curbs data paralysis. Preliminary implementation feedback showed a unanimous reduction in cognitive overwhelm among participating students. This model creatively shifts AI from being an end-to-end generator to an intermediate feedback tool, successfully re-anchoring human spatial judgment and memory retention.

Keywords: Artificial Intelligence; Landscape Architecture Students; Cognitive Overload; ADA Model; Memory Retention

Introduction

The integration of Artificial Intelligence (AI) in landscape architecture education offers unprecedented access to broad domain knowledge, yet its unmediated deployment presents a critical pedagogical challenge: digital inattentiveness, cognitive overload, and a diminishing reliance on human judgment. As students increasingly default to automated ideation across all design stages, foundational cognitive processes nurtured through manual sketching—such as spatial intuition, critical filtering, and deep working memory engagement—are at risk of being eclipsed by passive data retrieval (Goldstein, 2019; Schön, 1983). Previous research confirms that AI usage not only hinders students' memory retention but also their information retrieval (Ceylan & Sahin, 2023; Jamirsah et al., 2026), as AI-assisted learning encourages students to seek quick answers rather than engaging in deeper processing.

To address this challenge without rejecting technological advancement, this study introduces the ADA-Studio: The "Analog-Digital-Analog" Framework. This structured three-phase pedagogical model is designed to re-anchor human professional judgment within AI-assisted landscape design. Instead of banning AI or allowing unstructured use, this model establishes structured phases where students alternate between analog cognition and AI curation to build digital resilience and retention.

Objectives

- To investigate the impact of unmediated AI usage on landscape architecture students' spatial reasoning, memory retention, and cognitive overload during the design process.
- To develop and implement the ADA (Analog-Digital-Analog) Framework as a structured three-phase pedagogical model that re-anchors manual synthesis and controlled AI curation in design studio education.
- To evaluate the effectiveness of the ADA Framework in reducing digital inattentiveness, improving information comprehension, and empowering students to exercise independent professional judgment.

The following sections outline how the ADA model embeds novelty, creative cognition, pedagogical innovativeness, and institutional applicability into studio learning.

NALI Approach

Novelty

The ADA Model introduces a unique 'Counter-Cyclical Hybrid Pedagogy' that directly addresses the emerging phenomenon of AI-induced cognitive overload in design education (Sweller, 2020). Unlike traditional studio practices that either completely ban AI or permit unstructured generation, this approach creates a structured sandwich model (Analog -> Digital -> Analog). It redefines Generative AI not as an ideation engine, but strictly as an intermediate feedback and curation tool.

Creativity

The creative design of the ADA Model intentionally uses analogue constraints such as trace paper and hand sketching (Figure 2) as cognitive anchors, forcing working memory engagement before digital saturation can occur (Goldstein, 2019). Students do not use text prompts to generate designs from

scratch; instead, they digitize their own physical sketches as baselines for micro-parameter AI querying. The model creatively merges motor-tactile learning with critical reasoning by forcing students to physically trace over selected AI options while completing a self-critique matrix.

Innovativeness
This framework transforms studio pedagogy by shifting student engagement from passive data consumption to active cognitive synthesis. By imposing a strict variation limit on AI outputs, the framework directly counters data paralysis, teaching students how to curate rather than drown in information. By re-engaging hand-eye coordination, the framework restores spatial memory and deep comprehension traditionally lost to screen-based outputs.

Applicability
The ADA model is engineered for high adaptability, scalability, and long-term sustainability across higher education. The workflow can seamlessly scale to Architecture, Interior Design, Industrial Design, Urban Planning, and Graphic Design programs facing similar challenges. The framework requires no expensive software and functions as a modular pedagogical overlay that can be integrated into existing design studio curricula without a total restructuring of course learning outcomes.

Innovation Description, Process and Implementation

The innovation is executed through a strict three-phase sequence:

- **Phase 1:** Pre-AI Analog Ideation: Students are restricted to manual sketching, trace paper overlays, and physically drawn bubble diagrams for site analysis and initial spatial concepts. Banning AI at this phase preserves intuitive spatial reasoning and forces active working memory engagement.
- **Phase 2:** Controlled AI Integration: Students input their digitized manual sketches into generative AI tools to test specific micro-parameters (e.g., planting density or shadow movement). Outputs are capped to prevent information overload and force active selection.
- **Phase 3:** Analog Re-anchoring & Defense: Students manually redraw their refined AI feedback back onto physical trace paper to re-engage motor memory and tactile spatial processing. They conclude with a 'Design Defense Matrix' to justify why specific AI-suggested data was kept, modified, or rejected, fostering reflective practice during the curation phase (Schön, 1983).

Key Findings

To evaluate the real-world efficacy of the ADA-Studio framework, a pilot study was conducted with a cohort of 23 first-year landscape architecture students engaged in foundational design studio projects. Data was gathered through a post-implementation evaluation measuring cognitive load, focus levels, and subjective learning retention compared to previous unstructured AI usage. As illustrated in Figures 1 and 2, the quantitative feedback highlights significant improvements across all three operational phases of the framework.

The framework's efficacy was evaluated through a pilot implementation in a foundational landscape architecture studio. The findings demonstrate highly positive general trends:

- Compared to unstructured AI usage, student feedback indicated a unanimous reduction in cognitive overwhelm, with the vast majority reporting feeling significantly more focused during the design process.
- Preliminary qualitative data suggests that the structured workflow leads to enhanced understanding and knowledge retention as the primary learning outcomes, mitigating the rapid memory decay associated with instant AI generation.
- Observational and self-reported feedback demonstrated that Phase 3 (manual redraw) was highly effective in successfully re-engaging motor memory and rebuilding intuitive spatial judgment

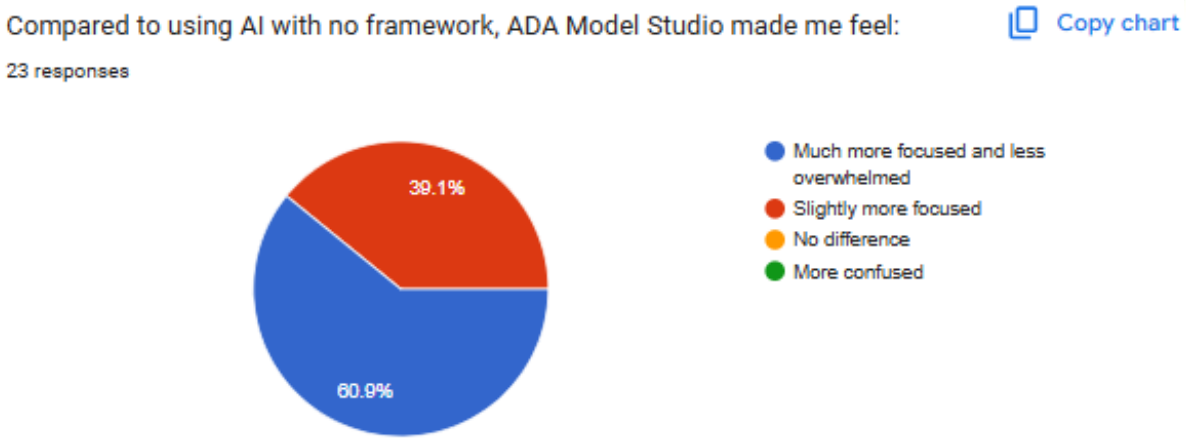


Figure 1: Pie chart showing the students feedback on how ADA Model make them feel post implementation

As shown in Figure 1, 100% of respondents reported positive cognitive outcomes when using the structured ADA framework compared to unstructured AI usage. Specifically, 60.9% of students felt 'much more focused and less overwhelmed,' while 39.1% reported feeling 'slightly more focused'. Notably, zero respondents selected 'no difference' or 'more confused'. This unanimous positive response highlights how enforcing structural boundaries—such as pre-AI sketching and capped variations—effectively eliminates the data paralysis and cognitive fatigue commonly caused by open-ended AI generation.

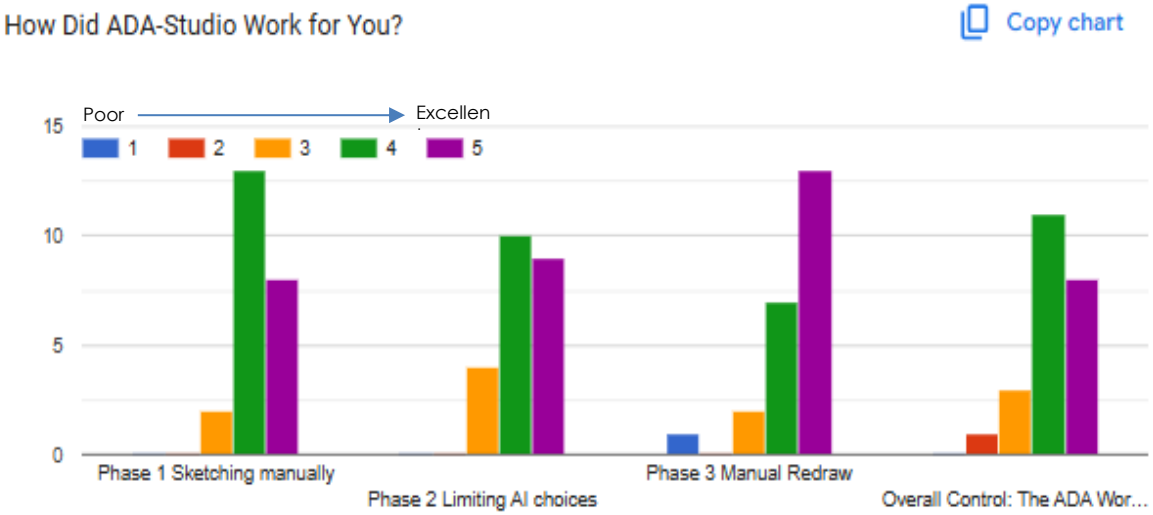


Figure 2: Bar chart showing the students feedback on how ADA-Studio worked for them

Figure 2 illustrates student ratings (on a 1 to 5 scale) evaluating the helpfulness of each specific phase in the ADA workflow. Phase 1 (manual sketching) and Phase 2 (limiting AI choices) received high satisfaction ratings, primarily clustered at levels 4 and 5. Most significantly, Phase 3 (manual redrawing of AI ideas) received the highest proportion of top ratings (level 5), with 13 out of 23 students rating it as extraordinarily effective. This confirms that physically redrawing digital feedback on trace paper is perceived by students as the most critical step for regaining personal agency, enhancing spatial clarity, and rebuilding intuitive spatial control.

Beyond quantitative metrics, qualitative feedback was gathered to examine whether manual redrawing in Phase 3 actively reduced digital inattentiveness and enhanced spatial memory. Table 1 details key student responses regarding their perception of knowledge retention, spatial visualization, and critical design ownership when translating digital feedback back to paper.

Table 1: Students' feedback on does this ADA Model helps them in designing

No.	Redrawing AI ideas manually (Phase 3): Did this step help you retain/understand the information better than just looking at a screen?	95.7% Say Yes Phase 3 helps	Reducing digital inattentiveness	Improve information comprehension	empowering students' independent judgement
1	Yes				
2	Yes, even makes me enhance the skills and remember the steps				
3	Yes.. its so helping me cause ai actually dont really understand what we want.. if we draw first we will give ai guide so ai can make like we want				
4	Yes. Redrawing the AI-generated ideas manually helped me understand and retain the information better than simply viewing it on a screen. By sketching the concepts myself, I had to pay closer attention to the details, relationships, and layout, which reinforced my understanding.				
5	Absolutely				
6	Maybe little bit, but I end up relying on it heavily. Over time, it leads to "brain rot" because it will be focusing on how to redraw things rather than coming up with actual ideas.				
7	Yes, it did. At first, I thought it would just take more time, but when I started redrawing the ideas myself, I realized I understood the concepts much better. It made me pay attention to the details and think about why the design was created that way instead of just looking at the AI-generated result.				
8	Yes. Manually redrawing the Ai generated ideas helped me understand and remember the information better because it required active engagement instead of passive viewing				
9	Yes				
10	Yes				
11	Yes				
12	Yes, its help me visualizing the ideas and the functions more clearly				
13	It helps me understand the information better				
14	Yes, I can get more inspirations for there also				
15	Yes drawing manually helps significantly because it helps me into active understanding				
16	Yes, it helps me improve and rationalize the AI design to fit the intended idea based on the task given.				
17	Yes it help me understand better about my design				
18	Yes, it helped me understand and remember the information better.				
19	Yes				
20	Yes, a physical paper will always show a clearer image than in screen				
21	Yes. Redrawing the ideas helped me remember and understand them better.				

No.	Redrawing AI ideas manually (Phase 3): Did this step help you retain/understand the information better than just looking at a screen?	95.7% Say Yes Phase 3 helps	Reducing digital inattentiveness	Improve information comprehension	empowering students' independent judgement
22	Yes it is				
23	Yes because took 100% AI its not original idea from us maybe we can get the input and redraw based on our ideas for make it better and more realistic and logic.				

While 95.7% of participants confirmed that Phase 3 significantly improved their comprehension over passive screen viewing, the implementation process also highlighted areas for pedagogical refinement. The constructive feedback provided by students demonstrates that structured physical-digital friction does not hinder creativity; rather, it provides the scaffolding required for meaningful human-AI collaboration. These qualitative insights directly inform the broader pedagogical impact and strategic recommendations for studio implementation outlined below.

Impact

The innovation successfully curbs cognitive overload and fosters focus and comprehension for students. By shifting AI interaction from low-level retrieval to high-level evaluation, the framework empowers the designer over the AI and re-anchors professional judgment. For educators and institutions, it offers a sustainable pedagogical model that trains students to maintain agency alongside evolving tech tools, mitigating the issue where AI acts as an external hard drive that bypasses long-term memory.

Recommendations for Classroom Practice

To successfully integrate and replicate this pedagogical innovation across different educational contexts, educators must enforce strict manual constraints during Phase 1 prior to any digital integration to ensure active working memory engagement. As the workflow transitions to digital tools, instructors should strictly cap AI outputs during generation to prevent data paralysis and encourage informed, deliberate selection by the learner. Finally, to solidify learning outcomes and adapt the framework to varying subject areas, the implementation of a "Design Defense Matrix" is highly recommended; this explicitly forces students to defend their curation of AI data, thereby formulating final critical reasoning and ensuring they retain cognitive ownership over their work.

Acknowledgement

I would like to thank the foundational landscape architecture students who participated in this pilot framework implementation.

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ID 45: Awang Matik: Design and Development of an Ethnomathematics Learning Kit for Year 4 Orang Asli Jakun Primary Students

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Highlights: This project presents an ethnomathematics learning kit for Year 4 Orang Asli Jakun primary students in Johor, developed using a Design and Development Research (DDR) framework. Addressing learning gaps in primary mathematics, the kit integrates authentic Jakun cultural elements with Year 4 mathematics learning objectives via the 5E Instructional Model. Needs analysis involved teacher interviews across SK Orang Asli in Johor and student diagnostic tests. Design consensus on content, environment, and learning style constructs was established through Focus Group Discussions and Fuzzy Delphi Method (FDM). The kit enhances mathematical understanding, student engagement, and cultural identity preservation.

Keywords: Ethnomathematics; Orang Asli Jakun; Design and Development Research (DDR); Fuzzy Delphi Method (FDM); 5E Instructional Model

Introduction

Mathematics education for Indigenous primary school students specifically the Orang Asli Jakun community in Johor, Malaysia presents unique pedagogical challenges. While Orang Asli pupils frequently demonstrate exceptional spatial awareness and practical computational skills in their daily lives, conventional classroom instruction struggles to translate these innate strengths into formal academic achievement. This disconnect becomes particularly acute when mathematical operations are embedded within text-heavy word problems. Demonstrating the severity of this issue, a study involving Grade 4 and 5 Orang Asli students revealed that 54.5% of pupils failed to score a single mark on a basic five-item word-problem test (Abd Jalil & Abdullah, 2025). The root of this struggle is largely linguistic. Since Malay is a second or third language for most Orang Asli children, they are forced to process a dual cognitive load, decoding complex academic terminology while simultaneously performing mathematical calculations. Consequently, standardized assessments end up evaluating language proficiency rather than actual mathematical competency (Shanmugam et al., 2025). Compounding this linguistic barrier is a severe contextual mismatch, word problems frequently ask students to navigate urban scenarios such as shopping malls, escalators, subway systems, or bank transactions that are entirely foreign to children raised in remote, forest-dwelling communities (Ntumi et al., 2026). Awang-Matik incorporates Ubiratan D'Ambrosio's ethnomathematics framework to bridge this cultural and linguistic divide. By anchoring formal Year 4 mathematical concepts in authentic Jakun cultural artifacts, oral storytelling, and visual-tactile manipulatives, Awang-Matik bypasses textual barriers to make mathematical reasoning intuitive, accessible, and meaningful.

Objectives

- To establish expert consensus on learning content, learning environment, and learning style constructs incorporating authentic Orang Asli Jakun cultural elements using the Fuzzy Delphi Method (FDM).
- To design and construct an ethnomathematics learning kit structured around the 5E Instructional Model.

NALI Approach

Novelty

Awang-Matik redefines ethnomathematics learning kits by pairing intentional cultural revitalization with a complete, curriculum-aligned teaching and learning ecosystem. Rather than using culture as a passive background theme or superficial context, the kit explicitly begins every activity with a purposeful cultural re-introduction, actively reconnecting Jakun students with their heritage tools, oral traditions, and spatial wisdom before bridging into formal mathematics. Unlike standard student-only activity kits that leave classroom execution to teacher guesswork, Awang-Matik incorporates a comprehensive Teacher's Guide that explicitly maps every task to specific DSKP Year 4 Learning Standards while providing a step-by-step breakdown across all phases of the 5E Instructional Model to ensure full conceptual mastery by the end of each lesson.

Creativity
Creativity in Awang-Matik is embedded through the multi-faceted integration of Jakun living traditions, traditional crafts, and indigenous dance into dynamic mathematical explorations. Rather than limiting ethnomathematics to static visual aids, the kit transforms diverse cultural domains into active, creative problem-solving challenges across the 5E learning cycle. Students engage in tactile spatial reasoning by designing and weaving authentic patterns to discover geometric properties, choreographing traditional dance steps to internalize spatial coordination and pattern sequencing, and applying arithmetic logic to real-world community scenarios, such as equitably dividing daily fish catches to master division and fractions.

Innovativeness
Rather than acting as a standalone game or fragmented exercise set, the entire kit natively structures every topic around the full 5E Instructional Model (Engage, Explore, Explain, Elaborate, Evaluate), providing a turnkey solution that shifts classroom practice from rigid, teacher-centered lectures to active, student-centered facilitation.

Applicability
Natively mapped to the national Year 4 Mathematics curriculum (DSKP KSSR Semakan), Awang-Matik requires no alteration to standard learning objectives. This allows for straightforward rollout across all Sekolah Kebangsaan Orang Asli (SKOA) nationwide, as well as mainstream primary classrooms seeking inclusive, hands-on STEM interventions. Additionally, the underlying DDR-5E framework serves as a universal pedagogical blueprint. While Awang-Matik is currently tailored to the Orang Asli Jakun community, the kit can be replicated for other Indigenous sub-ethnic groups by updating the narrative comic stories and swapping localized cultural artifacts.

Innovation Description, Process and Implementation

The innovation consists of a physical and pedagogical Ethnomathematics Learning Kit engineered specifically for Year 4 primary mathematics instruction. The design and development process followed a Design and Development Research (DDR) model as detailed in Table 1.

Table 1: Design and Development Process

DDR Phase	Methodology	Target Participants	Key Output
Design	Fuzzy Delphi Method (FDM)	Expert in Indigenous Education, Mathematics Teacher in SK Orang Asli and Cultural Heritage Leader	Expert consensus ($d \leq 0.2$, $\geq$ 75% agreement) on Content, Environment & Learning Styles
Development	5E Model Activity Structuring	Year 4 Primary Mathematics Curriculum (KSSR Semakan)	Interactive kit covering the 1st learning objective of all Year 4 math topics

Key Findings

A primary outcome of the design and development phase was the systematic, expert-validated mapping of authentic Jakun cultural practices directly to Year 4 KSSR Semakan Mathematics Learning Standards across all four primary curriculum themes, structured seamlessly within the 5E Instructional Model.

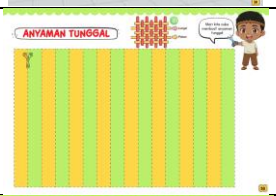
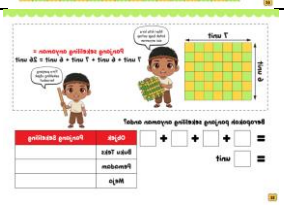
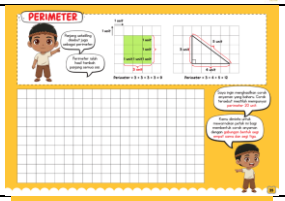
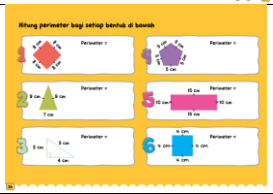
Table 2: Ethnomathematical Mapping of Jakun Cultural Artifacts to Year 4 Mathematics Learning Standards.

JAKUN CULTURAL ELEMENT	THEME	TOPIC	LEARNING STANDARD
Rotan Sega (Sega Rattan)	Numbers & Operations	Whole Numbers & Basic Operations	**1.1.2** State the place value and digit value for any number.
Lukah (Traditional Fish Trap)		Fractions	**2.1.1** Convert improper fractions to mixed numbers and vice versa.
Sentoyot (Traditional Basket)	Measurement & Geometry	Time	**4.1.1** Know the relationship between the 12-hour and 24-hour systems.
Sumpitan (Blowpipe)		Measurement (Length)	**5.1.3** Convert units of length involving millimeters and centimeters.
Anyaman Kelarai (Woven Pattern)		Space	**6.3.1** Determine the perimeter of polygon shapes.
Tarian Sewang (Sewang Dance)	Relationship & Algebra	Coordinates	**7.1.1** Identify x-axis, y-axis, and origin. **7.1.2** Determine coordinates in the first quadrant and vice versa.

JAKUN CULTURAL ELEMENT	THEME	TOPIC	LEARNING STANDARD
Kercang (Traditional Rattan Puzzle)	Statistics & Probability	Data Management	**8.1.1** Construct pictographs for ungrouped data. **8.1.2** Interpret constructed pictographs.

The following exemplar details the complete lesson sequence for the topic of Space, mapped to the cultural craft of Woven Patterns (Anyaman Kelarai) (DSKP Standard 6.3.1: Perimeter of Polygons) to illustrate how the 5E Instructional Model is operationalized in practice.

Table 3: Exemplar 5E Instructional Model: Anyaman Kelarai

5E PHASE	ACTIVITY DESCRIPTION	AWANG-MATIK
Engage	Narrative comic featuring Anyaman Kelarai set within a heritage exhibition context	
Explore	Hands-on weaving (teknik anyaman tunggal)	
Explain	Teacher explicitly introduces formal mathematical terminology (Perimeter) and connects physical grid counting to formal operations.	
Elaborate	Students are given a pre-determined perimeter and must design/color a new kelarai pattern on a grid matching that exact value.	
Evaluate	Students calculate perimeters of six formal geometric shapes with varying side lengths, presented without grid overlays.	

Impact

Awang-Matik transforms primary mathematics education for Orang Asli Jakun students by replacing text-heavy word problems with culturally grounded visual-tactile manipulatives, immediately reducing language-driven cognitive load and elevating classroom engagement. For educators, it enhances teaching effectiveness through a research-validated 5E pedagogical framework that replaces rigid instruction with intuitive, student-centered facilitation tailored to indigenous learners. Institutionally, the kit advances Ministry of Education equity mandates by providing a scalable, DSKP-aligned blueprint that actively narrows the urban-indigenous performance gap. Beyond the classroom, Awang-Matik delivers long-term societal value to Jakun village communities and elders by embedding traditional spatial wisdom into formal STEM education, simultaneously boosting student confidence and preserving endangered cultural heritage.

Recommendations for Classroom Practice

Since the Awang-Matik learning kit is natively pre-structured around the complete 5E Instructional Model for every Year 4 mathematics topic, educators can implement it directly as a turnkey pedagogical solution without redesigning lesson flows. Teachers facilitate the kit's built-in sequence: launching lessons

with narrative comic stories featuring traditional Jakun cultural tools while inviting pupils to share their own lived experiences using or encountering those tools (Engage), guiding tactile manipulation of physical materials (Explore), connecting physical observations to formal mathematical notation (Explain), applying concepts to contextualized village scenarios (Elaborate), and administering icon-based self-checks (Evaluate). Awang-Matik can also be customized across several dimensions to ensure successful adoption across diverse educational contexts. The kit's underlying ethnomathematical manipulatives easily extend beyond mathematics into science (investigating structural forces, natural materials, and measurement). The kit's modular framework allows easy adaptation for other Indigenous sub-ethnic groups (such as the Semai or Temiar) simply by updating the narrative comics and swapping localized cultural artifacts. Long-term institutional sustainability is secured by sourcing replacement manipulatives from low-cost, locally available natural materials, supported by school-cluster Professional Learning Community (PLC) workshops that empower teachers to act as student-centered facilitators.

Acknowledgement

Heartfelt gratitude is extended to the State Education Department (JPN), District Education Offices (PPD), and the leadership and teachers of Sekolah Kebangsaan Orang Asli (SKOA) for granting approvals and serving as key research respondents. Sincere appreciation is also expressed to the Department of Orang Asli Development (JAKOA) and academic specialists in Indigenous studies, whose cultural insights and field expertise were instrumental in structuring and refining the Awang-Matik learning activities.

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ID 46: Learning AI by Building AI Through a Hands-On Process Modelling Approach for Chemical Engineering Education

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Highlights: Conventional process modelling instruction is based on rigid, complex simulators that constrain exploration and impose a manual assessment burden on instructors. This innovation bridges that gap by training students to create AI-based process models, rather than merely using current technologies. A two-session workflow with an acid gas removal unit on Google Colab helps students learn about problem identification, model training, and evaluation. It was piloted with 53 students achieving 57% outstanding satisfaction and 62% good usefulness. Its value add: re-positioning AI as a skill students build, not consume, a low-cost, scalable path to AI literacy.

Keywords: AI-based process modelling; Hands-on learning; Chemical engineering education; AI literacy

Introduction

Process modeling remains at the heart of chemical engineering education, appreciated for its capacity to reliably represent, simulate and analyze chemical systems (Ryan & Heavy, 2006). However, in practice this is done typically using commercial simulation software that is limited in control and complicated in operation, especially during optimization (Okuyelu et al., 2024). Students sometimes spend a disproportionate amount of time working thru the software's comprehensive, step-by-step specs rather than interacting with the underlying concepts, and each error along the way requires intensive, time-consuming troubleshooting. This same complexity makes it tougher for educators to measure student performance, adding to their effort in dealing with frequent technical challenges.

AI-driven process modeling can overcome the limitations by enabling fast and accurate issue solutions in situations when traditional methods are not applicable (Dobbelaere et al., 2021). Its industrial applications already include anticipating quality of products and optimizing processes with visual inspection and predictive maintenance (Ricci et al., 2025). This experience in the industry has also been translated into education, where AI is widely used as a learning tool per se (Thon et al., 2021). In classes on process modeling and simulation AI automates much of the underlying complexity and makes the topics easier to understand. This incorporation, together with the hands-on teaching approach, increases the learning efficiency and gives students a better understanding of the process modeling as a whole – providing AI-based optimization in a more accessible form to grasp and interact with in a shorter time.

Objectives

- To enable chemical engineering students to identify key process variables and formulate AI-solvable problems from a real industrial case study (acid gas removal unit).
- To build students' capability to develop and train AI-based process models independently, using open-access tools and selected machine learning algorithms.
- To improve students' ability to evaluate model performance using numerical and graphical methods, strengthening their understanding of accuracy and optimization in process modelling.
- To provide educators with a replicable, structured framework for embedding hands-on AI modelling into existing process modelling curricula.

NALI Approach

Novelty

This innovation requires students to build their own AI-based model from problem identification to evaluation using a real acid gas removal unit case study, in contrast to traditional process modelling training that regards AI as a ready-made instrument students merely run.

Creativity
Innovation pairs conceptual grounding with independent execution, structuring learning so students first internalize the "why" before building the "how" themselves.

Innovativeness
It shifts chemical engineering pedagogy from teaching students about AI to teaching through AI, embedding applied machine learning practice directly into independent coding work rather than lecture-based instruction.

Applicability
The framework can be easily modified to various unit activities, courses, or institutions with little cost or infrastructure investment because all it needs is a dataset, a free coding platform, and a guided notebook.

Innovation Description, Process and Implementation

This innovation takes the form of a two-session, hands-on AI modeling program for chemical engineering students. The first session provides conceptual footing via theory and problem identification; the second takes students into Google Colab, where they import data, visualize variables, map relationships, split datasets and develop prediction models. Fifty-three students were involved and outcomes were assessed using structured questionnaires administered post-session. The overall workflow, from concept preparation through evaluation, is illustrated in Figure 1.

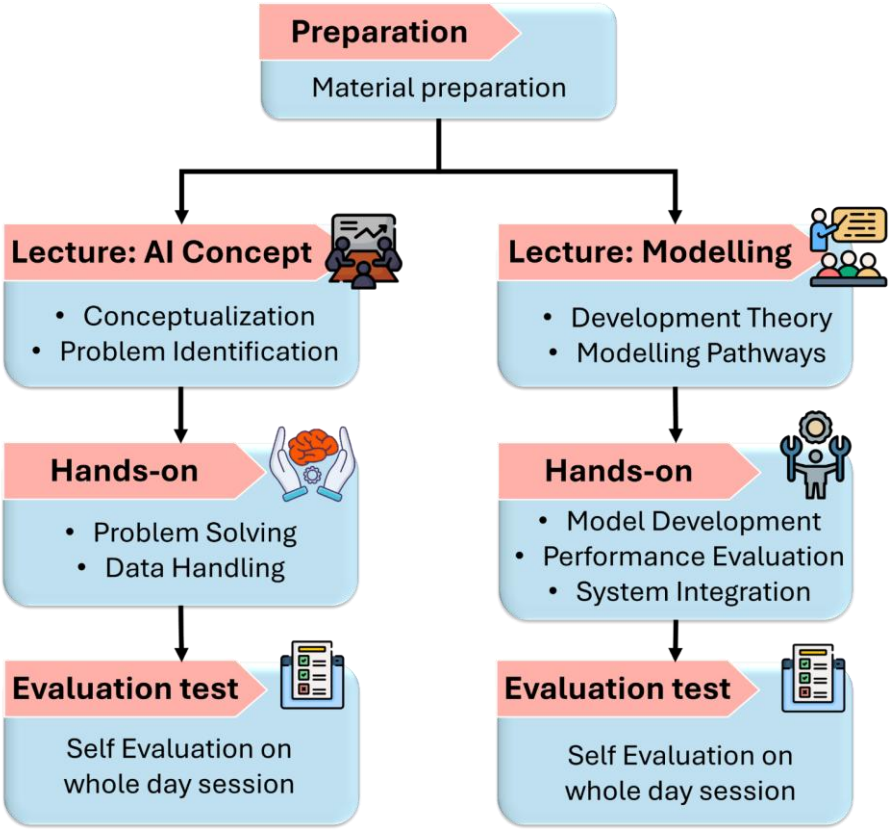


Figure 1: Two-session hands-on AI modelling workflow, from concept preparation through evaluation.

Key Findings

Strong feedback was received after the session: 57% of participants rated their overall experience as outstanding, 36% as good, and 62% said the material was very helpful and in line with their learning objectives. The hands-on pace was appropriate for their ability level, as seen by the 58% who assessed difficulty as moderate. Qualitatively, students' application of AI ideas improved with time, demonstrating the method's efficacy in developing practical AI competency.

Impact

The technique cultivates hands-on AI skills and confidence beyond passive tool use for students. To educators it provides an out-of-the-box module that folds in AI literacy without needing to alter the core curriculum. For the institution, this means being leading the way in applied AI pedagogy as industry demand for AI-literate graduates grows. Long term it can proliferate onto other courses, maintaining impact beyond this experiment.

Recommendations for Classroom Practice

Educators may consider pairing each AI concept with a real industrial case study, using free, browser-based tools like Colab to ease cost barriers. Sequencing sessions theory-first, then hands-on, can help manage cognitive load, while guided templates support learners with limited programming background. The workflow may adapt to other courses by substituting the dataset, transferable across subjects without altering its structure.

Acknowledgement

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ID 47: AI-Integrated Critique Cybergogy (AICC): A Human-AI Collaborative Learning Approach for Analytical Learning

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Highlights: AICC Framework: Positions Generative AI as an active critique partner rather than a passive solution generator to foster higher-order analytical thinking. Iterative Human-AI Cycle: Features a 4-phase learning workflow; Independent Construction, AI Critique Engagement, Human Reflection/Judgement, and Model Refinement. Empirical Validation: Implemented in an undergraduate Software Requirements Engineering class (N=42 completed reflection evaluations, 79 pre-test attempts). Limitation: A smaller number of drop-offs in student participation in reflection evaluation. Impact: Approximately 90% of students reported model improvements via critique prompts; demonstrated enhanced critical evaluation of AI-generated hallucinations and assumption.

Keywords: Cybergogy; Critique teaching; Analytical learning; Software Engineering Education

Introduction

Analytical learning is essential in higher education as it enables students to evaluate information, question assumptions, justify decisions, and develop well-reasoned solutions to complex problems (Campo et al., 2023; Anthonysamy et al., 2024; Wani & Hussian, 2024; Van Damme et al., 2023). However, many students tend to focus on producing answers rather than engaging in deeper analysis, reflection, and evaluation of their work (Lindblom-Ylänne et al., 2019; Zhang, 2024). The increasing availability of Artificial Intelligence (AI) tools has further intensified this challenge, as learners may become passive consumers of AI-generated content instead of actively constructing knowledge and exercising critical judgement (Nasr et al., 2025; Hosseini, 2025). To address this challenge, AI Integrated Critique Cybergogy (AICC) was introduced as a human-AI collaborative learning approach. Instead of using Artificial Intelligence (AI) to generate solutions, students engage with AI-generated critique prompts that encourage analysis, reflection, and refinement of their use case models. Through iterative critique cycles, students evaluate AI feedback, identify modelling weaknesses, and justify decisions to improve. This approach positions AI as a critique partner that supports higher-order thinking while maintaining learners as the primary decision-makers. While AICC is designed as a domain-independent framework for analytical learning, its implementation in this study focused on a Software Requirements Engineering course. Requirements Engineering provides an ideal context for applying AICC because students are required to analyse problem scenarios, identify stakeholder needs, model system interactions, and justify design decisions. These tasks demand higher-order thinking skills that go beyond memorising concepts or producing solutions.

Objectives

- To enhance students' analytical thinking skills in Software Requirements Engineering through AI-assisted critique prompting.
- To improve students' ability to identify, evaluate, and refine weaknesses in use case models through iterative reflection and feedback.
- To establish a human-AI learning partnership that promotes critical evaluation rather than passive acceptance of AI-generated responses.

NALI Approach

Novelty

A paradigm shift in GenAI pedagogy that transitions AI from an answer generator into a cognitive critique partner. By forcing learners to critique both their work and the AI's feedback, AI serves as an analytical catalyst rather than a shortcut.

Creativity

Combines guided, self-improvement, role-playing, and reflective prompting strategies into a dynamic learning sprint. By prompting AI to play real-world stakeholder roles (e.g., system administrator, end-user), students gain multi-perspective domain insights.

Innovativeness
Establishes a scalable, automated feedback loop for large classroom settings. It addresses the educator feedback bottleneck without replacing human cognitive agency.

Applicability
Highly scalable, low-cost, and domain-independent. While tested in Software Engineering, AICC adapts seamlessly to Business Model Canvas design, Essay/Translation refinement in Languages, Clinical Case Analysis in Medicine, or System Design in Information Systems.

Innovation Description, Process and Implementation

Innovation Descriptions and Process
AICC operates through a four-phase Human-AI Critique Cycle.

Phase 1: Independent Knowledge Construction: Students complete an initial task (e.g., Use Case Diagram) independently to establish autonomous domain reasoning without AI influence.

Phase 2: AI Critique Engagement: Students feed their baseline work into AI using structured critique prompts (focusing on completeness, edge cases, consistency, and logic).

Phase 3: Human Reflection and Judgement: Students critically evaluate the AI's critique against course requirements and domain rules to identify underlying assumptions or potential hallucinations.

Phase 4: Refinement and Improvement: Students revise their artefacts based on validated insights, iteratively repeating the loop.

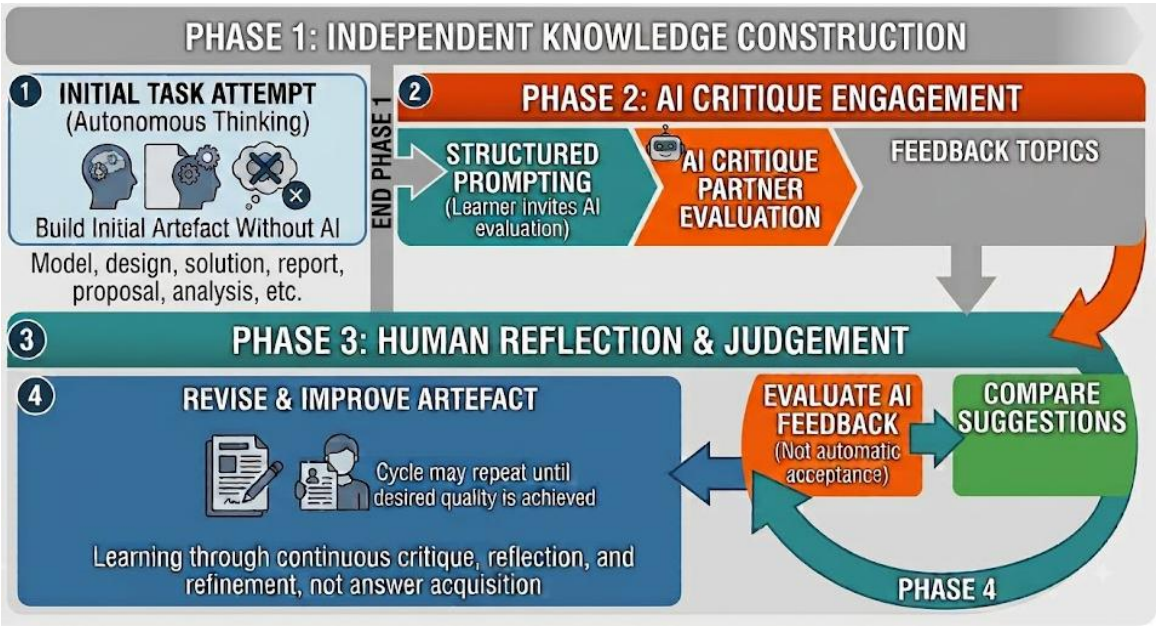


Figure 1: AICC Framework

Classroom Implementation
AICC was piloted during a Prompt-Guided Use Case Modelling Sprint in the undergraduate course WIF2002: Software Requirement Engineering at Universiti Malaya.

- Baseline Sprint (Phase 1): Students created an initial use-case diagram for a Library Management System without AI tools.
- Critique Sprint (Phase 2 & 3): Using custom "Gem Brainstorm Partners," students submitted their baseline diagrams alongside structured prompts focusing on missing actors, relationship logic (<<include>>/<<extend>>), and edge cases.
- Refinement & Reflection (Phase 4): Students updated their diagrams in draw.io and submitted a reflection capturing how AI feedback altered their models and where AI recommendations were rejected. (Refer to Appendix Photos: Classroom Activity & LMS Interfaces).

Key Findings

Data collected from N=42 completed reflection evaluations and 79 pre-test attempts revealed significant positive shifts in student analytical behavior.

Impactful AI Critique Prompts

Approximately 90% of students confirmed that AI critique prompts directly improved their initial use-case models.

Table 1: AI Critique Prompt Analysis

PROMPT FOCUS AREA	FREQUENCY (N=42)	APPROX. FREQUENCY	KEY COGNITIVE GAIN
Missing Actors / External Systems	17	40%	Identification of omitted system boundaries
Missing or Weakly Defined Use Cases	11	24%	Uncovering correct <<include>>/<<extend>> logic
Relationship Logic Evaluation	10	26%	Expanding system functional scope
Other (Chain-of-thought, custom prompts, no improvement)	4	10%	Tailored domain-specific probing

Top Discovered Modelling Defects

- AI critique successfully led students to discover critical gaps in their original work:
- Missing actors & external system integrations ($n = 18$)
- Missing or poorly defined use cases ($n = 16$)
- Omission of authentication, login, and registration workflows ($n = 10$)
- Relationship & structural logic errors ($n = 8$)
- Overlooked fine payment and exception handling ($n = 7$)

Evidence of Critical Human-AI Synergy

Approximately 33% of students explicitly demonstrated higher-order critical evaluation by identifying and rejecting flawed AI feedback:

- Over-complexity: Students noted AI tended to *"keep trying to make the use-case diagram too complex,"* requiring human intervention to bound system scope.
- Unwarranted Assumptions: Students observed AI *"focuses on real-world library systems by making assumptions"* outside the given assignment scenario.
- Technical Hallucinations: Multiple students caught AI incorrectly labelling database infrastructure as a secondary actor (e.g., *"it suggested me to include database as the secondary actor"*), demonstrating active filtering over passive acceptance.

Recommendation for Practice

Approximately one-third of students explicitly acknowledged that AI-generated suggestions should not be accepted uncritically and recognised the need for human judgement to validate, filter, and contextualise AI feedback.

Some of the feedback is given below:

- One student noted that AI "*can make the use case diagram too complex*" and "*keep trying to make the use case diagram too complex*", suggesting the need for human judgement when determining the appropriate level of system detail.
- Another student reported that "*The AI focuses more on what functionalities a real-world library system usually includes by making assumptions*", indicating that AI may introduce assumptions beyond the requirements provided in the scenario.
- Some students observed that AI occasionally generated incorrect modelling suggestions, such as "*it said database is an actor*" and "*it suggested me to include database as the secondary actor*", demonstrating that AI recommendations require validation before adoption.

Impact

The implementation of AICC has positively impacted students by transforming them from passive recipients of information into active learners who critically analyse, evaluate, and refine their own work. Through structured AI critique prompts, students developed stronger analytical thinking, reflective reasoning, and problem-solving skills. For educators, AICC provides a scalable approach for facilitating higher-order thinking and delivering timely feedback, particularly in large classroom environments. At the

institutional level, AICC supports the integration of Artificial Intelligence into teaching and learning in a pedagogically meaningful manner. In the long term, AICC contributes to the development of graduates who can work effectively with AI while maintaining critical judgement and independent thinking.

Recommendations for Classroom Practice

AICC can be integrated into teaching and learning activities by requiring students to develop their initial solutions independently before engaging with AI-generated critiques. Through the human-AI critique cycle, students use AI to analyse, evaluate, and refine their own work rather than relying on AI to generate complete solutions. This approach promotes responsible AI usage in the classroom, demonstrating that AI serves as a learning partner that enhances critical thinking, reflection, and continuous improvement while preserving student ownership of the learning process. AICC can be effectively implemented across different disciplines and learning environments. For example, business students can refine business models, language students can improve essays or translations, and medical students can evaluate clinical case analyses through AI-assisted critique, while remaining responsible for validating feedback and refining their own work through reflection and iterative improvement. AICC can be customized to suit different learner needs, subject areas, and institutional settings by adapting the critique prompts, learning tasks, and level of guidance to match the course objectives and student competency levels.

Acknowledgement

I express my sincere gratitude to the students in the WIF2002-Software Requirement Engineering class for participating in the teaching and learning activities. Other than that, I would also like to express my gratitude to the team members who have helped me prepare the materials needed for the AICC implementation.

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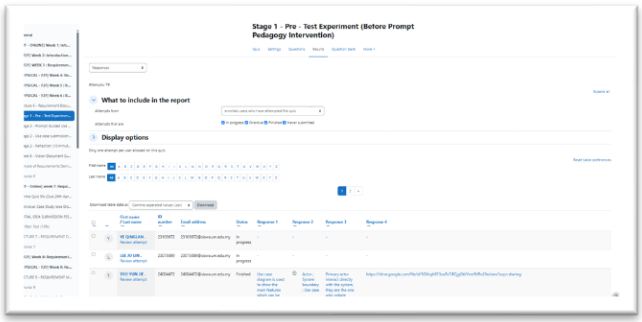
Appendices

Appendix A: Pictures taken during the activity

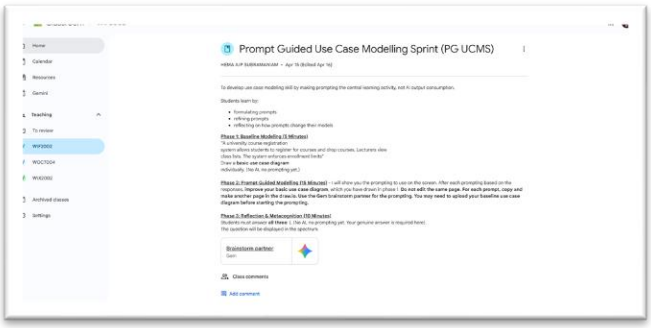





Appendix B: Pre-Test Assessment Used to Capture Students' Initial Understanding of Use Case Modelling



Appendix C. AICC Learning Activity: Prompt-Guided Use Case Modelling Sprint



ID 48: ChemVerse AI: An immersive AI-powered Virtual Laboratory for Computer-Aided Chemistry

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Highlights: Computer Aided Chemistry subject is often taught as a sequence of disconnected software tutorials, leaving students procedurally competent but conceptually unclear. ChemVerse AI addresses this through a browser-based, chapter-structured virtual laboratory that pairs embodied 3D interaction using Joy-Con motion control with AURA, a Socratic AI tutor. Students predict, test, and reason through each computational technique rather than simply executing procedures. Chapter 1 (Molecular Docking) was piloted with 50 students, with conceptual understanding increasing by 37.8 percentage points and spatial ability by 32.1 percentage points (both $p < 0.001$), alongside 92% overall satisfaction. These findings demonstrate a scalable approach to teaching Computer-Aided Chemistry through reasoning rather than clicking.

Keywords: Computer Aided Chemistry; immersive learning; AI tutoring; molecular docking; embodied interaction

Introduction

Computer-Aided Chemistry (CAC), spanning molecular docking, molecular dynamics, chemometrics, pattern recognition, and modelling and simulation, is central to modern chemistry practice, yet it remains one of the hardest subjects to teach conceptually. Courses typically progress through each computational technique via its own software interface, so students learn to operate a tool before they understand the chemistry it models, leaving abstract 3D concepts, decision justification, and interaction reasoning underdeveloped (Rodríguez-Becerra et al., 2020). ChemVerse AI is built around the genuine synergy between human educators and artificial intelligence in pedagogy, in which AI extends what the educator and student can accomplish together rather than replacing either. The human educator designs each mission and facilitates discussion, the AI tutor AURA observes student actions and responds with Socratic questions rather than direct answers, and the student explores, predicts, and reasons within the environment. Advances in browser-based 3D rendering, motion-based interaction, and AI tutoring make this three-way collaboration possible, building on evidence that active, inquiry-driven approaches strengthen conceptual understanding and engagement in chemistry more broadly (Byusa, Kampire, & Mwesigye, 2022). This project presents ChemVerse AI and its Molecular Docking chapter, piloted with 50 undergraduate students for Computer Aided Chemistry module.

Objectives

- To develop an immersive, chapter-based virtual laboratory that enables embodied, interactive exploration of molecular structures and interactions for teaching Computer Aided Chemistry concepts.
- To integrate an AI tutor that adapts to student responses and promotes scientific reasoning over passive procedure-following.
- To pilot and evaluate the Molecular Docking chapter for its impact on conceptual understanding, spatial ability, docking competency, and engagement among 50 students.

NALI Approach

Novelty

Conventional Computer-Aided Chemistry teaching commonly relies on lecture slides followed by computer laboratory sessions using step-by-step software manuals (Rodríguez-Becerra et al., 2020). While students learn to operate computational tools, the learning process can become procedure-driven, with limited opportunities to explore molecular concepts and justify computational decisions. Active, inquiry-driven approaches have been shown to strengthen conceptual understanding and engagement in chemistry more broadly (Byusa, Kampire, & Mwesigye, 2022). ChemVerse AI transforms this approach into an immersive, inquiry-driven experience where students explore molecular structures in 3D, predict outcomes, test their decisions using actual computational outputs, and explain their reasoning through AURA, a Socratic AI tutor. To the best of our knowledge, ChemVerse AI is among the first browser-accessible, chapter-structured computational chemistry learning environments to combine embodied

molecular interaction with a Socratic AI tutor within an extensible computational chemistry curriculum (Bennie et al., 2019; Iakovou, Laycock, & Hayward, 2022; Mishra et al., 2024).

Creativity
Students take on the role of a computational scientist working an authentic drug-discovery mission rather than following a worksheet. The AI tutor, AURA, is designed as a research-assistant persona that questions rather than answers, and the seven-stage Explore–Reflect cycle mirrors the structure of genuine scientific inquiry rather than a software manual.

Innovativeness
ChemVerse AI integrates interactive 3D molecular exploration, actual AutoDock Vina-generated docking outputs, and AI-guided reasoning within a single learning environment. AURA evaluates students' predictions and explanations to identify common misconceptions, such as assuming that the top-ranked docking pose necessarily represents the correct binding mode, and responds with scaffolded questions rather than providing direct answers. This creates an immediate predict–test–reflect feedback loop, transforming conventional computer-lab exercises from procedure-following into active scientific reasoning.

Applicability
ChemVerse AI is designed for integration into existing Computer-Aided Chemistry courses and can be used during lectures, computer laboratory sessions, or independent learning. Its chapter-based architecture allows the same learning framework to be adapted across diverse topics, including molecular docking, molecular dynamics, chemometrics, pattern recognition, neural networks, optimization, multivariate calibration, and modelling and simulation. The platform can therefore grow alongside the course curriculum while providing consistent AI-guided reasoning and interactive learning across different computational concepts.

Innovation Description, Process and Implementation

ChemVerse AI is a browser-accessible virtual laboratory structured as a series of chapters, each covering a different Computer-Aided Chemistry technique within the same immersive environment and AI-tutoring framework. The Molecular Docking chapter serves as the pilot reported here. Students explore a protein binding pocket in 3D, grab and reposition a ligand using a Joy-Con motion controller, and commit to a predicted binding pose. The system then retrieves validated, precomputed AutoDock Vina docking outputs for comparison with the student's predicted pose. AURA subsequently asks scaffolded questions (e.g., "Why do you think the docking pose prefers this orientation?") to prompt students to examine key molecular interactions, including hydrogen bonds, hydrophobic contacts, π–π stacking, and electrostatic interactions, and revise their reasoning through a seven-stage learning cycle (Figure 1).

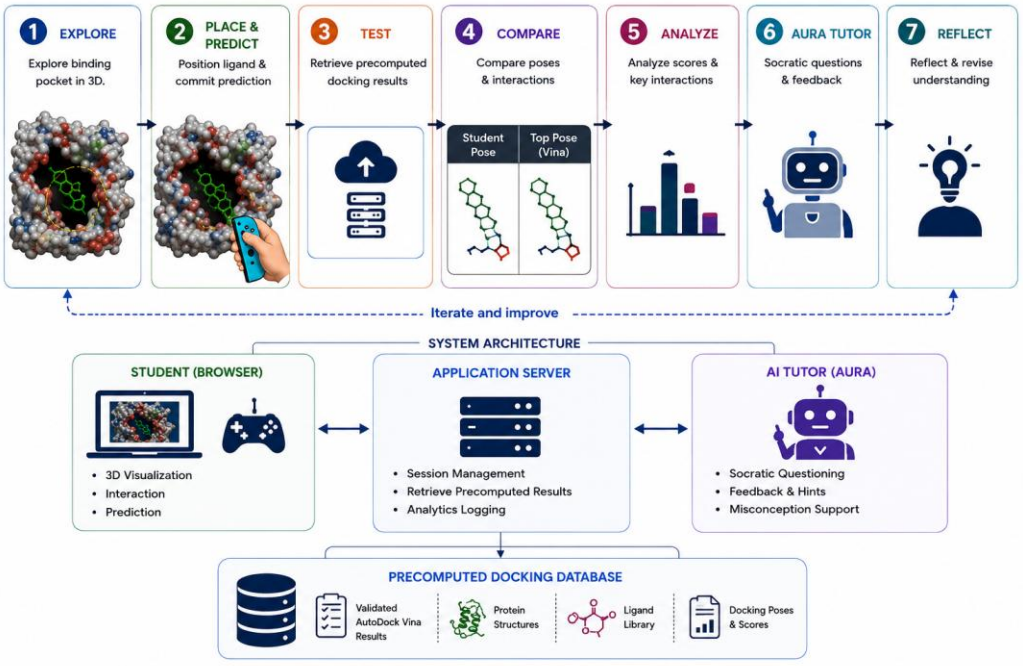


Figure 1: ChemVerse AI Learning Cycle

The pilot involved 50 undergraduate students enrolled in a Computer-Aided Chemistry course over a four-week intervention using a pre–post quasi-experimental design. The human educator designed the learning activity and facilitated discussion; ChemVerse AI captured student interactions, evaluated their predictions and explanations, and provided scaffolded hints and feedback through AURA; while students explored, predicted, compared, reasoned, and reflected within the environment. Effectiveness was evaluated using four instruments: a conceptual understanding test, an engagement survey, the Purdue Spatial Visualization Test (PSVT), and a rubric-based docking competency assessment, supplemented by system analytics and open-ended feedback.

Key Findings

Conceptual understanding increased from a pre-test mean of 46.3% to a post-test mean of 84.1% (+37.8 percentage points, $p < 0.001$), while PSVT:R spatial ability increased from 48.2% to 80.3% (+32.1 percentage points, $p < 0.001$). Docking competency improved across all rubric criteria, including interaction identification, appropriate interpretation of docking scores, pose interpretation, and justification of decisions. Learning engagement was high (mean = 4.53/5) across enjoyment, interest, immersion, usefulness, and motivation, while overall satisfaction reached 92% (Table 1).

Table 1: Summary of pre–post outcomes from the Chapter 1 pilot (n = 50).

METRIC	PRE-TEST	POST-TEST	CHANGE / SIGNIFICANCE
Conceptual Understanding (%)	46.3	84.1	+37.8 percentage points (p < .001)
Spatial Ability – PSVT:R (%)	48.2	80.3	+32.1 percentage points (p < .001)
Docking Competency (/10)	2.9*	8.0*	Improved across rubric criteria
Learning Engagement (mean/5)	–	4.53	High overall engagement
Overall Satisfaction (%)	–	92	Satisfied / Very Satisfied

System analytics recorded 214 sessions (mean duration = 34.7 minutes), 1,842 3D explorations, 366 ligand placements and docking-result comparisons, 1,164 AI-tutor questions answered, and 132 hints requested, indicating sustained active engagement. Misconceptions identified through student responses also declined between pre- and post-intervention checkpoints. These findings suggest that AURA's scaffolded questioning supported students in reconsidering specific reasoning errors. Students also reported that embodied ligand manipulation made molecular interactions "feel real" and that AURA's questions encouraged them to think rather than wait for an answer.

Impact

For students, ChemVerse AI replaces passive procedure-following with active, embodied reasoning, producing measurable gains in conceptual understanding, spatial ability, and docking competency alongside high engagement. For educators, the AI tutor absorbs much of the individualised Socratic questioning that is difficult to sustain across a class of 50, while system analytics comprises of misconception rates and session data give instructors direct, actionable insight into where students are struggling.

Recommendations for Classroom Practice

Each ChemVerse AI chapter should begin with a short introduction by the instructor to explain the topic and learning task before students start the activity. Student responses and system analytics can be reviewed after each session to identify common difficulties. These findings can then be discussed in the next lecture session to improve students' understanding.

Other relevant information

Copyright registration has been submitted for the innovation, and a research paper based on ChemVerse AI has been submitted to *Chemistry Education Research and Practice* (Royal Society of Chemistry).

Acknowledgement

The author thanks the students of SSCC3553 (Computer-Aided Chemistry) for their participation in the Chapter 1 pilot, and the Department of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, for supporting this work under the Virtual Lab Task Force initiative.

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ID 49: Human-AI Synergy in Standards-Driven Petroleum Engineering Learning

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Highlights: Engineering students often encounter industry standards as dense reference documents rather than active tools for professional decision-making. This innovation combines generative AI, authentic API and PETRONAS standards, collaborative inquiry, and instructor verification in a structured standards-driven learning cycle. Students developed prompts, interrogated standards, checked AI outputs against source documents, justified technical decisions, and communicated their findings. Pre-post evaluation showed significant improvement across six learning outcomes, with a 23.18% overall mean gain and a large composite effect (d = 0.98). The framework advances responsible human-AI collaboration while strengthening standards literacy, engagement, and industry readiness.

Keywords: generative AI; engineering education; industry standards; authentic learning; petroleum engineering

Introduction

Professional engineering practice requires graduates to locate, interpret, compare, and apply technical standards when making defensible decisions. In petroleum engineering, API and PETRONAS Technical Standards provide authentic links between classroom concepts and field practice, yet their length, specialized language, and cross-referencing can limit meaningful undergraduate engagement. Generative AI can make complex information more approachable, but uncritical use may produce inaccurate explanations and weaken students' ownership of reasoning. A human-centred design is therefore needed in which AI supports inquiry while students and instructors retain responsibility for verification, interpretation, and judgment.

The Human-AI Synergy in Standards-Driven Petroleum Engineering Learning innovation addresses this need through an authentic learning framework. It positions generative AI as a cognitive and dialogic scaffold rather than an answer generator. Students use AI to formulate questions, unpack terminology, contrast provisions, and organize evidence, then validate every substantive claim against the original standards and engineering principles. The classroom consequently becomes both a learning environment and a structured site of pedagogical inquiry, connecting technical education, responsible AI literacy, and professional practice.

Objectives

- To increase students' mean understanding and application of engineering standards across measured learning outcomes.
- To improve students' ability to interpret API and PETRONAS technical documents and connect them to petroleum engineering design and field operations.
- To develop responsible AI literacy through prompt iteration, source verification, critical comparison, and transparent human oversight.
- To strengthen collaborative learning, technical communication, professional confidence, and readiness for industry practice.
- To establish a transferable framework that educators can adapt to standards-intensive subjects across engineering disciplines.

NALI Approach

Novelty

The innovation is distinctive because it integrates three elements that are often taught separately: professional standards literacy, generative AI literacy, and authentic engineering decision-making. AI is embedded within a controlled verification cycle: prompt, retrieve or explain, compare with primary sources, challenge inconsistencies, justify a decision, and reflect. This shifts AI use from convenient text production to disciplined evidence interrogation. The resulting learning product is not an AI answer, but a student-owned, standards-supported engineering argument.

Creativity
Student teams converted conventional standards reading into an inquiry challenge. Each team mapped a petroleum production topic, such as inflow performance, well completion, artificial lift, or production operations, to relevant API and PETRONAS provisions. They crafted and refined prompts, built comparison matrices, annotated evidence, identified limitations in AI responses, and translated technical conclusions into reports and presentations for peer and instructor scrutiny. The combination of prompt trails, standards maps, engineering cases, and oral defence made otherwise static documents interactive and professionally meaningful.

Innovativeness
The design introduces a repeatable human-AI workflow with explicit checkpoints for accuracy, attribution, and engineering judgment. Unlike unrestricted AI use, every output must be traced to an authoritative source, evaluated for contextual suitability, and accepted, revised, or rejected by students. Assessment emphasizes reasoning quality, evidence use, verification, and communication rather than polished text alone. This approach supports active learning while reducing the risk that AI fluency is mistaken for technical competence.

Applicability
The framework is low-cost and can be implemented using institutionally approved generative AI tools, licensed or instructor-provided standards extracts, and existing group-assessment formats. Its cycle is adaptable to mechanical, chemical, civil, electrical, safety, environmental, and energy programmes that depend on codes, regulations, or professional guidelines. It can be scaled from a single tutorial to a semester project and sustained through reusable cases, prompt exemplars, verification checklists, and assessment rubrics.

Innovation Description, Process and Implementation

The innovation was implemented in an undergraduate petroleum production engineering learning activity. Students worked collaboratively with authentic API and PETRONAS standards and used generative AI under instructor guidance. The process was organized into six connected stages shown in Table 1. The instructor introduced the purpose and limitations of standards and AI, set ethical expectations, monitored evidence quality, and provided formative feedback. Students retained responsibility for reading standards, checking claims, applying engineering principles, and defending final decisions.

Table 1: Human-AI standards-driven learning cycle

STAGE	LEARNING ACTION	HUMAN-AI RESPONSIBILITY
1	Contextualize	Instructor frames the engineering problem, intended outcomes, source boundaries, and responsible AI rules.
2	Prompt and inquire	Students develop iterative prompts to clarify terminology, relationships, assumptions, and possible standards pathways.
3	Locate and compare	Teams consult original API/PETRONAS documents and compare provisions, contexts, and AI explanations.
4	Verify and challenge	Students identify unsupported claims, omissions, or inconsistencies and reconcile them using primary evidence and engineering principles.
5	Apply and justify	Teams apply verified requirements to an authentic case and defend a standards-based engineering decision.
6	Communicate and reflect	Students present findings, respond to questions, document AI use, and reflect on learning and limitations.

Evaluation combined matched learning-outcome items from pre- and post-intervention surveys with post-activity perception items and open-ended reflections. The dataset contained 45 usable pre-survey responses and 46 usable post-survey responses. As only two records contained both pre and post values, the primary comparison used Welch's independent-samples t-test. Descriptive statistics, percentage gains, agreement rates, and Cohen's d were used to judge practical as well as statistical significance.

Key Findings

The composite mean across six common learning outcomes increased from 3.43 (SD = 0.90) before the intervention to 4.22 (SD = 0.71) after the intervention. The gain of 0.80 points represented a 23.18%

improvement and was statistically significant, $t = 4.68$, $p < .001$, with a large effect size ($d = 0.98$). Every item improved significantly. The largest percentage gain was recorded for interpreting API/PETRONAS technical documents (29.48%), while relating standards to real field operations produced the largest item-level effect ($d = 1.01$).

Table 2: Summary of pre-post learning outcomes

LEARNING OUTCOME	PRE M	POST M	GAIN	GAIN %	D
Purpose of engineering standards	3.91	4.48	0.57	14.50	0.66
Influence of standards on well design	3.56	4.30	0.75	21.06	0.86
Selection of relevant subsurface standards	3.42	4.26	0.84	24.51	0.89
Interpretation of API/PETRONAS documents	3.02	3.91	0.89	29.48	0.85
Confidence using engineering standards	3.31	4.15	0.84	25.40	0.89
Connection to real field operations	3.36	4.24	0.88	26.33	1.01
Composite across six outcomes	3.43	4.22	0.80	23.18	0.98

Agreement or strong agreement also increased across all outcomes. For example, agreement that students could identify relevant standards and relate standards to field operations rose from 42.2% to 82.6% for both outcomes. Post-intervention perceptions further supported the learning impact: 91.3% agreed that AI tools helped them understand standards, 91.3% agreed that group work improved learning, 89.1% reported improved understanding of standards, and 89.1% reported increased peer engagement. Open-ended feedback indicated that students valued simplified access to complex technical language, comparison of standards, authentic application, and collaborative problem-solving. Reported challenges included lengthy documents, technical terminology, locating relevant clauses, and the need to verify potentially incomplete or inaccurate AI responses.

Impact

For students, the innovation strengthened standards literacy, technical-document interpretation, evidence-based reasoning, collaboration, communication, and confidence for future engineering tasks. It also developed an important professional habit: AI outputs must be questioned and validated rather than accepted at face value. For educators, the framework provides an observable learning process through prompt trails, comparison matrices, source annotations, and oral defence, enabling feedback on both disciplinary reasoning and AI literacy. For programmes and institutions, the approach supports industry-aligned curricula, responsible digital transformation, authentic assessment, and graduate readiness. Long term, the reusable workflow can help build communities of practice around human-centred AI integration in standards-intensive disciplines.

Recommendations for Classroom Practice

Begin with a bounded engineering case and a curated set of authoritative standards so that students can focus on interpretation rather than uncontrolled searching.

Require a transparent AI-use record containing prompts, selected outputs, rejected claims, source checks, and revisions.

Assess evidence, verification, reasoning, and oral defence more heavily than language fluency or presentation polish.

Use instructor checkpoints before students finalize technical conclusions, particularly where standards are context-dependent or safety-critical.

Combine individual reflection with group output to preserve accountability and reveal each student's learning.

Pilot the framework with one topic, review student feedback and verification errors, then scale through reusable cases and rubrics.

Ethical Considerations

Participation and reporting followed principles of transparency, confidentiality, academic integrity, and responsible AI use. Microsoft Copilot was used only to support language refinement, text rephrasing, and the organization and presentation of researcher-generated statistical analyses. AI tools were not used to

generate research data, fabricate responses, determine statistical outcomes, or produce the study's key findings and conclusions. All data verification, analytical decisions, interpretations, and final reporting remained under researcher oversight and responsibility. Student use of generative AI similarly required source verification and acknowledgement, with original API and PETRONAS documents retained as the authoritative basis for engineering claims.

Other Relevant Information

The innovation has strong potential for replication and continued development through discipline-specific case libraries, verification checklists, prompt-design guides, and analytic rubrics. Future implementation can compare cohorts, examine retention of standards literacy, test transfer to new engineering cases, and evaluate the contribution of individual framework components. Commercialization or formal intellectual-property status is not claimed in this submission.

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ID 53: Ethnomathematics Activities Integrating Batik Terengganu, Traditional Chinese Lanterns and Rumah Limas to Support Lower Secondary Geometry Learning

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Highlights: This innovation addresses the challenge of linking abstract geometrical concepts to meaningful real-world and cultural contexts by integrating ethnomathematics through three cultural artefacts: Batik Terengganu, traditional Chinese lanterns, and Rumah Limas Johor. Using the ADDIE instructional design model, the innovation combines GeoGebra with physical manipulatives to develop contextualised geometry activities for lower-secondary students. Expert validation demonstrated high content validity, with strong agreement on the artefacts' relevance, suitability, usability, and effectiveness. The innovation integrates cultural heritage, digital technology, and geometry learning to support student-centred learning, geometrical thinking, digital competence, and cultural appreciation.

Keywords: Ethnomathematics; GeoGebra; Geometry; Mathematics Education

Introduction

Mathematics education increasingly emphasises connecting learning with students' everyday experiences, particularly within Malaysia's Secondary School Standard Curriculum (KSSM), which promotes contextual and 21st-century learning. However, students continue to struggle to visualise abstract geometrical concepts (Ministry of Education [MOE], 2024), highlighting the need for meaningful and culturally relevant approaches. Ethnomathematics addresses this challenge by revealing geometry embedded in cultural practices, crafts, architecture, and artefacts (D'Ambrosio, 1985). Although research reports positive effects on geometrical understanding and engagement, challenges remain in curriculum integration, teacher preparedness, and instructional resources (Kyeremeh et al., 2024). A key gap is the limited availability of structured activities integrating Malaysian cultural artefacts with digital technology while maintaining curriculum alignment. Therefore, this innovation integrates Batik Terengganu, traditional Chinese lanterns, and Rumah Limas Johor with GeoGebra and hands-on activities, guided by the ADDIE model.

Objectives

- To analyse the geometric concepts embedded in the selected cultural artefacts (Batik Terengganu, traditional Chinese lanterns and Rumah Limas Johor).
- To develop curriculum-aligned, ethnomathematics-based activities that enhance students' understanding and visualisation of geometric concepts through selected cultural artefacts (Batik Terengganu, traditional Chinese lanterns and Rumah Limas Johor).
- To evaluate the content validity, suitability and usability of the developed ethnomathematics-based activities through expert evaluation.

NALI Approach

Novelty

The innovation integrates ethnomathematics with culturally relevant geometry learning using Batik Terengganu, traditional Chinese lanterns, and Rumah Limas Johor. GeoGebra is incorporated to support visual exploration of geometric concepts, connecting abstract mathematical ideas with authentic cultural objects and practices.

Creativity

Creativity is demonstrated through the recontextualisation of cultural heritage into geometry activities. Traditional patterns, structures, and artefacts are transformed into hands-on, visual learning experiences that encourage students to explore and develop geometric thinking.

Innovativeness

Innovation combines ethnomathematics, activity-based learning, instructional design, and digital technology to provide contextualised geometry learning. The use of structured approaches such as ADDIE and the 5E Model, together with GeoGebra where applicable, supports systematic development and interactive exploration of geometrical concepts.

Applicability

The approach can be adapted across different geometrical topics and cultural contexts. Teachers can replace cultural artefacts with locally relevant objects while maintaining the pedagogical structure. Implementation may depend on teacher readiness, time, resources, and access to technology.

Innovation Description, Process and Implementation

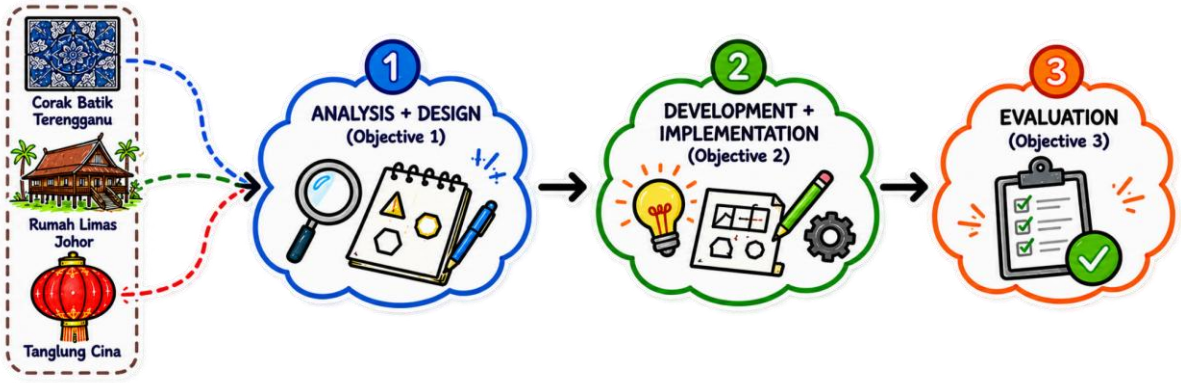


Figure 1: Phases of ADDIE Model.

Based on Figure 1, the Analysis and Design phases address the first objective: analysing geometrical concepts embedded in Batik Terengganu, traditional Chinese lanterns, and Rumah Limas Johor. During Analysis, each artefact is examined to identify mathematical structures and geometric concepts within its cultural design and construction (Adeoye et al., 2024). Traditional Chinese lanterns incorporate polygons, circles, spheres, cylinders, 2D nets, 3D structures, surface area, volume, reflectional and rotational symmetry, transformations, and spatial relationships, while Rumah Limas Johor supports the Pythagorean Theorem, plans, and elevations. The Design phase organises these concepts by linking cultural artefacts, embedded geometry, curriculum content, and learning experiences (Dilaines et al., 2024), establishing the mathematical and pedagogical foundation.

The Development and Implementation phases address the second objective: developing curriculum-aligned ethnomathematics activities to enhance students' understanding and visualisation of geometry (Devioni et al., 2025). During Development, identified concepts are transformed into structured activities, instructional materials, teacher guidance, physical construction tasks, visual representations, and technology-supported resources (Abuhassna et al., 2024). Activities are aligned with the DSKP to ensure cultural contexts support prescribed mathematical objectives (Adeoye et al., 2024). For example, Chinese lantern activities involve regular polygons, 2D-to-3D transformations, prisms, pyramids, surface area, volume, and symmetry. GeoGebra supports visualisation and manipulation, while the GeoPress Kit provides tangible representations of Rumah Limas Johor.

Implementation involves two complementary approaches. First, selected experts are interviewed to assess clarity, practicality, suitability, cultural relevance, and potential to improve students' geometric understanding and visualisation through real-life contexts (Panyasai & Ambele, 2025). Second, classroom implementation engages students in observation, identification, construction, visualisation, manipulation, mathematical reasoning, and reflection, connecting culturally embedded mathematical concepts with formal geometry.

Finally, the Evaluation phase addresses the third objective by determining the content validity, suitability, and usability of the activities through expert evaluation (Masuwai et al., 2024). The CVI assesses learning objectives, appropriateness of ethnomathematics activities, cultural relevance, effectiveness, and usability. To conclude, ADDIE provides a systematic pathway from identifying culturally embedded mathematical knowledge to designing, developing, implementing, and evaluating a curriculum-aligned ethnomathematics innovation.

Key Findings

Table 1: Content Validity Index (CVI) Findings Across the Three Ethnomathematics Activities.

STUDY	NO. OF EXPERTS	I-CVI	S-CVI/AVE	S-CVI/UA	INTERPRETATION
Batik Terengganu Activities	6	0.83–1.00	0.97	0.85	High content validity, although some items showed less universal agreement
Traditional Chinese Lanterns Activities	6	0.88–0.96	0.93	1.00	High content validity and strong expert consensus
Rumah Limas Johor Activities	6	1.00	1.00	1.00	Maximum content validity and unanimous expert agreement

The Content Validity Index (CVI) findings across the three ethnomathematics activities demonstrate consistently high expert agreement. For Batik Terengganu, six experts evaluated the activities, with I-CVI values ranging from 0.83 to 1.00, meeting the minimum acceptable level recommended for six experts (Yusoff, 2019). The S-CVI/Ave of 0.97 indicates very high content validity, while S-CVI/UA of 0.85 reflects substantial universal agreement. For Traditional Chinese Lanterns, I-CVI values ranged from 0.88 to 0.96, exceeding the recommended threshold and demonstrating strong item relevance (Yusoff, 2019). The S-CVI/Ave of 0.93 and S-CVI/UA of 1.00 further confirm high validity and complete agreement. Rumah Limas Johor achieved the strongest results, with I-CVI, S-CVI/Ave, and S-CVI/UA all at 1.00. Overall, all three activities demonstrate strong content validity, with Rumah Limas Johor showing the highest expert agreement.

Impact

The proposed innovation bridges cultural heritage and geometry learning through Batik Terengganu, Chinese lanterns, and Rumah Limas Johor. Integrating geometrical concepts with familiar contexts, GeoGebra, and the 5E instructional model promotes visual, contextualised, and student-centred learning. These artefacts strengthen students' conceptual understanding, geometric thinking, problem-solving, and appreciation of cultural heritage, identity, and diversity (Batiibwe, 2024; Indriati et al., 2022). For educators, the innovation provides an adaptable resource for integrating ethnomathematics while meeting curriculum requirements. Digital technology and hands-on exploration support reasoning, digital literacy, and critical thinking. For policymakers and institutions, it demonstrates the integration of cultural sustainability, digitalisation, and mathematics education through resources, professional development, and STEAM initiatives. Ultimately, it supports meaningful geometry learning while preserving cultural heritage.

Recommendations for Classroom Practice

Teachers should integrate ethnomathematics and digital technology as complementary approaches, ensuring cultural artefacts align with curriculum standards and learning outcomes. Activities should consider students' readiness, prior knowledge, cultural backgrounds, and resources, with scaffolding for less proficient learners and open-ended tasks for advanced learners. Cultural artefacts and GeoGebra can extend beyond geometry to algebra and calculus. Teacher preparedness is essential; professional development should strengthen digital competencies and meaningful integration of cultural knowledge. Schools can support sustainability through shared repositories of validated lesson plans and digital resources, reducing preparation demands and facilitating replication. Future applications should incorporate traditional foods, dances, and other cultural practices to explore mathematics. This flexibility maintains local relevance while supporting curriculum goals and cultural appreciation across diverse educational settings.

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ID 54: THINK Before PROMPT: A Student–AI Synergy Framework for Responsible Learning in Integrated Case Study Course

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Highlights: Generative AI has created new opportunities for students to obtain rapid explanations, ideas and polished academic outputs, but unrestricted use may weaken independent thinking and make genuine learning difficult to demonstrate. This innovation introduces a five-stage Student–AI Synergy Framework which is THINK → PROMPT → VERIFY → REFLECT → DEMONSTRATE; this is conducted within an Integrated Case Study course. Students first develop their own analysis, use AI to extend rather than replace their thinking, verify AI-generated suggestions, reflect on changes in their understanding, and demonstrate ownership of the final learning. Student responses indicate stronger awareness of critical evaluation, broader perspectives, responsible AI use and the need to defend learning independently.

Keywords: Generative AI; Student–AI synergy; Critical thinking; Responsible AI learning; Integrated Case Study

Introduction

The use of AI among University students is uncontrollable, raising continuous concerns about over-reliance, misinformation, diminished independent thinking, and academic integrity (Fitri, et al, 2026). Thus, scholars highlight the need for AI literacy, critical thinking, and fact-checking strategies rather than unrestricted tool use (Kasneci et al., 2023). In addition, there is a need for a student-centred approach where AI supports meaningful learning while safeguarding integrity (Miao & Holmes, 2023). This innovation addresses the challenge through a structured Student–AI Synergy Framework in a final year Integrated Case Study (ICS) course. When given a case, students first establish their own thinking and reasoning through brainstorming session, then engage with AI to evaluate how it modifies or extends their ideas. The outcome is not merely a polished report, but the ability to explain and defend the reasoning behind the final answer during the oral presentation. The framework comprises five stages: THINK → PROMPT → VERIFY → REFLECT → DEMONSTRATE. Its core principle is: Allow AI assistance, but ensure students demonstrate responsible and ownership of their thinking. Student feedback following implementation provides evidence of how learners experienced the framework and perceived AI's role in their learning.

Objectives

- To develop students' ability to question, verify, and evaluate AI-generated information against the case context, course knowledge and supporting evidence.
- To encourage students to reflect and demonstrate on how interaction with AI changes, extends or challenges their original thinking.



Figure 1: The framework

NALI Approach

Novelty

The innovation in the framework is about repositioning AI from an answer generator to a structured partner in learning, creates a visible learning trail and developing and owning student's thinking process. Student responses highlight this distinction: during THINK, learners reported brainstorming, using prior knowledge (recall), mind maps, and group discussions before consulting AI. One student described the process as "using my own brain first before being dependent on any help."

Creativity
The creative strength lies in transforming AI use into a structured learning journey rather than a one-step intervention. Students engage with AI for distinct cognitive purposes, using PROMPT to expand ideas, identify overlooked issues, explore perspectives, organise information, and clarify concepts based on their own initial input. AI may confirm, challenge, or extend student thinking, but learners decide what to accept, modify, or reject. During VERIFY, students critically evaluate AI outputs by comparing them with their own ideas, case facts, lecture materials, and evidence, recognising that convincing AI responses may still be inaccurate, overly general, or contextually unsuitable.

Innovativeness
The framework introduces an improved pedagogical process for integrating GenAI into authentic case-based learning, differentiating between student's and AI's responsibilities.

Table 1: Cognitive responsibilities between the student and AI.

STUDENT RESPONSIBILITIES	AI RESPONSIBILITIES
Identifying and interpreting the problem	Generating alternative perspectives
Generating initial ideas	Expanding ideas
Making decisions	Identifying possible gaps
Evaluating AI suggestions	Organising information
Verifying evidence	Clarifying concepts
Deciding what to accept or reject	Challenging assumptions
Reflecting on learning	Improving structure and communication
Demonstrating understanding	—

This distinction is critical because students recognised that AI outputs are not inherently superior. While some found AI explanations stronger or more detailed, others noted they were too general or unsuitable for specific cases. The framework therefore reframes the question from *"Did the student use AI?"* to *"How did the student use AI, and what was learned from that interaction?"*

Applicability
The framework is simple, adaptable, and discipline-independent. Although implemented in an Integrated Case Study (ICS) course, its five stages can be applied across disciplines and learning activities, including case studies, projects, problem-based learning, and authentic assessment. Its sustainability requires no new technology; instead, it focuses on redesigning learning processes and assessment expectations to promote responsible AI use, self-regulation, and academic integrity (Xia et al., 2024).

Innovation Description, Process and Implementation

The innovation was implemented in an Integrated Case Study (ICS) course where students collaboratively analysed a complex business case, selected appropriate analytical tools, developed recommendations, and communicated their findings through five stages. In THINK, students activated prior knowledge and analysed the case independently to identify problems, causes, stakeholders, tools, and possible solutions, establishing a baseline of their reasoning. In PROMPT, students used AI to expand, organise, explain, and challenge their initial ideas. In VERIFY, they critically evaluated AI suggestions against case evidence, lecture materials, and academic sources. In REFLECT, students considered how AI influenced their thinking, identifying new perspectives and areas they had overlooked. Finally, in DEMONSTRATE, students showed ownership by explaining their analysis, defending decisions, and articulating their reasoning without relying on AI during presentations. The implementation was evaluated through students' reflective responses at each stage.

Key Findings

1) A total of 42 responses revealed several consistent themes.
2) Ownership in THINK: Students valued developing ideas independently and collaboratively during the 3-hour brainstorming session before AI use, recognising existing knowledge and gaps.
3) AI as assistant in PROMPT: Learners positioned AI as a supportive tool, not a substitute, explicitly rejecting full reliance on AI.
4) Critical evaluation in VERIFY: Students acknowledged AI's limitations and stressed the need to understand and defend reasoning rather than accept outputs at face value.
5) Perspective broadening in REFLECT: AI encouraged exploration of alternative explanations and consequences, though students noted that comprehensiveness did not always equal quality.
6) Learning ownership in DEMONSTRATE: Students emphasised that genuine learning meant explaining, justifying, and defending their analysis independently. One noted that the strongest

evidence of learning was not a polished report, but the ability to explain how and why it evolved during the case presentation.

Table 2: Student Voices Across the THINK–PROMPT–VERIFY–REFLECT–DEMONSTRATE Framework

STAGE	STUDENT RESPONSES	WHAT THE RESPONSES DEMONSTRATE
THINK	**R1:** "At this stage, I prefer to think and develop my own ideas first instead of immediately relying on AI."	Students establish their own understanding and initial ideas before engaging with AI.
	R19: "Before using AI, I first tried to think and brainstorm the ideas on my own based on what I had learned in class. I wanted to understand the topic from my own perspective and identify the points that I already knew."	Students activate prior knowledge and recognise what they already understand before AI intervention.
PROMPT	**R1:** "AI helps me to improve and develop the ideas that I have already generated during the brainstorming process... I mainly use AI as an assistant to support my thinking rather than allowing AI to completely generate my work."	AI is positioned as an assistant that extends existing student thinking rather than replacing it.
	R10: "After having our own initial ideas, we used AI to help us organise and develop our analysis... However, we treated the AI responses as suggestions rather than directly copying them into our report."	Students use AI for idea development and organisation while retaining ownership of the final analysis.
VERIFY	**R2:** "I did not assume that everything produced by AI was automatically correct... This verification process helped me distinguish between information that was useful and information that I should question, modify, or leave out."	Students critically evaluate AI-generated information rather than accepting it automatically.
	R4: "If they do not align, I stop and check why my group's ideas are different from what the AI suggested. I use it as a learning moment to see if we missed a blind spot or if our logic was wrong."	Disagreement between human and AI becomes an opportunity for critical inquiry and deeper learning.
REFLECT	**R11:** "After using AI, I learned to look at the case from different points of view and consider ideas that I had not thought about before. I also learned that not every answer given by AI is correct or suitable for the case."	Students recognise that AI can broaden perspectives while also requiring judgement and caution.
	R8: "Having more information does not automatically mean having better understanding. I started using AI less like a writer and more like a second person sitting beside me and giving suggestions."	Students develop metacognitive awareness of the difference between receiving information and actually understanding it.
DEMONSTRATE	**R1:** "I can demonstrate my learning by explaining the reasoning behind the ideas and decisions in my report... The final work should reflect my own understanding rather than simply copying the output generated by AI."	Genuine learning is demonstrated through explanation, reasoning and ownership rather than AI-generated output alone.
	R8: "My learning can be demonstrated by showing the process behind the final answer... This shows more learning than simply submitting a polished report."	Learning evidence shifts from the final product to the process, decisions and reasoning behind it.

The responses show the evidence that the framework helped develop students' ability to question, verify, and evaluate AI-generated information against the case context, course knowledge and supporting evidence. It also encourages students to reflect and demonstrate on how interaction with AI changes, extends or challenges their original thinking. The whole process implemented in the ICS course has shown that AI is a thinking partner rather than a replacement thinker, promoting Student-AI synergy. This is consistent with calls for educational approaches that combine the opportunities of GenAI with critical evaluation, human oversight and responsible use (Kasneci et al., 2023; Miao & Holmes, 2023).

Impact

The most significant impact of this innovation is the shift in students' perception of responsible AI use. Rather than viewing AI as an issue of "allowed" or "not allowed," students experienced it as part of a where human judgment remained central. The framework strengthened critical thinking, broadened analysis, enhanced information evaluation, encouraged metacognitive reflection, and built confidence in explaining their own work. Importantly, students recognised that AI-generated fluency does not guarantee accuracy or relevance, learning instead to compare, question, modify, and reject AI suggestions when necessary.

For educators, the framework offers a practical method of integrating GenAI without resorting to prohibition. It provides a pedagogical structure for discussing responsible AI use and enables teachers to observe the development of student reasoning rather than focusing solely on polished outputs. For institutions, the innovation shifts emphasis from AI detection toward authentic evidence of learning and

reasoning, reflection, oral explanation, and demonstration of understanding. This aligns with emerging research advocating assessment approaches that cultivate responsible learning, self-regulation, and academic integrity in the GenAI era (Xia et al., 2024). The longer-term contribution is a paradigm shift: from AI avoidance to AI literacy, and from AI-generated output to student-owned learning. In addition, the framework contributes to SDG 4 (Quality Education) and SDG 9 (Innovation) by promoting responsible AI-enabled learning while strengthening students' innovativeness, critical thinking, digital literacy, judgement and ownership of learning.

Recommendations for Classroom Practice

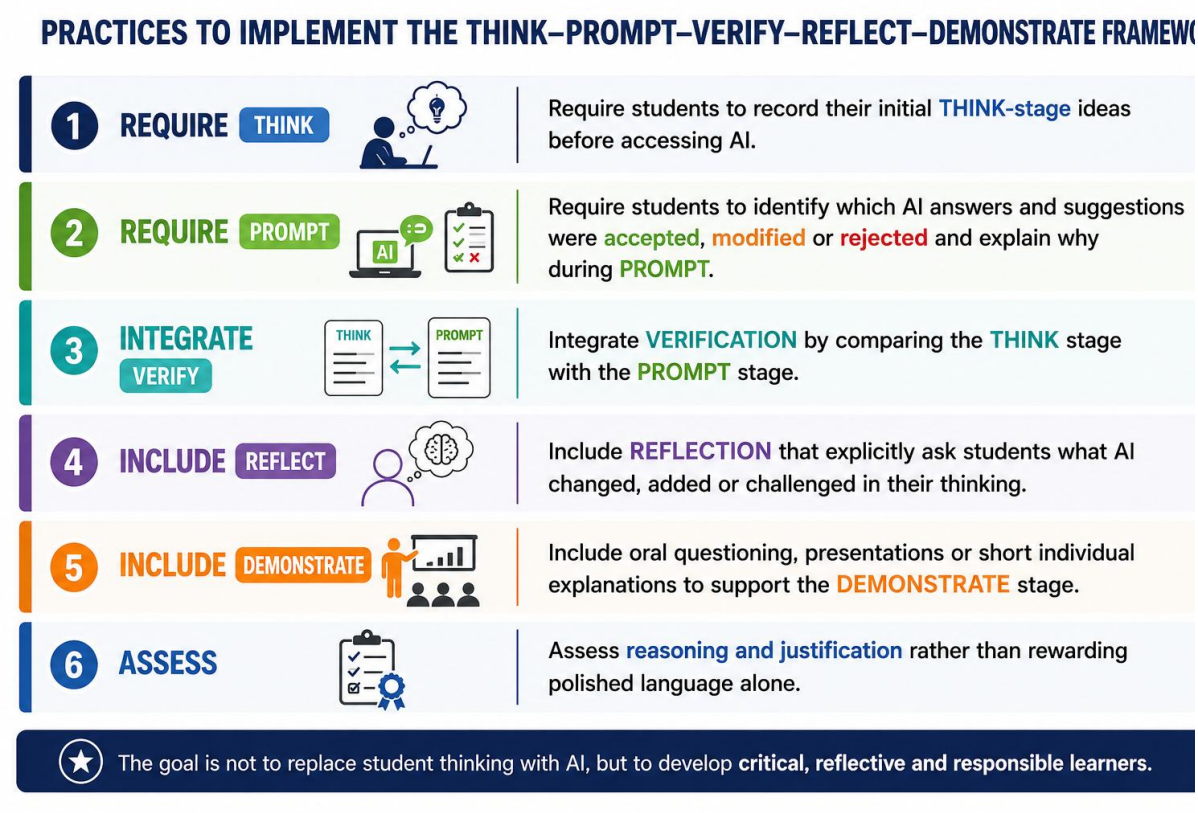


Figure 2: Several recommendation for clasroom practices

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ID 56: E²THICaL - Engineering Ethics Through Hands-on, Immersive Collaborative Learning

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Highlights: Engineering ethics can remain abstract when students lack exposure to real-world dilemmas. This initiative, called E²THICaL, introduces an immersive, hands-on approach in the Engineers in Society course through three activities. First, an Ethics Board Game uses real-life scenarios linked to the Board of Engineers Malaysia's Code of Conduct, allowing students to learn through play. Second, AI-Powered Debates use ChatGPT as a "devil's advocate", challenging students to defend and refine their ethical reasoning. Finally, a "Cradle to Grave" Sustainability Challenge encourages students to consider the long-term ethical, societal and environmental impacts of engineering decisions. Together, these activities make ethics practical, engaging and relevant.

Keywords: Engineering Ethics; Immersive Learning; Human–AI Collaboration

Introduction

In 2023, Prime Minister Anwar Ibrahim introduced Malaysia MADANI, promoting values of respect, care and compassion, which align with engineering ethics and the responsibility to prioritise societal well-being, sustainability and integrity. The 2024 Engineering Programme Accreditation Standard also expects students to apply ethical principles and understand diversity, inclusion and relevant laws. However, studies show that students struggle to apply ethics due to limited exposure to real-world dilemmas (Herkert, 2000; van de Poel, 2016). Ethics education can remain focused on abstract codes, making it difficult to connect principles to practice. This creates a gap: engineering students struggle to internalise ethical principles and apply them meaningfully in real-world situations. Previous students similarly could recite ethical codes but expressed uncertainty when applying and justifying ethical decisions in realistic project scenarios. To address this gap, E²THICaL was developed as an immersive, hands-on approach to simulate ethical decision-making in engineering practice. Implemented in the Engineers in Society course at Sunway University, E²THICaL combines three activities:

1. Game-based Approach: Students engage in an "old-school" board game, where progress depends on their ability to analyse and resolve real-world ethical scenarios, ensuring an interactive and competitive learning experience. Each scenario is linked to the Board of Engineers Malaysia's Code of Conduct.
2. AI-Powered Debates: Students engage in simulated discussions between engineers (themselves) and stakeholders (AI). AI takes a "devil's advocate" stance, challenging students to defend their ethical decisions and strengthen their reasoning.
3. Sustainability Analysis: Using life-cycle analysis ("Cradle to Grave"), students evaluate real-world products through an ethical and sustainability-focused lens, reinforcing their responsibility as engineers.

This approach is aligned with SDG 4, particularly Targets 4.4 and 4.7.

Objectives

E²THICaL has two (2) main objectives:

- To transform ethics from abstract theory into practical decision-making for students – Traditional ethics education often feels abstract, making it difficult for students to apply ethical principles in real-world situations. In teaching this course, it was observed that students struggled to move beyond explaining codes of ethics, finding it difficult to apply these in real-world scenarios. This initiative addresses that gap by progressing from passive learning to interactive, scenario-based engagement. The game-based approach immerses students in ethical dilemmas, requiring them to analyse and respond in real time, while the AI debate challenges them to defend their decisions against a dynamic, opposing perspective.
- To encourage students to think beyond short-term solutions and focus on the long-term impact on society and the environment – Students often approach ethical decision-making with short-term mindsets rather than considering broader implications. The life-cycle analysis ("Cradle to Grave") requires students to evaluate the long-term environmental and societal impact of engineering decisions. For example, students are required to develop a cradle-to-grave diagram

for the assigned item/product.

NALI Approach

Novelty

The novelty of E²THICaL lies in moving engineering ethics from passive understanding of professional codes to active, hands-on ethical decision-making. Rather than teaching ethical principles as standalone concepts, the initiative combines three different learning approaches into one connected learning experience. The Ethics Board Game uses a behavioural learning approach, where students analyse real-world ethical dilemmas and progress through the game by making appropriate ethical decisions. The AI-Powered Debate uses a social learning approach, where AI takes the role of a stakeholder and challenges students to defend and justify their ethical decisions. This simulates real-world discussions between engineers and stakeholders and requires students to consider opposing perspectives. Finally, the "Cradle to Grave" Sustainability Analysis uses a constructivist approach, requiring students to evaluate the wider ethical, societal and environmental consequences of engineering decisions. The novelty therefore lies in the deliberate progression from experiencing an ethical dilemma, to defending an ethical decision, and finally reflecting on its wider consequences. The three approaches work together to move students from knowing ethical principles to applying, defending and reflecting on them in context.

Creativity

The creative aspects of E²THICaL are demonstrated through the design of each learning activity, which transforms conventional ethics teaching into hands-on, interactive and contextualised learning.

- Ethics Board Game: A custom ethics board game was designed to simulate real-life ethical dilemmas that engineers may face in industry. Students pick scenario cards and must analyse the situation, identify the relevant Code of Conduct and make an ethical decision to progress in the game. The use of competition, game progression and real-world scenarios creates a fun and interactive way for students to engage with professional ethics.
- AI-Powered Debates: AI was leveraged to simulate ethical debates, with models such as ChatGPT and DeepSeek taking a "devil's advocate" stance on ethical dilemmas. Students must defend their ethical decisions and convince AI that their reasoning aligns with the Code of Conduct. Students also evaluate AI's counterarguments and refine their perspectives. This creatively transforms AI from a tool that provides answers into a stakeholder that challenges students' thinking, simulating real-life interactions between engineers and stakeholders.
- Sustainability Challenge: Students analyse products from a "Cradle to Grave" perspective, evaluating their lifecycle and the associated ethical and sustainability concerns. Rather than considering ethics in isolation, students explore how engineering decisions affect society and the environment over the entire lifecycle of a product. This encourages holistic learning and long-term thinking.

Innovativeness

The innovativeness of E²THICaL lies in changing how students engage with engineering ethics, from receiving and explaining ethical principles to actively applying, defending and reflecting on ethical decisions. The approach integrates game-based learning, AI-powered debate and life-cycle analysis into a single learning experience that connects professional ethics with real-world engineering practice. A key innovative element is the use of AI as a stakeholder rather than simply as a source of information. During the AI-Powered Debates, students make an initial ethical decision, after which AI adopts a "devil's advocate" position and challenges their reasoning. Students must evaluate these counterarguments, defend their position and refine their thinking. This creates a Human → AI → Human learning loop, where AI challenges the student's thinking while the final ethical judgement remains with the student. The innovation also extends ethical decision-making beyond the immediate situation. Following the board game and AI debate, the "Cradle to Grave" Sustainability Challenge requires students to consider the wider societal and environmental consequences of engineering decisions. This moves ethics beyond professional conduct and encourages students to consider the longer-term impact of engineering practice.

Applicability

E²THICaL'score learning activities are designed with flexibility, making them easily adaptable for various engineering courses or even different disciplines. For example, if this required a chemical engineering focus, the board game could focus on ethical issues relating to hazardous waste disposal. The game-based approach and AI debates can be easily customized for other subjects. The structure of the board game and the debate format can be adjusted to reflect discipline-specific ethical dilemmas. In other disciplines such as computing for example, the debate may focus on data privacy. The initiative is also

designed to scale effectively, allowing it to reach larger numbers of students or be implemented across multiple cohorts and universities. With 90 students, the current course structure requires 8 contact hours per week for one lecturer (2 hours lecture + 6 hours tutorials across three groups of 30 students). Based on Engineering Accreditation Council guidelines, this constitutes about 50% of a lecturer's allowable workload. Therefore, the course can scale up to 180 students with one lecturer delivering 14 contact hours per week (2 hours lecture + 12 hours tutorials across six groups), which remains within the acceptable workload limits. Learning materials essentially focused on preparation of the board game sets, while the integration of AI technology platforms utilized existing freeware versions of such platforms. Overall, the resources required for this large class was minimal and manageable. The AI debates can be scaled by dividing students into smaller groups to ensure every student has the opportunity to engage in debates. The ethics board game can also be adapted for larger groups by creating multiple sets of the game or using digital platforms for remote or asynchronous play. These initiatives can also be easily replicated and scaled across differing departments with clear guidelines for teaching faculty. For example, if students were tripled to 240, we anticipate the most significant investment would be the additional lecturers to support the additional tutorial classes.

Innovation Description, Process and Implementation

E²THICaL adopted a Plan–Do–Check–Act (PDCA) cycle to systematically implement and improve the initiative.

- PLAN: Two course learning outcomes, CLO1 and CLO3, were selected and linked to Objectives 1 and 2.
- DO: Three activities were implemented: the Ethics Board Game (Behavioural Learning), where students applied the BEM Code of Conduct to real-world dilemmas; AI-Powered Debates (Social Learning), where AI acted as a "devil's advocate" to challenge students' ethical reasoning; and the Sustainability Challenge (Constructivist Learning), where students conducted "Cradle to Grave" life-cycle analysis. Students worked in teams of 4–6 during 2-hour tutorials.
- CHECK: Impact was evaluated through post-activity surveys, learning outcome attainment and course-level surveys.
- ACT: Findings informed CQI and future improvements, including enhanced board-game design and further development of the AI-powered debates.

Key Findings

For the Ethics Board Game and AI-Powered Debate activities, a post-activity survey was conducted to evaluate their impact on students' learning of engineering ethics. Students rated their understanding on a scale of 1–10, with scores of 7–10 classified as "good" or "Yes" responses and scores of 6 and below classified as "not good" or "No" responses. A total of 68 responses were received. The findings showed that 83.8% of respondents reported a clear understanding of the responsibilities of an engineer towards society, while 83.7% reported that they could identify ethical dilemmas in engineering practice. 76.5% reported that they could relate the Code of Conduct to real-world scenarios. In addition, 89.7% agreed that the board game demonstrated the relationship between real-world engineering scenarios and the Code of Conduct in an engaging manner, while 94.1% agreed that the ChatGPT activity challenged their reasoning and strengthened their knowledge of professional ethics in an engaging manner. For the Sustainability Challenge, 55 students responded to the post-activity survey. 94.5% valued the importance of life-cycle analysis, while 69.1% showed interest in exploring sustainable engineering solutions.

Impact

The impact of E²THICaL extends beyond students' immediate understanding of ethical principles. By requiring students to apply, justify and defend ethical decisions, the initiative provides opportunities to develop critical thinking, ethical reasoning and stakeholder awareness in a context that resembles professional engineering practice. The mixed student cohorts also provided an opportunity to observe differences between students at different stages of their studies. Teams consisted predominantly of Year 1 students, while Electronic and Electrical Engineering included students from Years 1–3. Among these students, 85% of sophomore students achieved A grades compared with 70% of freshmen, suggesting that students' prior academic and learning experiences may support their ability to engage with and apply the ethical concepts. However, this difference should be interpreted as an observation rather than evidence that the initiative directly caused the difference in grades. Where possible, students were also grouped across disciplines and seniority. This created opportunities for more senior students to take on mentoring roles within their teams, while junior students benefited from peer support. One senior student

reflected: "I think definitely yes, at least we can base it on what we've learnt and seen over the past two years in academic or industrial visits and so on, helping to relate the things we've learnt in the past to this ethics course." This suggests that the initiative can support peer learning and knowledge sharing between students at different stages of their studies. More importantly, exposing Year 1 students to realistic ethical situations early in their programmes may help them develop the confidence and ability to apply ethical principles as they progress through their engineering education.

Recommendations for Classroom Practice

Based on the implementation and findings of E2THICaL, educators should use real-world ethical dilemmas to help students apply professional codes rather than relying solely on theoretical explanations. Game-based learning can provide an engaging, low-risk environment for practising ethical decision-making. AI should be used as a stakeholder or "devil's advocate" to challenge students' reasoning and encourage them to defend or refine their decisions. Activities should provide opportunities to consider different stakeholder perspectives and the wider consequences of engineering decisions. A "Cradle to Grave" approach can extend ethics learning to longer-term societal and environmental impacts. A progressive sequence of experiencing, defending and reflecting can connect the activities into one learning experience. Finally, educators should use student feedback and learning evidence for CQI and adapt scenarios to different engineering disciplines, cohorts and levels of study.

Other relevant information

E^2THICaL was recognised with the T-LINC Gold Award for Teaching & Learning Innovation in 2025 at Sunway University under the Immersive Learning category. The innovation was also recognised as the T-LINC Gold Award Champion. The work has subsequently been disseminated through a peer-reviewed, Scopus-indexed publication: Namasivayam, S. and Ng, L.Y. (2025), "Immersive learning approaches in enhancing the student learning experience for engineering ethics", International Journal of Mechanical Engineering Education. DOI: 10.1177/03064190251400058.

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ID 58: An Industry-Integrated Professional Learning and Curriculum Enhancement Ecosystem (iPLACE) for TVET Accounting Education

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Highlights: The Industry-Integrated Professional Learning and Curriculum Enhancement Ecosystem (iPLACE) is a TVET curriculum innovation that connects students, academics, industry practitioners, professional bodies, alumni and employers across semesters throughout the programme. Unlike conventional stand-alone industry engagement, iPLACE continuously translates current professional, regulatory and technological developments into enhanced Course Learning Outcomes (CLOs), updated teaching materials, authentic assessments, SULAM activities, Work-Based Learning (WBL) and Continuous Quality Improvement (CQI). The ecosystem strengthens curriculum relevance, professional competency development and graduate readiness by ensuring that TVET accounting education remains responsive to rapidly evolving industry practices and technologies.

Keywords: Professional learning community (PLC); TVET accounting education; Curriculum enhancement; Experiential learning; Industry collaboration.

Introduction

Accounting education must respond rapidly to developments in artificial intelligence, digital accounting, e-Invoicing, sustainability reporting, data analytics and evolving employer competency requirements. However, curriculum enhancement is often conducted periodically, while industry engagement is commonly limited to advisory meetings, guest lectures and industrial training. As a result, students may only encounter current workplace systems and professional practices during industrial attachment, requiring them to adapt quickly to unfamiliar technologies and professional expectations.

Professional Learning Communities (PLCs) are collaborative networks that promote continuous knowledge sharing, reflective practice and collective responsibility for improving learning. The proposed Industry-Integrated Professional Learning and Curriculum Enhancement Ecosystem (iPLACE) extends the conventional PLC concept by integrating academics, students, industry practitioners, professional bodies, employers, alumni and community partners into a continuous curriculum enhancement ecosystem. Unlike traditional Industry Advisory Panel (IAP) and Experiential Education (EE) approaches, where industry participation is largely confined to periodic curriculum reviews or workplace placement, iPLACE positions industry as a co-educator and curriculum partner throughout a complete subject pathway. For example, in taxation, one of the eight core accounting subject pathways, LHDN and tax practitioners continuously collaborate with academics from introductory tax to advanced tax courses, ensuring that emerging tax regulations, e-Invoicing requirements and professional practices are immediately reflected in Course Learning Outcomes (CLOs), learning activities and authentic assessments.

As a pioneering provider of TVET accounting education in Malaysia, Universiti Malaysia Perlis (UniMAP) has developed iPLACE to strengthen the alignment between curriculum and industry. Through continuous collaboration, professional and industry updates are translated into enhanced CLOs, updated course content and authentic pedagogies such as SULAM, mentoring, industry projects, Work-Based Learning (WBL) and industrial training. Rather than treating curriculum enhancement as a periodic institutional exercise, iPLACE establishes a continuous feedback loop in which stakeholder input directly informs curriculum delivery and Continuous Quality Improvement (CQI). This ecosystem advances the TVET philosophy of competency-based, practice-oriented and industry-responsive learning while ensuring that graduates are better prepared for contemporary professional practice.

Figure 1 illustrates the proposed iPLACE Educational Framework. This framework illustrates a continuous ecosystem that connects students, academics, industry partners, professional bodies, employers, alumni and community partners throughout the accounting programme. The Professional Learning Community (PLC) serves as the central mechanism for continuously identifying emerging industry needs, reviewing competency requirements and enhancing Course Learning Outcomes (CLOs), curriculum content and

authentic assessments. These improvements are delivered through student-centred and competency-based pedagogies, including SULAM, project-based learning, experiential learning, industry mentoring, Work-Based Learning (WBL), industrial training and reflective practice. Continuous feedback from all stakeholders supports Continuous Quality Improvement (CQI), ensuring that the curriculum remains responsive to industry developments and produces competent, industry-ready TVET accounting graduates.

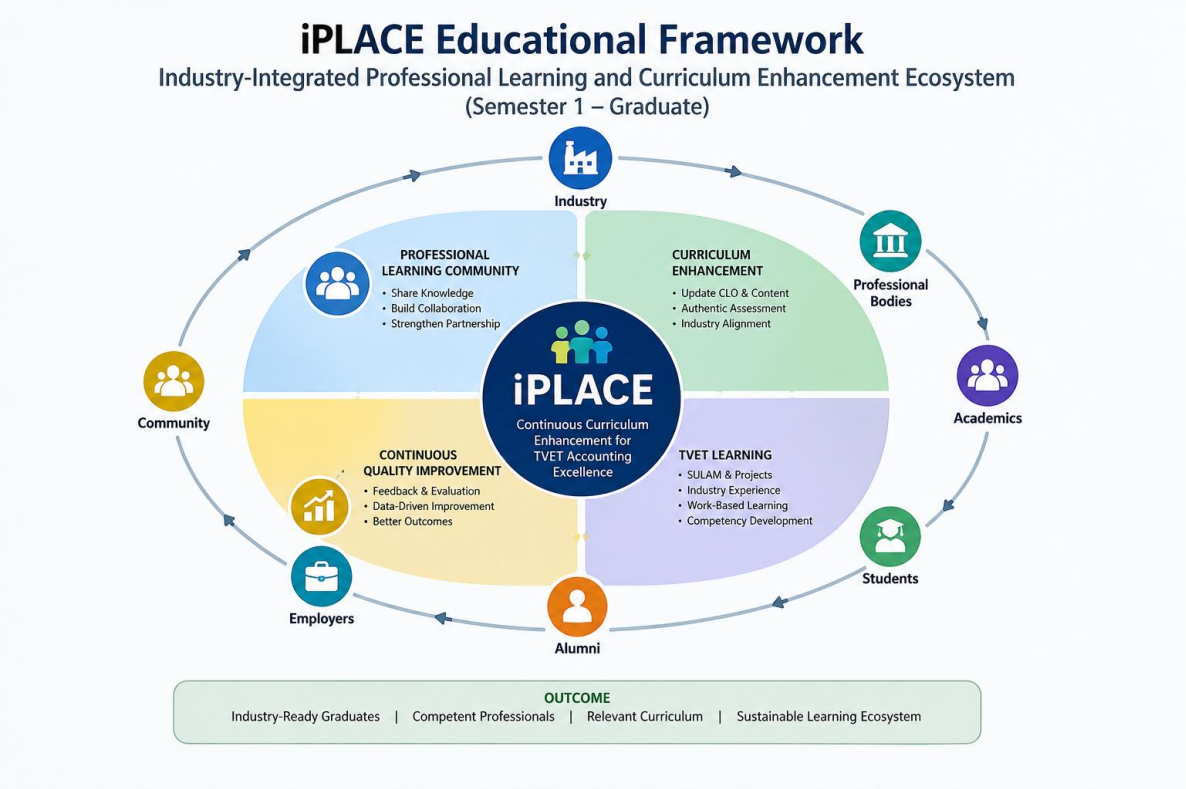


Figure 1: iPLACE educational Framework

Table 1 highlights how the proposed iPLACE ecosystem differs from conventional Industry Advisory Panel (IAP) and Experiential Education (EE/WBL) approaches by transforming industry from a periodic advisor into a continuous co-educator and curriculum partner.

Table 1: Comparison of Traditional Industry Engagement Approaches and the Proposed iPLACE Ecosystem

TRADITIONAL IAP	TRADITIONAL EE/WBL	IPLACE PLC (INNOVATION)
Periodic advisory meetings	Industry involvement mainly during internship	Continuous collaboration in a complete subject pathway start from beginning of Semester 1 until graduation
Focus on programme review	Focus on workplace exposure	Focus on continuous curriculum enhancement
Industry acts as advisor	Industry acts as placement provider	Industry acts as co-educator, mentor and curriculum partner
Curriculum reviewed periodically	Learning occurs during attachment	Curriculum, CLOs and assessments continuously updated
Limited student interaction	Student–industry interaction only during placement	Continuous student–industry engagement through SULAM, projects, mentoring, WBL and industrial training
Feedback mainly for accreditation	Feedback after placement	Continuous CQI driven by all PLC members

Objectives

The objective of iPLACE is as follows:

- To establish a sustainable multi-stakeholder Professional Learning Community across complete accounting subject pathways.
- To continuously align Course Learning Outcomes, course content, assessments and learning activities with current industry and professional requirements.
- To strengthen competency-based, authentic and experiential learning through SULAM,

mentoring and industry-linked projects.

- To develop students' technical, digital, ethical, communication and problem-solving competencies before industrial attachment.
- To establish a closed-loop Continuous Quality Improvement mechanism using feedback from students, academics, industry practitioners and professional bodies.

NALI Approach

Novelty

The novelty of iPLACE lies in positioning it as a continuous curriculum enhancement ecosystem rather than treating industry engagement as a stand-alone activity, particularly during internship. Within iPLACE, industry practitioners, professional bodies and other PLC members collaborate across complete accounting subject pathways, such as taxation from introductory tax to advanced tax courses. They identify regulatory changes, digital developments and emerging competency requirements, and translate them into revised CLOs, updated teaching resources, authentic assessments and experiential learning activities. As a result, industrial attachment becomes an advanced stage for applying competencies that students have already developed through continuous industry-integrated learning.

Creativity

The iPLACE ecosystem creatively integrates PLC principles with TVET pedagogy, SULAM, active learning, problem-based learning, project-based learning, professional mentoring, hybrid engagement and reflective practice. Taxation serves as the flagship example because its regulations, digital systems and compliance requirements evolve rapidly. The same iPLACE approach can then be translated into other core accounting subject pathways, including financial reporting, auditing, management accounting, accounting information systems, sustainability reporting and public sector accounting, allowing each subject to be continuously enhanced through relevant industry and professional engagement.

Innovativeness

The iPLACE ecosystem introduces an industry-informed CLO review mechanism, responsive curriculum updates, competency-based authentic assessment, shared academic–industry supervision, digital knowledge exchange and continuous stakeholder feedback. Together, these elements promote active participation, collaborative knowledge construction, reflective learning and learner empowerment. Human–AI synergy is embedded through the guided use of AI-assisted accounting applications, data analytics and digital platforms, while professional judgement, academic integrity, ethical responsibility and verification remain central to student learning.

Applicability

The iPLACE ecosystem is modular and can be implemented by universities, polytechnics and TVET institutions. Institutions may begin with one subject-level PLC, such as taxation, before scaling the approach across other accounting subject pathways and eventually to programme level. Engagement can be conducted physically or virtually, enabling wider participation by industry practitioners, professional bodies and alumni. The ecosystem can also be adapted to other professional programmes where curriculum relevance depends on continuous alignment with evolving industry practices and competency requirements.

Innovation Description, Process and Implementation

The iPLACE ecosystem operates through four continuous stages. First, a subject-level Professional Learning Community is established involving students, academics, industry practitioners, professional bodies, alumni and employers. Second, members share current regulatory, technological and competency developments through advisory discussions, webinars, mentoring, professional talks and digital platforms. Third, course coordinators map these inputs against CLOs, course content and assessment, and then introduce relevant learning activities. Finally, evidence from student performance, reflection and stakeholder feedback is returned to the PLC to support Continuous Quality Improvement.

Table 2: Taxation as an Example of the iPLACE Ecosystem

STAGE	PLC ENGAGEMENT	STUDENT-CENTRED ACTIVITY	CURRICULUM/CLO ENHANCEMENT
Introductory taxation courses	LHDN officers, tax practitioners and academics introduce the taxation ecosystem, ethics and professional expectations.	SULAM Basic Tax Awareness programme for schools, youth or community groups.	Feedback identifies foundational knowledge, communication and ethical competencies.

STAGE	PLC ENGAGEMENT	STUDENT-CENTRED ACTIVITY	CURRICULUM/CLO ENHANCEMENT
Intermediate taxation courses	PLC members share updates on tax regulations, e-Filing, e-Invoicing, documentation and digital compliance.	SME Tax Readiness Clinic conducted under practitioner supervision.	Cases, practical exercises and assessments are updated using current professional applications.
Advanced taxation courses	Tax firms contribute authentic corporate tax and tax planning cases and mentor student teams.	Problem-based and project-based analysis of real or simulated organisational tax issues.	CLOs are strengthened to emphasise professional judgement, digital literacy, critical thinking and problem-solving.
WBL and industrial training related with taxation firms	Academic and industry supervisors monitor competency application and provide structured feedback.	Students apply current tax systems and professional practices in the workplace.	Workplace evidence informs course-level and programme-level CQI for the next cycle.

The iPLACE ecosystem is not limited to taxation. The same approach can be translated into other accounting subject pathways. Financial reporting partners may contribute current MFRS and sustainability reporting cases; audit firms may support internal control simulations and working-paper exercises; software providers may guide cloud accounting and accounting information system projects; manufacturers may contribute costing and budgeting problems; and public agencies may support governance and accountability projects. Cross-disciplinary activities may also be designed around one authentic organisational context, such as an SME SULAM project that integrates record preparation, costing, taxation, internal controls and digital accounting. This creates meaningful, interdisciplinary and practice-oriented TVET learning.

Key Findings

As iPLACE is currently presented as a curriculum innovation, no empirical performance or satisfaction outcomes are claimed. Based on its design and the reviewed literature, the ecosystem is expected to strengthen student engagement, improve theory-to-practice integration, expand authentic and collaborative learning, and develop professional competencies through more responsive curriculum enhancement. Its effectiveness will be evaluated using evidence from CLO attainment, authentic and competency-based assessment, student reflections, practitioner feedback, placement readiness and employer evaluations. PLC participation, the frequency of curriculum updates and the adoption of industry-informed learning activities will also be monitored to support evidence-based improvement in teaching, learning and student achievement.

Impact

Students benefit from continuous exposure to professional expectations, authentic workplace problems and current digital applications across their subject pathways. Academics gain access to contemporary cases and practitioner knowledge, strengthening teaching effectiveness and curriculum relevance. Industry practitioners and professional bodies contribute directly to talent development and can identify competency gaps before placement. The institution gains a sustainable university–industry collaboration mechanism that supports Outcome-Based Education and Continuous Quality Improvement. In the longer term, iPLACE is expected to reduce the transition gap between university and employment and develop technically competent, adaptable, reflective and industry-ready TVET accounting graduates.

Recommendations for Classroom Practice

Educators should begin with a clearly defined subject-level PLC, appoint academic and industry coordinators, agree on a regular communication schedule and map each external contribution to specific CLOs. SULAM and industry-linked activities should use authentic but manageable problems supported by clear ethical, confidentiality and data-protection procedures. Assessment should capture both technical outcomes and professional competencies through portfolios, reflective presentations, peer collaboration and practitioner feedback. A digital platform should document updates, decisions, learning materials and evidence of improvement to support continuity, transparency and scalability.

The iPLACE ecosystem transforms TVET accounting education from fragmented, stand-alone industry engagement into a continuous curriculum enhancement process across complete accounting subject pathways. Its central contribution is the systematic translation of industry and professional developments into enhanced CLOs, updated content, authentic learning, competency-based assessment and CQI.

Taxation demonstrates how SULAM tax clinics, e-Invoicing activities, practitioner mentoring and workplace feedback can keep learning current, while the same approach can be applied to other accounting subject pathways. iPLACE therefore offers a practical and scalable mechanism for responsive TVET accounting education and the development of industry-ready graduates.

Other Relevant Information

iPLACE has potential to be developed into a programme-development toolkit containing stakeholder-role guidelines, CLO-mapping templates, SULAM activity designs, authentic-assessment rubrics, feedback instruments and a digital CQI dashboard. These components can support replication across institutions, accounting subject pathways and other professional disciplines.

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ID 59: Read–Record–Reflect (R³): A Human–AI Collaborative OBE Speaking Assessment Model for Short-Term Korean Language Courses

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Highlights: R³ (Read–Record–Reflect) emerged in response to the disruption of conventional speaking assessment during the COVID-19 pandemic, transforming one-shot assessment into a continuous Human–AI collaborative learning ecosystem. Through guided reading, two-stage recording, AI-assisted diagnosis, metacognitive reflection, and lecturer mentoring, R³ integrates assessment with learning and improvement. Since its implementation in 2021, the model has been continuously applied in UTM Korean language courses, involving approximately 1,680 student enrolments over five years (2021–2026). The model demonstrated sustained OBE achievement with gradual improvement across the implementation period, reaching consistently high CLO attainment of 92%–94%. Its key contribution is repositioning Generative AI from an automated correction tool to a diagnostic and reflection partner within a human-led assessment process.

Keywords: Human–AI Collaboration; Innovation Model; Outcome-Based Assessment; Rapid Speaking Development; Korean Language Education; Metacognitive Reflection

Introduction

The COVID-19 pandemic disrupted conventional face-to-face language teaching and assessment in higher education, creating particular challenges for evaluating speaking performance remotely. For short-term foreign language courses, the shift towards online and technology-supported learning highlighted the limitations of one-shot speaking assessments, which often provide limited opportunities for repeated practice, self-monitoring, feedback, and improvement.

At Universiti Teknologi Malaysia (UTM), Korean language courses are typically completed within one semester, requiring an assessment approach that can support oral development within limited instructional hours while generating valid evidence of learning achievement. In response to these challenges, the Read–Record–Reflect (R³) model was introduced in 2021 to transform speaking assessment from a one-off performance task into a continuous learning and assessment process.

Rather than replacing lecturers with AI, R³ redesigns the relationship between learners, Generative AI, and lecturers. Students repeatedly practise, record, analyse, critically evaluate AI feedback, reflect on their performance, and receive expert lecturer guidance. Assessment therefore becomes not only an assessment of learning, but also an assessment for and as learning.

Objectives

- To establish an AI-supported Korean speaking innovation model designed for rapid oral development in short-term university language courses.
- To introduce a two-stage scaffolded assessment pathway integrating audio self-audit and authentic video performance.
- To reposition Generative AI as a reflective learning partner that enhances responsible AI literacy and self-regulated learning.
- To generate portfolio-based evidence for direct OBE alignment, CLO measurement, and continuous quality improvement.

NALI Approach

Novelty

R³ reconceptualises conventional one-off speaking assessment as a continuous, evidence-based learning cycle comprising Read → Audio Audit → Authentic Video → AI Diagnostic → Metacognitive Reflection → Lecturer Mentoring. Unlike conventional assessment, which primarily evaluates final performance, R³ uses each stage to generate feedback and guide subsequent improvement. The central novelty is therefore the integration of assessment, feedback, reflection, and improvement into a single iterative process.

Creativity
R³ integrates authentic video performance with a structured four-part Reflection Log comprising Self-Audit, AI Findings, Critical Comparison, and Action Plan. Students do not simply submit a speaking performance; they analyse their own performance, interpret AI-generated feedback, critically verify the suggestions, and formulate specific improvement strategies. This makes metacognitive reflection visible, structured, and directly connected to authentic Korean communication.

Innovativeness
The key innovation lies in positioning Generative AI as a diagnostic and reflection partner, rather than an answer generator or replacement for lecturer judgement. AI supports pattern detection, language diagnosis, and immediate feedback, while lecturers retain responsibility for pragmatic, cultural, and contextual judgement. This deliberate division of roles establishes a responsible Human–AI assessment model that strengthens feedback, metacognition, academic integrity, and speaking development within limited instructional hours.

Applicability
R³ is designed as a scalable framework that can be implemented using accessible digital technologies. It can be adapted across proficiency levels and delivery modes, including face-to-face, online, blended, HyFlex, microcredential, and lifelong learning contexts. Although developed for Korean speaking, the structured cycle, Reflection Log, and Human–AI feedback mechanism can be adapted to other foreign languages and communication-based subjects. Its portfolio evidence can also support CLO measurement, OBE documentation, and CQI.

Innovation Description, Process and Implementation

The R³ model operates through a progressive 9-step learning and assessment ecosystem:

1. INPUT (Reading Scaffolding): Students study target Korean expressions and texts to develop vocabulary, pronunciation, and sentence structures.

2. READ (Guided Oral Practice): Students conduct guided oral reading to internalise target structures and pronunciation patterns.

3. RECORD STAGE 1 (Audio Self-Audit): Students record oral reading tasks and listen back to evaluate pronunciation, pauses, and speech pace.

4. RECORD STAGE 2 (Authentic Video Task): Students produce an authentic video simulating real-life Korean communication and undertake multiple practice takes before submitting their best performance.

5. AI CHECK (Diagnostic Analysis): Students use Generative AI such as ChatGPT or Gemini to identify patterns in syntax, vocabulary, and grammatical usage.

6. REFLECT (Metacognitive Reflection Log): Students complete a four-part Reflection Log: Self-Audit → AI Findings → Critical Verification → Action Plan.

7. LECTURER FEEDBACK (Expert Mentoring): Lecturers evaluate the video portfolio and reflection log, focusing on pragmatic naturalness, cultural appropriateness, and communicative effectiveness.

8. OBE ACHIEVEMENT (CLO Measurement): Performance evidence and assessment results are compiled to measure direct CLO attainment.

9. CQI (Continuous Quality Improvement): Aggregated assessment evidence informs subsequent curriculum and assessment refinement.

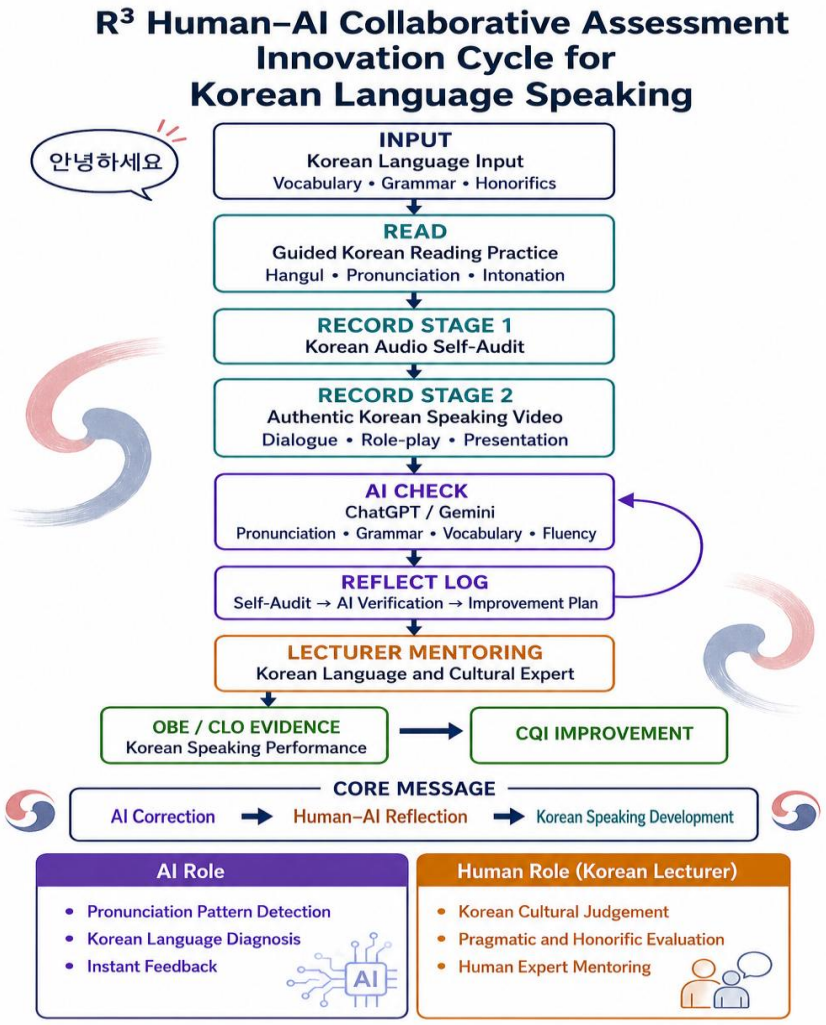


Figure 1: R³ Human–AI Collaborative Assessment Innovation Cycle Structure

Table 1: Implementation Framework and Evidence Portfolio of the R³ OBE Assessment Model

STAGE	VISUAL MODULE TITLE	KEY ACTION & VISUAL WORKFLOW	EVIDENCE PORTFOLIO ARTIFACT
01	INPUT & READ	• Study target vocabulary and grammar rules • Oral reading practice for phonetics and pronunciation rules	Textbook Practice Log
02	RECORD (Stage 1)	• Complete 1st audio reading recording and listen back • Self-audit pronunciation accuracy, pauses, and speech pace	Audio Recording
03	RECORD (Stage 2)	• Apply natural, real-life conversational Korean expressions • Multiple practice takes to produce 'Personal Best Performance'	Authentic Video Portfolio
04	AI CHECK	• Input script into ChatGPT/Gemini for instant syntax audit • Automated check on grammar errors, vocabulary richness, and structure	AI Diagnostic Report
05	REFLECT	• Complete 4-part Metacognitive Log: ① Self-Audit -> ② AI Diagnostic -> ③ Critical Verification -> ④ Action Plan	4-Part Reflection Log
06	LECTURER FEEDBACK	• Comprehensive evaluation of video portfolio and reflection log • Expert mentoring on pragmatic naturalness and cultural appropriateness	Rubric Assessment
07	OBE & CQI	• Direct measurement of CLO1–CLO4 achievements • Continuous curriculum and assignment refinement semesterly	CLO Attainment Report

Key Findings

The R³ model was introduced in 2021 as a pedagogical response to the disruption of conventional speaking assessment during the COVID-19 pandemic. Since then, it has been continuously implemented in UTM Korean language courses across five years (2021–2026), involving approximately 1,680 student enrolments.Following the introduction of R³, s

peaking assessment was transformed from primarily one-off performance tasks into an iterative process of guided practice, recording, AI-supported diagnosis, reflection, and lecturer mentoring. Across the five-year implementation period, CLO attainment showed gradual improvement, reaching consistently high levels of 92%–94%, providing evidence of the model's sustained educational effectiveness and scalability.

Analysis of student reflection logs indicated increased awareness of pronunciation, sentence construction, and pragmatic appropriateness. Importantly, students were required to critically evaluate AI-generated suggestions rather than accept them automatically, supporting the development of responsible AI literacy and self-regulated learning.

Table 2: OBE Alignment and Learning Outcome Achievement of the R³ Model

LEARNING STAGE	R³ ACTIVITY	ALIGNED CLO	EVIDENCE & PEDAGOGICAL FOCUS	AVG. ATTAINMENT (%)
Read	Guided Reading Input	CLO1	Controlled practice: Pronunciation and Structural accuracy	94%
Record (Stage 1 & 2)	Audio & Authentic Video Tasks	CLO2	Authentic speaking performance: fluency, naturalness, and confidence	92%
AI Check	ChatGPT / Gemini Syntax Check	CLO3	AI-assisted error analysis and self-correction	93%
Reflect	Metacognitive Reflection Log	CLO4	Critical AI reflection and personalised improvement planning	94%
Lecturer Feedback	Expert Pragmatic Review	CLO Mastery	Human validation: contextual and cultural appropriateness	Target Met

Impact

Table 3: Multilevel Stakeholder Impact Matrix of the R³ Innovation

STAKEHOLDER LEVEL	CORE EDUCATIONAL IMPACT
Students	Accelerated speaking development, responsible AI literacy, and metacognitive self-regulated learning
Educators	Reduced routine feedback burden, enabling higher-value pragmatic and socio-cultural mentoring
Institution	Evidence-based OBE quality assurance and scalable, ethical AI integration in language education

Recommendations for Classroom Practice

1. Structured Reflection Logs: Provide a four-part Reflection Log to guide students in critically verifying AI suggestions against authentic communicative contexts.

2. Low-Stakes Practice: Use two-stage recording tasks as low-stakes practice to encourage repeated attempts before submission of the best-performance portfolio.

3. Human Oversight: Maintain lecturer responsibility for pragmatic, cultural, and contextual judgement when integrating Generative AI into language assessment.

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ID 60: WARM: Bringing Primary Science to Life through a WebAR-Supported Learning Environment

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Highlights: Primary Science pupils often struggle to visualize abstract structures and processes presented through two-dimensional materials. WARM was developed as a WebAR-supported blended learning environment for the Year Five topic of Humans, integrating curriculum-aligned, CTML-guided multimedia with 5E inquiry-based learning. In a four-week quasi-experimental study involving 58 Year Five pupils, those learning with WARM achieved significantly higher achievement scores and inquiry-skill levels than those learning without WARM, with large effect sizes, while post-use acceptance was positive. WARM integrates browser-based WebAR without requiring a dedicated AR application within a curriculum-aligned and pedagogically structured learning environment.

Keywords: WebAR; Learning Environment; Blended Learning; Inquiry-Based Learning; Primary Science Education

Introduction

Science learning often involves abstract structures and processes that are difficult for pupils to visualize when learning relies heavily on two-dimensional materials (Jofri et al., 2022). A preliminary study involving 15 Year Five pupils similarly found that the majority experienced difficulty understanding Science content requiring mental visualization of abstract phenomena, while pupils indicated that augmented reality (AR) could potentially support their understanding of such content. In response, Web-Based Augmented Reality Manusia (WARM) was developed as a WebAR-supported blended learning environment for the Year Five Science topic of Humans, covering the human skeletal system, human circulatory system and relationships between body systems. WARM aligns with the Year Five Science curriculum, with its multimedia content designed according to the Cognitive Theory of Multimedia Learning (CTML) and its learning activities structured through the 5E Inquiry-Based Learning Model.

Objectives

- To design and develop WARM, a WebAR-supported blended learning environment for the Year Five Science topic of Humans, integrating CTML-guided multimedia and 5E inquiry-based learning activities.
- To evaluate the effectiveness of WARM in improving pupils' achievement and inquiry-skill levels.
- To assess pupils' acceptance of WARM following its implementation.

NALI Approach

Novelty

A systematic literature review of augmented reality (AR) in primary science education found that explicit reporting of theoretical and pedagogical foundations in the development and implementation of AR-supported learning remained limited (Ahmad & Abu Samah, 2024). This is important because Mayer (2021) emphasized that educational technologies should be designed around appropriate learning theories and instructional principles. WARM extends existing AR-supported learning by systematically integrating WebAR, CTML-guided multimedia design and the 5E Inquiry-Based Learning Model within a blended and curriculum-aligned Year Five Science learning environment. Its novelty lies not in any single component, but in the coherent integration of these elements as a pedagogically structured learning environment, with WebAR embedded within the learning design rather than added as an isolated digital feature.

Creativity

WARM creatively connects digital resources with face-to-face classroom activities through a structured 5E Inquiry-Based Learning sequence. Videos, digital notes, WebAR activities and quizzes function as interconnected learning components through which pupils engage with multimedia and guiding questions, explore concepts collaboratively, discuss and explain their observations, apply their understanding, and evaluate their learning through digital quizzes with immediate feedback. A distinctive creative feature of WARM lies in the design of its WebAR activities. For the human skeletal and circulatory

systems, when markers worn on the front and back of a pupil's body are scanned, corresponding three-dimensional representations are displayed, enabling pupils to view the structures from different perspectives and relate them to their positions on the human body. For exploring relationships between body systems, a single marker enables pupils to navigate among multiple three-dimensional systems within the same WebAR activity using Next and Back functions. These WebAR interactions are embedded within the wider learning environment to support pupils' observation and exploration during classroom learning.

Innovativeness

WARM improves the delivery of augmented reality in primary Science learning by using browser-based WebAR rather than relying on a dedicated AR application. Conventional app-based AR generally requires users to download and install an application, whereas WebAR enables AR content to be accessed directly through a compatible web browser without installing an additional application (Nitika & Kumari, 2020; Zhang & Lu, 2019). In WARM, browser-based WebAR activities are integrated with videos, digital notes and quizzes through a common website structure and organized learning sequence, allowing pupils to move between multimedia learning, WebAR exploration and classroom activities within the same environment. This allows WebAR to function not as a separate digital resource, but as an integrated technological component of a broader pedagogically structured learning experience.

Applicability

WARM has the potential to be adapted and replicated beyond its current implementation in the Year Five Science topic of Humans. Its underlying design structure, comprising curriculum-aligned content, CTML-guided multimedia, 5E inquiry-based learning activities and integrated WebAR components, can be adapted to other Science topics according to the relevant learning objectives, content and pupils' ability levels. Its browser-based delivery also supports wider implementation without requiring additional application installation. However, scalability depends on the availability of camera-enabled devices, reliable Internet access and compatible web browsers, while sustainable implementation requires appropriate teacher preparation, technical support and continued curriculum alignment. Wider implementation should therefore be preceded by classroom trials across schools with different technological facilities and educational contexts to establish its applicability beyond the present study.

Innovation Description, Process and Implementation

WARM was developed as a WebAR-supported blended learning environment integrating learning videos, digital notes, quizzes and marker-based WebAR activities for the Year Five Science topic of Humans. Its website was developed using HTML, CSS and JavaScript, while three-dimensional models were edited using Blender and delivered through browser-based WebAR using A-Frame and MindAR. The development was human-led and AI-assisted, with generative AI serving as a technical co-pilot for coding, debugging and WebAR implementation, while curriculum alignment, pedagogical design, Science content accuracy and classroom implementation remained human-led. The development process followed the ADDIE model, encompassing analysis of pupils' learning needs and target content, curriculum-aligned design, and development and integration of multimedia, quizzes, three-dimensional models, markers and WebAR components. Before classroom implementation, the WARM learning environment was evaluated by two experts, its CTML-based learning videos were evaluated by three experts, and alpha testing was conducted with 10 Year Five pupils, with feedback used for refinement and technical optimization. WARM was then implemented over four weeks in a pretest–posttest quasi-experimental study involving a final sample of 58 Year Five pupils from two primary schools, comprising 28 pupils in the treatment group and 30 in the control group. The treatment group learned through a teacher-facilitated 5E sequence involving multimedia, collaborative WebAR exploration, discussion, explanation, application and digital quizzes with immediate feedback, while the control group studied the same Science topic over the same period without WARM. Achievement and inquiry-skill levels were evaluated before and after the intervention in both groups, while WARM acceptance was assessed among treatment-group pupils after the intervention.

Key Findings

The four-week implementation of WARM showed significantly better outcomes for the two primary learning measures evaluated in the study. Table 1 summarizes the main quantitative findings.

Table 1: Key learning outcomes following the implementation of WARM.

LEARNING OUTCOME	GROUP		STATISTICAL EVIDENCE
	TREATMENT	CONTROL	
Achievement	Adjusted posttest mean = 32.017/50	Adjusted posttest mean = 25.150/50	$F(1, 55) = 19.626$, $p < .001$, partial $\eta^2 = .263$ (large)
Inquiry-skill levels	18/28 at Moderate or High levels	30/30 at Low level	$U = 150.000$, $p < .001$, $r = .680$ (large)

For achievement, the treatment group obtained a significantly higher adjusted posttest mean than the control group after controlling for pretest scores, with a large effect size. For inquiry-skill levels, pupils in the treatment group attained significantly higher post-intervention levels than those in the control group. Notably, 18 of the 28 treatment-group pupils were at Moderate or High post-intervention inquiry-skill levels, whereas all 30 pupils in the control group were at the Low level. Pupils also showed positive acceptance of WARM after the intervention, with 82.1% classified at the High level for attitude towards WARM and 78.6% at the High level for behavioural intention, while no pupils were classified at the Low level for either construct. Exploratory Decision Tree analysis further identified attitude as the main attribute distinguishing behavioural intention levels, with 25 of the 28 cases (89.29%) correctly classified within the study dataset.

Collectively, the convergence of significantly better achievement and inquiry-skill outcomes, both with large effect sizes, together with positive post-use acceptance, provides strong empirical support for the educational value and effectiveness of WARM as an integrated WebAR-supported learning environment within the study context.

Impact

The most immediate impact of WARM is on pupils' learning. Pupils who learned using WARM achieved significantly higher achievement and inquiry-skill outcomes than those who learned without WARM, with large effect sizes for both measures. Beyond these measured outcomes, WARM provides pupils with opportunities to observe and explore three-dimensional representations of human body systems, discuss their observations, explain scientific ideas and apply their understanding through structured inquiry activities. Its learning design therefore extends beyond content viewing by engaging pupils in observation, exploration, explanation and application of scientific concepts within the same blended learning environment. Positive post-use acceptance further indicates that pupils responded favourably to the overall WARM learning experience.

For educators, WARM provides a curriculum-aligned structure for facilitating inquiry-oriented Science learning with technology, integrating videos, digital notes, quizzes and WebAR activities within an organized learning sequence while preserving the teacher's role in questioning, guiding discussion, supporting conceptual connections and providing technical assistance when necessary. At the school and education-system levels, WARM provides an evidence-based example of how browser-based WebAR can be integrated with curriculum content, multimedia design and inquiry-based pedagogy in primary Science education. Its design offers a potential reference for schools, curriculum developers and education authorities seeking to develop technology-supported learning environments driven by educational objectives rather than technological novelty alone, with further evaluation across different topics, schools and technological contexts needed before broader implementation.

Recommendations for Classroom Practice

WARM should be implemented as a structured blended learning environment rather than as a standalone WebAR activity. Teachers should organize its videos, digital notes, WebAR activities, worksheets or discussion tasks and quizzes within a purposeful learning sequence that encourages pupils to observe, explore, discuss, explain and apply scientific concepts, while providing appropriate questioning, conceptual guidance and technical assistance throughout the learning process. Before classroom use, device cameras, Internet access, browser compatibility and marker detection should be checked, and pupils who require greater support in using digital technologies should be given clear instructions and assistance. For adaptation to other Science topics or school contexts, the multimedia, inquiry activities and WebAR visualizations should be redesigned according to the relevant curriculum, learning objectives, topic content and pupils' ability levels rather than transferred unchanged. Schools should also consider device availability, Internet connectivity, teacher preparation and technical support, with initial classroom trials conducted before wider implementation.

Other relevant information

WARM has been submitted for intellectual property protection under Application No. P/CR/08993.

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ID 61: EQADAB®: From Knowing to Deciding

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Highlights: EQADAB® addresses two connected learning gaps: limited awareness of practical emotional-intelligence (EQ) strategies and Adab values, and difficulty applying them in emotionally challenging situations. Learners use realistic scenarios and tangible-digital cards to select, show, point to or discuss response options before explaining and reconsidering a decision. In a Bachelor of Landscape Architecture class, all 29 respondents agreed that the scenario was realistic and meaningful, reported engagement and recorded a value or insight. Seven valid group outputs documented deliberation and collective decisions. A pilot with 15 industry practitioners supported preliminary professional relevance and adult-learning applicability.

Keywords: card-mediated learning; experiential learning; Adab; emotional intelligence; professional readiness

Introduction

Professional conduct is often taught through explanations of values. Yet learners may have limited familiarity with specific Adab values or EQ strategies or may understand them but remain unsure what to do when they feel angry, criticised, treated unfairly or caught between competing priorities. Such situations can also be uncomfortable to discuss openly. EQADAB® turns EQ strategies and Adab values into visible choices that learners can select, show, point to and discuss before explaining a response. It supports both awareness of possible responses and practice in applying them. Generative AI can provide information and suggested answers, but learners remain responsible for context, emotions, consequences and accountable action. In a Human-AI learning context, EQADAB® strengthens the human judgement required to evaluate information and act responsibly, including when recommendations are AI-generated.

Adab connects knowledge with disciplined and appropriate conduct (Al-Attas, 1980). Emotional intelligence supports recognising and managing emotions in thought and action (Mayer et al., 2004). In EQADAB®, EQ helps learners notice and regulate emotion; Adab provides ethical and relational direction. Put simply, EQ helps learners recognise what they can do, while Adab helps them consider how they ought to act. The game-like format makes discussion more approachable because learners can begin with a card rather than immediate personal disclosure. Experiential learning turns the cards into a cycle of choosing, explaining, deciding, considering consequences and improving through reflection (Kolb, 1984). The wider conceptual basis is documented by Omar and Najib (2025).

Objectives

- To develop a card-mediated experiential tool designed to build awareness of EQ strategies and Adab values and support their application in emotionally challenging professional situations.
- To examine students' documented decision-making processes, immediate views of authenticity and engagement, and written values or insights after the activity.
- To assess professional relevance and adult-learning applicability through a landscape architecture industry pilot.

NALI Approach

Novelty

EQADAB® makes EQ strategies and Adab values visible, selectable and discussable as decision guides. Its distinctive contribution is pairing an EQ strategy with an Adab value within an emotionally difficult scenario. Learners may speak, point to wording or select a card before explaining a response. The initial choice, selected guides, group decision and improvement reflection create a clear record of deliberation and reconsideration.

Creativity

EQADAB® uses emotionally recognisable dilemmas with several defensible response options. The cards provide a shared focus, allowing learners to discuss a sensitive issue through selected words before

choosing how much to say personally. EQ cards offer strategies such as pausing, naming emotions and taking another perspective. Adab cards bring fairness, responsibility, respect and appropriate conduct into the discussion. Printed scenario cards with hybrids EQ and Adab guides, and structured reflection make difficult conversations more approachable while learners remain responsible for their reasoning.

Innovativeness

EQADAB® moves Adab from explanation into guided practice. Learners recognise an Adab value, connect it with an EQ strategy and practise applying both in a difficult situation. This changes the teaching of Adab values from explanation and recall to active recognition, expression, decision rehearsal and reflection. Peer and facilitator feedback occurs during discussion and reflection. The same structured process can be used with different scenarios and learner groups, while learners' recorded choices and reflections make their thinking visible.

Applicability

EQADAB® combines scenario-based learning, structured peer learning and reflective experiential learning. Learners first record an individual choice, explain and compare their reasoning with peers, agree on and justify a group decision, and reflect on how the response could be improved. The same cycle was used with Bachelor of Landscape Architecture students and professional learners from one landscape architecture firm across five role categories. Adaptable scenarios support professional programmes, internship preparation, TVET learning, and workplace development. This demonstrates preliminary classroom and workplace applicability. The next phase will extend testing to independent facilitators, additional disciplines and workplace settings.

Innovation Description, Process and Implementation

EQADAB® uses realistic scenarios and structured cards to make EQ strategies and Adab values visible, selectable and discussable. Learners first respond to an emotionally difficult situation, then use the cards to recognise possible actions, explain their reasoning, consider other perspectives and reflect on the consequences of their decision. Learners may speak, point to relevant wording or select and show a card before elaborating. For example, when a superior criticises a learner's work in front of others, the learner may connect Pause-Name-Breathe with Courtesy in Disagreement, compare possible responses and consider their consequences. The facilitator asks for reasons rather than prescribing one correct answer; different responses may be defensible depending on the context.



Figure 1: EQADAB® experiential decision-learning cycle.

The cycle produces three documented outputs: an individual starting choice, a justified group decision and an improvement reflection. The classroom session was conducted on 15 October 2025 in SBEZ4852 Landscape Research. The group-sheet dataset comprised 35 listed learners across seven groups. It recorded choices before discussion, final decisions, selected EQ and Adab guides, reasons and application reflections. Separately, 29 learners completed an anonymous post-session questionnaire with five five-point items, two open-ended questions and a self-described group role. The industry pilot was conducted on 6 December 2025 with 15 adult professional learners from one landscape architecture firm: two directors, one manager, five landscape architects, six designers and one administrative staff member. They worked in three groups of five. Evidence included seven five-point items, five open-ended questions, three group outputs and two observation records.

Descriptive statistics and thematic grouping were used. This early-stage evaluation examined immediate post-session evidence. Responses may have been overly positive, and the creator's roles as facilitator and observer may have influenced industry feedback. The classroom questionnaire did not directly measure whether the cards reduced reluctance, helped learners feel heard, or presented situations that learners had personally experienced. These points emerged from facilitator observations and informal verbal feedback, so they are treated as preliminary insights. Future evaluation will include a pre-session

assessment, comparison with the usual teaching approach and a decision-quality rubric to provide stronger evidence of learning.

Key Findings

Table 1 summarises the immediate questionnaire findings from the BLA classroom implementation and industry pilot. The questionnaire ratings are interpreted together with the classroom group outputs and industry observation records. The group records show the intended decision-learning process. All seven groups selected at least one EQ strategy and one Adab value, explained a final decision and described an application to real life or research. Five began with different individual choices, and all seven documented one collective decision. In two groups, the final decision differed from the initial majority; another resolved an initial split. These records support deliberation and reconsideration rather than measured improvement in decision quality.

Table 1: Immediate classroom outcomes and industry relevance indicators

CONTEXT	INDICATOR	M (SD)	AGREE / STRONGLY AGREE
Classroom questionnaire (n=29)	Cards easy to understand and use	4.66 (0.55)	96.6%
	Scenario realistic and meaningful	4.86 (0.35)	100%
	Connected emotions and Adab when deciding	4.48 (0.87)	93.1%
	Engaged and enjoyed group discussion	4.83 (0.38)	100%
	Would use the method again	4.52 (0.57)	96.6%
Industry (n=15)	Reflected on a real team situation	4.80 (0.41)	100%
	Understood team behaviour more clearly	4.87 (0.35)	100%
	Gained useful insight for workplace response	4.87 (0.35)	100%
	EQ & Adab practical and applicable to job	4.80 (0.41)	100%

Note. Five-point scale: 1 = strongly disagree to 5 = strongly agree. M = mean; SD = standard deviation. Percentages show participants who selected agree or strongly agree for each item.

The strongest classroom findings were authenticity, engagement and articulated takeaways. All 29 respondents agreed or strongly agreed that their scenario was realistic and meaningful and that they were engaged; 27 (93.1%) connected emotions and Adab when deciding. All 29 recorded a value or insight. Responses named fairness, honesty, standing up to unfairness, professionalism under criticism, respect for other views, emotion handling, empathy, reflection and Pause-Name-Breathe. Three explicitly linked the activity to the real world, daily life or prior experience. These are articulated takeaways, not measured learning gains. Participants requested more time and scenarios, simpler bilingual wording and visual support.

Industry findings provided professional-learning evidence and preliminary external support. All 15 participants agreed or strongly agreed with the four industry indicators shown in Table 1. All 15 recorded an intended action, while 14 expected a positive team effect. Observation records noted connections to real work and open or relaxed discussion. The creator facilitated and observed the session; a research assistant provided the second observation record. These findings support immediate professional relevance and applicability.

Impact

Immediate student outcomes included strong engagement, perceived authenticity, articulated values and options, and documented deliberation. All 29 respondents reported engagement and recorded a value or insight, while 27 connected emotions and Adab when deciding. The option to speak, point or select a card gives learners more than one way to participate, while recorded choices and reflections make reconsideration visible. The evidence supports immediate engagement and learner expression in reflective decision practice; it does not yet establish improved decision quality or long-term behaviour.

Recommendations for Classroom Practice

Educators should use discipline-specific dilemmas, allow learners to speak, point or select a card, record initial responses, and require final reasons and consequences. Groups need adequate time, clear bilingual wording and role-sensitive facilitation. The next evaluation should include measures of Adab and EQ awareness, response options and decision quality, as well as whether the cards help learners express difficult thoughts. It should also use an independent observer, a comparison condition and delayed follow-up.

Other relevant information

EQADAB® began as a 36-card TVET prototype at IPPIC2025. For NALI, it adds structured initial-to-final documentation, BLA classroom evidence and separate industry relevance testing. Its conceptual basis is documented by Omar and Najib (2025), while the tangible-digital design supports adaptable scenarios and facilitator-led professional learning.

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ID 63: SmartLewis: An AI-Powered Digital Canvas for Lewis Structure Drawing

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Highlights: Lewis structure drawing is a foundational yet cognitively demanding skill within chemistry Matriculation syllabus, where classroom observation of 23 engineering-stream students revealed 50-80% commit recurring errors that a single lecturer cannot verify and correct individually within the learning environment constraints of conventional tutorial sessions. SmartLewis application is an AI-powered, web-based digital canvas that addresses this feedback gap that preserves the authentic motor skills of hand-drawing while an integrated multimodal large language model (OpenAI GPT-5) recognizes, evaluates and generates immediate formative pedagogical feedback correspond to drawing submitted through the application. Two iterative prototype versions were tested with a pilot group enrolling Chemistry 1 EC015 module.

Keywords: Lewis structure; Artificial Intelligence-Enhanced Teaching and Learning; Digital canvas; Multimodal large language model; Pedagogical feedback

Introduction

The teaching and learning of Lewis structures within the Malaysian Matriculation Program presents a persistent pedagogical challenge that originates from three interrelated dimensions where the cognitive demand placed upon the students, the limitations of conventional instructional practice and the inadequacies of existing technological aids. A needs analysis of the Program by Abdussyukur, Saat and Alias (2021) concluded that chemistry teaching within matriculation colleges remains largely exam-oriented, with limitations of instructional media and teaching resources, and that twenty-first-century pedagogies are insufficiently emphasized. Recent investigations into matriculation students' learning experiences in chemistry likewise reported persistent difficulties in grasping the abstract concepts, with students explicitly identifying a need for visualization tools and individualized support that conventional classroom instruction does not adequately provide (Lok & Hamzah, 2021; Lok, 2022). Classroom observations conducted upon 23 engineering stream students at Johor Engineering Matriculation College revealed four recurring error categories in their Lewis structure drawings, namely incorrect valence electron count (50%), violation of the octet rule (70%), omission of lone pair electrons (60%), and incorrect use of single, double, and triple bonds (80%). Within a standard matriculation tutorial session of 20 to 25 students per hour, a single lecturer cannot realistically verify and correct each student's drawing simultaneously, resulting in a persistent feedback gap that allows misconceptions to deepen. Mat Salleh, Abd, Rauf and Saat (2022) reported that Malaysian chemistry teachers identify class size and time limitations as principal obstacles to the practice of differentiated instruction, restricting the lecturer's capacity to address the diverse needs of an individual learner.

The SmartLewis application is a web-based interactive application with AI-powered integration system that is innovatively designed for Lewis structure drawing purpose. It provides a digital drawing canvas where students can draw the Lewis structure of molecules by using hand doodling technique, stylus and mouse. The highlight features of this application are an AI-driven feedback engine integrated in the system that automatically recognizes and evaluates student's hand drawing in real time, identify the errors in drawing and responsively generate specific formative feedback and scaffolding hints based on the chemical bonding rules-based set in the GPT-5 multimodal Large Language Model (LLM).

Objectives

- To develop a web-based interactive digital canvas with AI-powered integrated system.
- To evaluate the effectiveness of the developed system in the application.

NALI Approach

Novelty

SmartLewis closes the feedback gap by giving immediate correction rather than waiting for delayed feedback on the next class session. The ability of the application to provide a real-time hint to support an active learning process and provide instantaneous formative feedback at the point of learning transforms the passive pen-and paper practice with intelligent technology in learning process. In addition, it reduces the scalability gap by enabling lecturer to effectively support every student regardless of the class size.

The application is accessible by electronic devices such as smartphones, tablets, laptops and desktops. Meanwhile, the existing commercial chemistry drawing tools available in the current market such as *ChemPix*, *ChemDraw*, *MarvinSketch*, *ChemSketch*, and *ChemDoodle* are unable to address this pedagogical need because these applications require selection of atoms and bonds from a toolbar palette. This corresponds to an interaction method that differs fundamentally from the freehand drawing skills demanded in formal examinations.

Creativity

SmartLewis offers an instantaneously corrected digital experience without altering the authentic motor skills of drawing by ensuring positive transfer skills from practice to assessment and efficiently recognizes, evaluates and pedagogically response to the structures. SmartLewis is therefore not a structure editor in which fixed atoms and bonds are selected using established palette but a canvas that allows students to directly draw the structures and AI interprets student's handwriting. The development of SmartLewis was guided by ADDIE instructional design framework.

Five design principles guided every implementation decision across both prototypes versions:

1. Authenticity of input: Student must draw with the same physical action used in actual examination where no clicking, dragging or selecting from fixed palette of atoms, bonds and lone pair electrons.
2. Reasoning over final conclusion: Each feedback message must explain why a drawing is wrong, not merely flag that the drawing is wrong.
3. Zero friction to access the application: The application must run on any device with a web browser, with no installation, no user account and no cost to the students.
4. Iteration as the unit of learning: A draw-check-redraw round must be accomplished in seconds, so that the students consolidate each correction while the cognitive context is still strong and fresh. This reduces the feedback delay gap in learning experience.
5. Data privacy: Student drawings are transmitted to the LLM provider for evaluation where no personally identifiable information is collected.

Innovativeness

SmartLewis converts the conventional pen-and-paper practice of Lewis structure drawing into an instantaneously corrected digital experience without altering the authentic motor skills of drawing. The fundamental design conviction is that the student draw the Lewis structure by using hand, stroke by stroke, freely making scribbles and corrections. The drawing surface thereby preserves the authentic motor and cognitive process of Lewis structure construction ensuring positive transfer skills from practice to assessment. Meanwhile, the system efficiently recognizes, evaluates and pedagogically response to what has been drawn. SmartLewis is therefore not a structure editor in which fixed atoms and bonds are selected using established palette but a canvas that allows students to directly draw the structures and AI integrated system interprets students' handwriting with supportive reasoning and feedback.

Applicability

SmartLewis is highly applicable because its domain-independent architecture allows easy adaptation to other chemistry topics, STEM subjects, and varying learner abilities, replication across institutions by simply editing the molecule bank to match any syllabus, scalability from a single class to nationwide use through its web-based design, automated grading, and offline mode for low-connectivity schools, and long-term sustainability through self-improving error data, shared materials, trained staff, and alignment with national digital education priorities.

Innovation Description, Process and Implementation

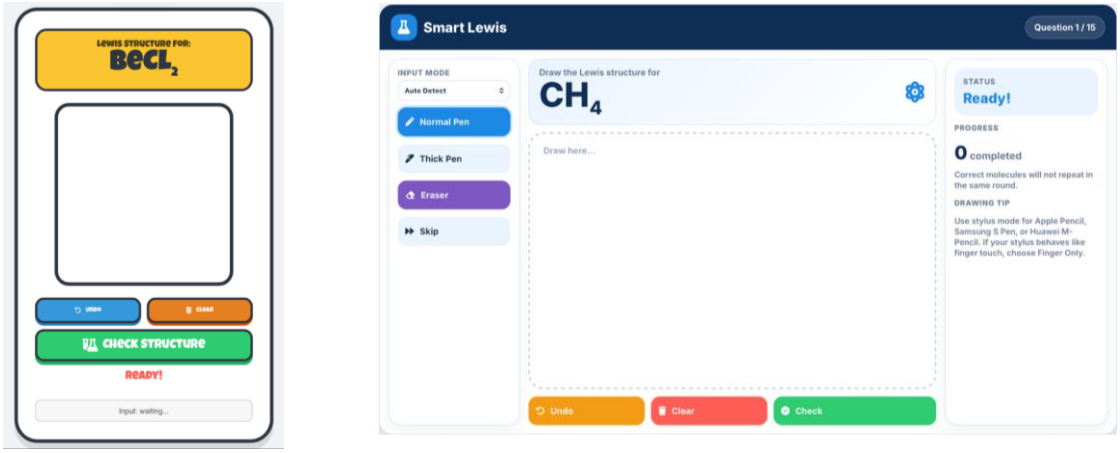


Figure 1: SmartLewis prototype version 2.0

SmartLewis is implemented as guided-practice teaching method during a chemistry tutorial session for an hour of duration. 10 students with different learning level were selected as the pilot cohort. The SmartLewis 1.0 was introduced on the first week of the pilot study session and the 2.0 version was introduced after three weeks for the second iterative cycle of the study. The method is structured with four stages of process that reposition the tutorial session from lecturer-led marking to student-led practice with real-time AI guidance while reserving the lecturer's expertise for the conceptual issues arises that genuinely require human judgement and assistance.

Key Findings

A mixed-methods within-subject paired pilot evaluation was conducted to assess practicality, feasibility and gather preliminary insight of SmartLewis innovation. 10 students were participated in this pilot study for version 1.0 and 2.0. Each student completed the same 17 items structured usability questionnaire on two separate events after the application of version 1.0 and 2.0 respectively. The questionnaire consists of five thematic sections measured on a five-point Likert scale (Strongly Disagree = 1; Strongly Agree = 5), together with three open-ended items that allow student's text feedback. Findings are intended to inform design iteration and directional insights rather than to draw generalizable conclusions.

Table 1: Within-subject paired analysis of SmartLewis Version 1.0 and 2.0 usability and the overall score

SECTION	VERSION 1.0 MEAN (N =10)	VERSION 2.0 MEAN (N=10)	MEAN Δ
A. Ease of Use	4.47	4.87	+0.40
B. AI Feedback and Hints	4.08	4.60	+0.52
C. Auto- Grading Accuracy	3.80	4.40	+0.60
D. Learning Experience	4.55	4.75	+0.20
E. Technical Performance	2.97	4.07	+1.10
Overall	4.01	4.55	+0.54

Table 2: Students' testimonial after using SmartLewis application

	WRITTEN FEEDBACK		WRITTEN FEEDBACK
S1	"The AI tips is very useful when you draw the wrong structure, and it is able to identify the wrong part specifically"	S3	"I felt more motivated to practice Lewis structure and the AI can find my mistake while practice it"
S2	"The AI-powered digital canvas is able to give me the right correction for my Lewis structure I draw. When I forget to add lone pair at certain atom, it gives me feedback on it. The canvas also does not count the scribble I accidently draw which is helpful"	S4	"AI identifies my mistakes correctly and gives me the correct hint. I really motivated to drawing the structure as I am not confident if my drawing is right or wrong."

Impact

SmartLewis improves the efficiency of Lewis structure drawing instruction across time, cost and productivity by fully delegating Lewis structure verification to AI. It frees lecturers from spending roughly 60 minutes of checking per about 25 student session, cut students feedback delay from 24-48 hours to

about 10 seconds, runs free in any web browser where it is the opposite with licensed digital drawing tools and lets students complete two to three times more practice where it shifting lecturers from routine verifier to pedagogical strategist.

Recommendations for Classroom Practice

SmartLewis should be introduced after concepts are taught, used with hints that fade over time and analytics that guide targeted correction, configured differently for weak and strong learners, adapted to other topics, levels, and low-resource settings through projection or device rotation, supported by teacher training and data privacy safeguards, and sustained by starting small, sharing materials, and refining it each semester.

Other relevant information

The intellectual property underlying SmartLewis has been formally registered with the Intellectual Property Corporation of Malaysia (Perbadanan Harta Intelek Malaysia, MyIPO) under Copyright Voluntary Notification No. CRLY2026E02070, dated 15 April 2026. This statutory registration confirms the originality of the work, establishes a verifiable national record of the innovation's date of creation, and provides the legal foundation necessary for subsequent licensing arrangements, inter-institutional collaboration, and potential commercialization across the Malaysian Matriculation Program.

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ID 64: AI Japanese Learning Assistant: An AI-Enhanced Blended Learning Model for Personalized Japanese Language Education

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Highlights: The project "AI Japanese Learning Assistant" addresses limited personalized pronunciation feedback in beginner Japanese learning through a low-cost, AI-supported blended learning model. It integrates real-time gojūon pronunciation scoring, individualized online practice, and data-informed classroom instruction. Experimental students achieved a 13.3-point improvement, compared with 4.5 points in the control group, while pronunciation correction time decreased from 30% to 18% of class time. Its key innovation is transforming individual pronunciation data into targeted learning and teaching support, offering a practical, scalable human–AI collaborative model for Japanese language education.

Keywords: AI; Personalized Learning; Japanese Language Learning, Language Education

Introduction

The rapid advancement of artificial intelligence (AI) is transforming education through personalized, adaptive, and learner-centered approaches that enhance autonomy, motivation, and learning progress (Mohebbi, 2025; Wang et al., 2025). In foreign language education, AI-powered technologies such as intelligent tutoring systems, chatbots, and virtual assistants provide individualized learning, authentic communication, translanguaging support, and immediate feedback (Orpy et al., 2026; Urbaite, 2025; Wang et al., 2025; Yuan et al., 2024; Zhao, 2025). AI can also function as a subject expert, interactive mediator, and pedagogical assistant, supporting data-informed teaching and learning (Xu & Ouyang, 2022). In Japanese language education, generative AI facilitates reading, writing, speaking, listening, and pronunciation development (Mori, 2026). However, concerns regarding linguistic accuracy, privacy, algorithmic bias, academic integrity, unreliable feedback, overdependence, and insufficient AI competencies highlight the importance of appropriate teacher guidance (Mori, 2026; Wang et al., 2025; Zhao, 2025).

In China, Japanese language education continues to face challenges associated with teacher-centered instruction, diverse learner proficiency, limited personalization, and insufficient real-time learning feedback (Li et al., 2026; Xie, 2026; Zhai, 2026). Teachers' limited AI competencies further constrain effective pedagogical integration, emphasizing the need for digital professional development (Zhai, 2026). A human–AI collaborative approach can address these limitations by combining AI-supported personalization, assessment, and feedback with teachers' roles in interaction, creativity, emotional support, and culturally grounded instruction (Li et al., 2026; Wang et al., 2025). Blended learning provides an appropriate framework for such integration by connecting AI-supported online learning with face-to-face instruction (Yu, 2026). Aligned with China's 2024 AI-enabled educational transformation initiative, the "AI Japanese Learning Assistant" addresses learner diversity and beginner pronunciation challenges through personalized practice and real-time pronunciation scoring for the foundational gojūon.

Objectives

- To develop an AI-supported gojūon pronunciation application with immediate feedback, integrate it into university Japanese instruction
- To improve pronunciation and learner autonomy while reducing teachers' workload,
- To establish a practical, transferable AI-enhanced personalized learning model that supports the broader integration of AI into Japanese language education.

NALI Approach

Novelty

"AI Japanese Learning Assistant" is a blended teaching model that integrate online independent learning + offline deep practice Japanese Language Learning application that uses learners' practice data and error records to inform subsequent teaching and learning activities.

Creativity
This project transforms AI-generated learning data into targeted pedagogical interventions. Students receive individualized pronunciation practice and feedback, while teachers use aggregated learning data to identify common difficulties and redesign classroom activities around students' actual learning needs.

Innovativeness
The project shifts Japanese language instruction from a teacher-centered repetition model to a human–AI collaborative approach. AI manages repetitive practice, data collection, and error identification, allowing teachers to devote more classroom time to interactive activities such as situational dialogues, group competitions, and communicative practice.

Applicability
This project can support continuous learning beyond the classroom, while the data-informed teaching process enables teachers to provide more targeted instruction and students to undertake individualized reinforcement practice.

Innovation Description, Process and Implementation

Description & Process
There are four tools centered on 〝AI Japanese Learning Assistant" application, including iFlytek, Moji Kana, Moji Dictionary, and AI Japanese Go shows in table 1. The project has established a progressive learning pathway from Pronunciation (step 1) → Vocabulary (step 2) → Grammar (step 3) → Conversation (step 4).

Table 1: Functions and Roles in 〝AI Japanese Learning Assistant"

TOOL	FUNCTION	ROLE IN APPLICATION	LEARNING PATH OF JAPANESE LANGUAGE
iFlytek	Speech recognition and evaluation	To assist with pronunciation training	Step 1: Pronunciation Students use the apps for pronunciation practice.
Moji Kana	Vocabulary recognition	To help students master vocabulary	Step 2: Vocabulary Students learn words, achieving the integration of "sound, form, and meaning
Moji Dictionary	Grammar correction	To assist with grammar error correction in short essay	Step 3: Grammar After acquiring a certain vocabulary foundation, teachers use Moji Dictionary to assist students in simple writing, and correction for grammar mistake
AI Japanese Go	Situational conversation simulation	To practice daily conversation	Step 4: Conversation Students use AI Japanese Go to conduct simple conversation.

Experimental Design
The project was implemented for13 months, from April 2025 to May 2026. The period for pre and post-test was eight weeks; an interview with five students and a Japanese lecturer was conducted after the experiment. The project selected two parallel classes enrolled in the University Foreign Language–Japanese course during the first semester of the 2025–2026 academic year for the intervention. There are two groups of students, each group are 20 person in experimental group and control group.

Table 2: Description of Experimental Design

EXPERIMENTAL GROUP (N=20)	CONTROL GROUP (N=20)
Students use the apps to review kana learned in class and complete pronunciation practice tasks. They were encouraged to practice at least three times per week	Students engaged in post-class pronunciation practice through traditional listen-and-repeat approach, which is they listened to audio recordings and practiced pronunciation without receiving immediate scoring or feedback.

Key Findings

The results in Table 3 and figure 1 demonstrated greater improvement in the experimental group following the implementation of the "AI Japanese Learning Assistant." The experimental group's mean score increased from 65.3 in the pre-test to 78.6 in the post-test, representing an average gain of 13.3 points. In comparison, the control group improved from 64.7 to 69.2, with an average gain of 4.5 points. These findings suggest that the AI-supported blended learning approach may have contributed to greater improvement in students' Japanese language learning performance compared with conventional instruction. Whereas, result from teacher interviews suggested that the "AI Japanese Learning Assistant"

enhanced classroom efficiency by reducing pronunciation correction time by approximately 10 minutes per session. The time allocated to pronunciation correction subsequently decreased from 30% to 18%, allowing teachers to devote greater attention to grammar instruction, role-play dialogues, and interactive learning activities.

Table 3: Mean Score between Experimental and Control Group

Indicator	Experimental Group (n=20)	Control Group (n=20)
Pre-test Mean Score	65.3	64.7
Post-test Mean Score	78.6	69.2
Average Improvement	13.3	4.5

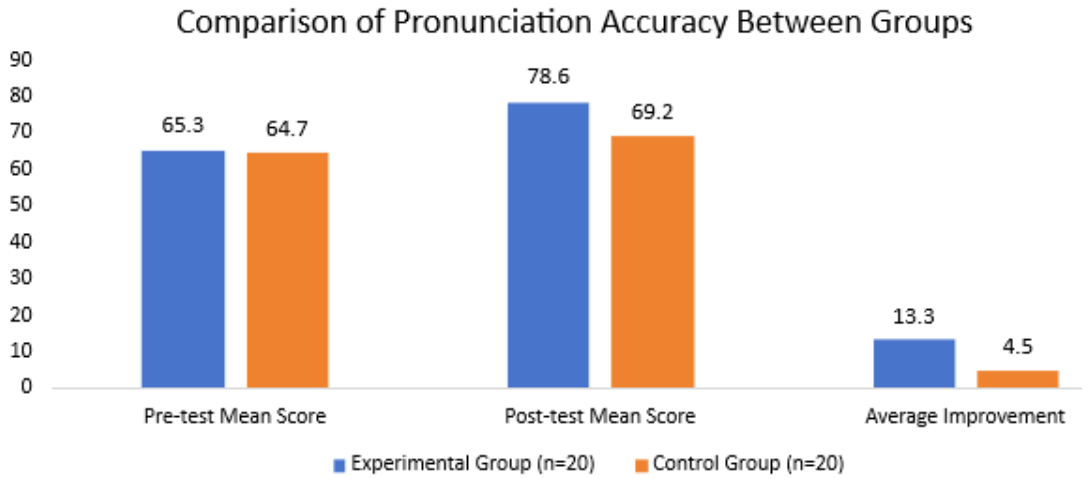


Figure 1: Comparison of Pronunciation Accuracy Between Group

Impact

This project lies in its low-cost and focused innovation, which addresses the long-standing challenge of the lack of immediate pronunciation feedback in beginner-level Japanese language learning. Mainstream Japanese language learning apps, such as Duolingo and Moji Kana, offer standard pronunciation models but generally lack individualized, real-time, and quantitative feedback for each kana sound. In response to this limitation, the project provides real-time pronunciation scoring at the level of individual sounds during the beginner stage, thereby addressing a notable gap in existing Japanese language learning applications.

Recommendations for Classroom Practice

For classroom practice, the AI Japanese Learning Assistant can be applied across diverse learning contexts. In public foreign language elective courses, it can provide non-Japanese majors with accessible introductory pronunciation training. It can also support top-up degree students with weaker language foundations by helping them strengthen fundamental pronunciation skills. Beyond formal classroom settings, the application may be made freely available to independent Japanese language learners, thereby extending AI-supported personalized learning to a broader community.

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ID 67: Digitalising Okara Nugget (Soydget) Innovation via Human-AI Collaborative Learning Module

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Highlights: Addressing the time-consuming trial-and-error and material waste in conventional food product development, this innovation digitalizes plant-based food innovation through a Human-AI Collaborative Learning Module. Students utilize an interactive interface to predict texture, moisture, and sensory profiles of upcycled okara nuggets before lab execution. Formulations are subsequently validated using a 9-point Hedonic scale, with sensory data integrated into an assessment dashboard. This approach enhances learning engagement, critical thinking, and food safety literacy. Unlike traditional static practices, this Human-AI synergy delivers a data-driven, sustainable experiential learning model that optimizes formulation efficiency and equips students for future food industries.

Keywords: Interactive learning module; Food Innovation; Okara nugget

Introduction

The global food industry faces a critical dual challenge: managing agricultural waste while meeting the growing demand for sustainable, plant-based protein alternatives. Annually, millions of tonnes of okara, an insoluble byproduct of soy milk and tofu processing, are discarded in landfills or relegated to low-value animal feed, driving environmental pollution and greenhouse gas emissions (Henchion et al., 2017). Despite being treated as waste, okara is rich in dietary fiber, high-quality protein, and bioactive compounds, making it an exceptional candidate for food upcycling. Transforming this byproduct into Okara Nuggets (Soydgets) provides a circular-economy solution that directly aligns with key United Nations Sustainable Development Goals (SDGs), particularly SDG 12 (Responsible Consumption and Production), SDG 2 (Zero Hunger), and SDG 13 (Climate Action), by turning agricultural waste into a Halal-compliant, eco-friendly food innovation (United Nations, 2015). In food science education, training students to formulate novel, sustainable foods, such as plant-based Okara Nuggets which presents distinct pedagogical challenges.

Traditional laboratory practices rely heavily on physical trial-and-error. Students manually alter ingredients, cook samples, and conduct sensory evaluations (Ismail et al, 2020). While hands-on, this conventional approach is often time-consuming, incurs high raw-material costs, and produces considerable food waste during the early development phase (Mustafa et al., 2026). Furthermore, students frequently lack real-time predictive tools to understand how minute adjustments in raw ingredient ratios affect key sensory parameters such as texture, moisture retention, aroma, and overall consumer acceptability.

Beyond technical formulation challenges, modern food science education must also address critical industry standards, including Halal compliance, food safety, and regulatory frameworks. When substituting animal-based ingredients with upcycled plant-based alternatives like okara, students must evaluate not only the physical matrix of the food, but also the Halal status, sourcing, and hygiene standards of all non-meat binders, enzymes, and flavoring agents used (Riaz & Chaudry, 2018). Integrating these multi-layered parameters into a traditional curriculum often creates a cognitive overload for students, who struggle to balance nutritional target optimization, cost efficiency, sensory quality, and Halal integrity simultaneously through manual experimentation alone (Sweller, 2011).

Consequently, there is an urgent pedagogical need for an intelligent, interdisciplinary framework that stream-lines complex product development while enhancing student engagement. By introducing AI as an active collaborative partner in the classroom, educators can transform static learning environments into interactive, data-driven laboratories (Luckin & Cukurova, 2019). To address both educational and environmental challenges, this project introduces the Human-AI Collaborative Learning Module to digitalize Okara Nugget (Soydget) innovation. Aligned with the NALI 2026 overarching theme, "Human-AI Synergy in Pedagogy," this synergistic model enables students to simulate multi-variable formulations digitally, assess real-time predictions, and critically validate their findings through empirical lab work. By

seamlessly bridging digital predictive analytics with physical laboratory validation, the innovation closes the gap between theoretical knowledge, digital fluency, environmental sustainability, and practical industry readiness.

Objectives

- To develop a Human-AI Collaborative Learning Module that enables students to digitally simulate and predict key sensory parameters (moisture, texture, and aroma) of plant-based Okara Nuggets (Soydgets) prior to physical experimentation.
- To evaluate student learning engagement and performance in plant-based food formulation by integrating digital AI prediction with empirical laboratory validation and dashboard-based assessment.
- To reduce raw-material waste and formulation trial-and-error time in laboratory practical sessions through data-driven Human-AI collaboration.

NALI Approach

Novelty
This innovation bridges digital AI simulation with hands-on lab work. Students use an interactive learning module to predict Okara Nugget texture and flavor before cooking, creating a novel closed-loop model where lab test results validate and refine the AI logic.

Creativity
The design creatively transforms complex food chemistry into an interactive touch-screen interface with ingredient sliders. It blends gamified digital predictions, physical cooking, and a 9-point Hedonic taste scale into one engaging activity on food sustainability and Halal awareness.

Innovativeness
It improves traditional teaching by shifting from wasteful trial-and-error lab work to a data-driven "Human-AI" model. AI pre-optimizes formulations to save time and materials, while students critically test the cooked results to build scientific reasoning.

Applicability
The module runs seamlessly on standard tablets or laptops, allowing higher education institutions to deploy interactive learning at scale without expensive specialized hardware.

Innovation Description

The "Digitalising Okara Nugget (Soydget) Innovation via Human-AI Collaborative Learning Module" transforms sustainable food product development education into an interactive, digital-first learning experience accessible via standard tablets or laptops. Guided by a structured approach, students master theoretical concepts across five core modules: 1) Introduction, 2) Importance of Halal Food, 3) Importance of Food Sustainability, 4) Food Innovation, and 5) Okara (Soy Waste) Nugget Formulation. Learners collaborate with an AI co-pilot to design and optimize formulation parameters virtually prior to practical application. Upon completing all module activities and interactive assessments, student progress and performance are directly evaluated by lecturers through a centralized system dashboard for holistic tracking.

Process and Implementation
Methodology Implementation Flow

Stage 1: Platform Orientation & Introduction (Module 1)

- Learners log into the tablet/laptop interactive kiosk.
- Completes an initial pre-assessment to establish baseline knowledge on upcycled food production.
- Receives an introduction to the Soydget project objectives, interface navigation, and the role of the AI co-pilot.

Stage 2: Foundational Theoretical Mastery (Modules 2 & 3)

- Module 2 (Halal Compliance): Learns Halal critical control points (CCPs), hygiene standards, and non-meat binder sourcing required for upcycled ingredient integration.
- Module 3 (Food Sustainability): Explores side-stream valorization principles, waste reduction metrics, and the environmental benefits of repurposing Okara.

Stage 3: AI-Assisted Food Innovation & Formulation Simulation (Modules 4 & 5)

- Module 4 (Food Innovation): Analyzes key functional food properties and processing variables.
- Module 5 (Okara Nugget Formulation): Interacts with the AI co-pilot via formulation sliders to calculate mass balances, moisture absorption ratios, and binder replacement levels.
- Simulates and predicts texture, moisture retention, and aroma profiles digitally before touching physical raw materials.

Stage 4: Empirical Laboratory Execution & Physical Validation

- Translates the optimized digital formulation into physical prototyping in the pilot kitchen.
- Prepares, cooks, and evaluates actual Okara nuggets using a 9-point Hedonic sensory scale.
- Inputs sensory results back into the system to validate digital predictions against empirical outcomes.

Stage 5: Evaluation & Feedback via System Dashboard

- Students complete final module assessments and upload sensory testing data.
- System aggregates student activity logs, score distributions, and formulation error alerts into the centralized Lecturer Dashboard.
- Lecturers analyze real-time performance analytics to conduct targeted micro-interventions, evaluate post-learning gain scores (g), and deliver final formative feedback

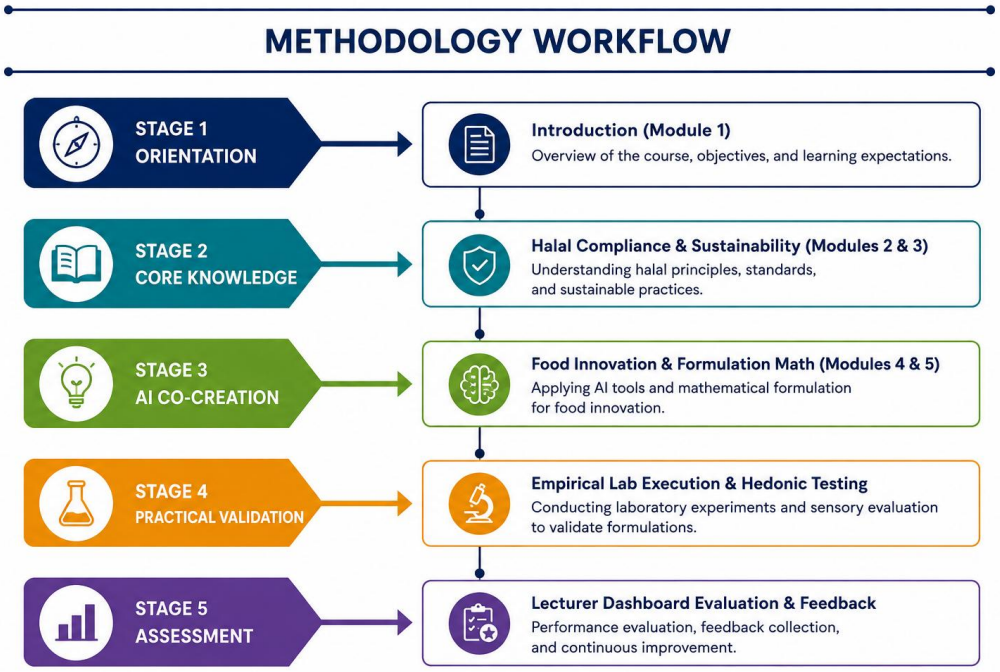


Figure 1: Methodology workflow of interactive learning module

Key Findings

The implementation of the Digitalising Okara Nugget (Soydget) Innovation via Human-AI Collaborative Learning Module demonstrated significant impacts on student engagement, conceptual mastery, formulation efficiency, and overall instructional workflow.

1. Enhanced Learning Outcomes & Knowledge Gain (Quantitative)

Pre- and post-implementation assessments across food technology student cohorts ($\boldsymbol{n = 120}$) demonstrated a measurable rise in theoretical understanding and practical formulation skills:

- Overall Concept Mastery: Normalized learning gain scores ($\boldsymbol{g}$) showed a high average improvement of $\boldsymbol{g = 0.72}$ across all five core theoretical modules.
- Module-Specific Knowledge Retention:
  - *Halal Compliance & Food Safety (Module 2):* +38% increase in post-test accuracy regarding Halal critical control points (CCPs) in upcycled ingredients.
  - *Food Sustainability (Module 3):* +45% improvement in explaining side-stream valorization and carbon footprint reduction via Okara upcycling.
  - *Food Innovation & Formulation Math (Modules 4 & 5):* +52% accuracy improvement in

calculating mass balances, moisture absorption ratios, and binder replacement levels prior to entering the physical lab.

2. Physical Lab Efficiency & Material Waste Reduction
By requiring students to optimize their Okara nugget formulas interactively with the AI co-pilot prior to physical trial-and-error, the module significantly optimized laboratory resource usage:

- *Ingredient Waste Reduction: Raw material consumption (Okara, binders, and seasonings) dropped by 64% during practical lab sessions due to fewer failed physical batches.*
- *Formulation Precision: Students using the AI-assisted digital simulator achieved an 85% first-trial success rate in producing physically cohesive, sensorially acceptable nuggets, compared to 35% in the control (traditional non-digital) cohort.*
- *Lab Execution Time: Time required to complete physical prototyping decreased by 40%, allowing instructors to reallocate lab hours toward advanced sensory evaluation and packaging analysis.*

3. Educator Dashboard Utility & Assessment Accuracy
The implementation of the centralized lecturer dashboard redefined formative assessment and instructional interventions:

- Real-Time Intervention Rate: Lecturers identified and assisted struggling students 3x faster by monitoring real-time attempt logs, score distributions, and formulation error alerts on the system dashboard.
- Grading & Feedback Efficiency: Automated scoring of module assessments reduced administrative grading time by 75%, allowing instructors to focus on targeted qualitative feedback

4. User Experience & Adoption Rate (Qualitative & System Metrics)
System usability and participant feedback were evaluated using standardized measures, including the System Usability Scale (SUS) and post-implementation surveys: System Usability Scale (SUS) Score: Achieved an overall score of 84.5 / 100 ("Grade A / Excellent"), confirming that deploying on low-cost, standard tablets and laptops provided high accessibility without technical friction.

Impact

The Digitalising Okara Nugget (Soydget) Innovation via Human-AI Collaborative Learning Module transforms food science education by delivering immediate and long-term value across all key stakeholders: it empowers students through risk-free digital simulation that builds industry-ready skills in AI-driven upcycling, provides educators with real-time dashboard analytics and automated scoring to enable targeted teaching, reduces resource consumption and lab expenses for institutions via scalable tablet-based deployment, and supports industry and community sustainability goals by training graduates to advance Halal-certified waste valorization within a circular food economy.

Recommendations for Classroom Practice

To effectively integrate the Digitalising Okara Nugget (Soydget) learning module into classroom practice, educators should adopt a blended, flipped-classroom approach where students complete the five theoretical modules and virtual AI formulation simulations asynchronously before entering the physical laboratory. Implementation begins by leveraging the centralized system dashboard during pre-lab briefings to identify conceptual weak spots such as formulation math or Halal critical control points and deliver targeted micro-interventions. For successful replication across diverse educational contexts, institutions should deploy the responsive module on existing student devices or standard low-cost tablets, while educators can easily customize the AI parameters and ingredient databases to suit other side-stream food waste materials (e.g., spent grain or fruit pomace), varying academic levels, or specific TVET curricula. Best practices include establishing a collaborative learning environment where students compare their AI-predicted sensory outcomes with empirical lab results, ensuring continuous reflective learning, optimized lab resource usage, and long-term instructional sustainability.

Acknowledgement

We are grateful to Majlis Bandaraya Iskandar Puteri (MBIP) as the main financial supporter of this project. Additional support from UTM FR Fundamental Research Grant (PY/2023/01337) and the UTM Encouragement Research Grant (UTMER) is also sincerely acknowledged. We extend our appreciation to all participants and collaborators for their valuable contributions and commitment throughout the project.

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ID 68: Neuropharm-Retain: A Longitudinal Team-Based Framework for Applied Neuropharmacology Learning

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Highlights: Neuropharm-Retain is a longitudinal team-based learning innovation designed to strengthen and evaluate sustained pharmacology knowledge beyond a single classroom session. It integrates structured preparation, individual accountability, team reasoning, clinical application, delayed retrieval, and feedback-informed refinement. Immediate feedback from 160 first-year medical students demonstrated high engagement and perceived learning value, with 76.3% identifying clinical scenarios as the most helpful component. Among 116 students completing six-month follow-up, individual assessment scores showed no statistically significant decline, supporting the feasibility of combining active learning with longitudinal evaluation.

Keywords: Team-based learning; Neuropharmacology; Knowledge retention; Clinical application; Active learning

Introduction

Pharmacology requires medical students to integrate extensive knowledge of drug mechanisms, adverse effects, and clinical indications and subsequently retrieve this knowledge during clinical training. However, teaching effectiveness is often evaluated immediately after instruction, providing limited information on whether knowledge remains accessible months later (Felemban et al., 2025).

Team-based learning (TBL) promotes active participation, individual accountability, peer learning, and application of knowledge (Alizadeh et al., 2024). Neuropharm-Retain extends conventional TBL into a longitudinal learning framework by combining classroom-based active learning with delayed individual retrieval and systematic learner feedback. The first module was implemented for neuromuscular junction (NMJ) blockers among first-year medical students.

Objectives

- To promote individual accountability, peer learning, and clinical application of neuropharmacological knowledge
- To evaluate individual knowledge approximately six months after the original TBL session
- To use immediate learner feedback and longitudinal outcomes to refine subsequent learning activities

NALI Approach

Novelty

TBL is an established educational strategy. Therefore, the novelty of Neuropharm-Retain lies in extending the TBL learning cycle beyond immediate classroom performance. A delayed individual assessment approximately six months after TBL allows educators to determine whether core knowledge remains independently retrievable. Immediate learner feedback provides a complementary measure of students' learning experience, enabling both educational outcomes and learner perspectives to inform subsequent improvement.

Creativity

Neuropharm-Retain organises learning into six interconnected stages: Prepare, Commit, Collaborate, Apply, Retrieve and Refine. Students first prepared using structured resources. They then commit to individual answers through the Individual Readiness Assurance Test (iRAT), collaborate during the Team Readiness Assurance Test (tRAT), and apply their knowledge to clinical scenarios. Core knowledge is subsequently retrieved individually after six months, while assessment results and student feedback are used to refine future sessions.

This design exposes learners to important concepts through multiple cognitive processes rather than repeated passive content delivery.

Innovativeness
Neuropharm-Retain transforms a conventional one-session TBL activity into a longitudinal, evidence-informed learning cycle. First, educational success is evaluated beyond immediate scores through delayed retrieval. Second, individual and team performance are considered separately, recognising that strong team achievement does not necessarily represent long-term individual mastery. Third, learner feedback and longitudinal assessment form a continuous improvement loop for refining educational resources, questions, clinical cases, and facilitation.

Applicability
The framework has been implemented in a large undergraduate medical cohort using existing classroom facilities and students' personal digital devices. No specialised infrastructure or proprietary technology is required. Although initially developed for NMJ blockers, Neuropharm-Retain is modular and can be adapted for other neuropharmacology topics such as antidepressants, antipsychotics, sedative-hypnotics, and opioids. Its structure may also be applied to other biomedical and clinical disciplines requiring integration of foundational knowledge with clinical reasoning.

Innovation Description, Process and Implementation

Approximately two weeks before the TBL session, students received learning outcomes, reference materials, and a visually supported learning resource. During the session, students independently completed a 10-item iRAT using their digital devices (10 minutes). They were subsequently assigned to 20 predetermined teams and completed the same questions collaboratively as a tRAT. The facilitator then reviewed challenging items.

Students subsequently completed the application phase using three clinical scenarios related to NMJ blockers. Teams discussed the assigned case and presented their reasoning during facilitator-guided discussion.

Immediately after TBL, students completed a structured feedback questionnaire assessing preparation, readiness assurance, application, teamwork, facilitation, engagement, and areas for improvement. Approximately six months later, students independently repeated the core 10-item assessment to evaluate longitudinal knowledge performance.

Key Findings

Immediate Learning Experience
A total of 160 students completed feedback immediately after TBL. Across 20 Likert-scale items, the overall mean rating was 4.80 out of 5 (96.0%).

Student engagement was particularly high: 98.8% agreed or strongly agreed that team members actively participated, 98.1% reported agree or strongly agree that TBL encouraged peer-to-peer learning, and 96.9% felt comfortable sharing their opinions (agree or strongly agree).

Clinical application emerged as a key strength. 95.5% agreed that the application questions helped them apply pharmacological concepts clinically. When asked which component contributed most to their learning, 122 out of 160 students (76.3%) selected the clinical scenarios, compared with tRAT (15.6%) and iRAT (8.1%).

Feedback also identified opportunities for refinement, including question clarity and difficulty, discussion time, and audiovisual accessibility.

Six-Month Knowledge Performance
A total of 116 students completed the six-month assessment. Baseline iRAT scores were 7.01 ± 1.70, compared with 6.56 ± 2.56 at six months. The difference was not statistically significant, $t(115) = -1.74$, $p = 0.084$.

Baseline individual performance showed a small positive correlation with six-month performance ($r = .206$, $p = 0.026$). In contrast, tRAT performance ($r = 0.045$, $p = 0.632$) and end-of-semester (modified essay questions on NMJ blockers) ($r = 0.016$, $p = 0.861$) were not associated with six-month individual performance.

Impact

Neuropharm-Retain demonstrates impact in student engagement, empowerment, clinical application, and longitudinal learning. High levels of participation and peer learning indicate that students were

actively involved rather than passively receiving information. The finding that 96.3% felt comfortable expressing their opinions further suggests that the learning environment supported learner participation and confidence.

Clinical scenarios were particularly valued, with more than three-quarters of students identifying them as the most helpful component. This highlights the importance of linking foundational pharmacology with clinically meaningful decision-making.

Importantly, Neuropharm-Retain evaluates learning beyond immediate satisfaction. Mean individual assessment performance remained relatively stable over six months, with no statistically significant difference from baseline. The lack of association between tRAT and six-month scores also reinforces the importance of maintaining individual accountability alongside collaborative learning. As there was no comparison group, these findings demonstrate longitudinal student performance following Neuropharm-Retain rather than superiority over other teaching approaches.

Recommendations for Classroom Practice

Educators should identify core concepts that students are expected to retain and align preparatory materials, readiness assessments, and clinical scenarios with these outcomes. Both individual and team assessments should be retained because they measure different aspects of learning.

Clinical application should remain central, while delayed individual assessment at three to six months can help identify concepts requiring reinforcement. Immediate student feedback and longitudinal results can then guide refinement of subsequent modules.

Other Relevant Information

Neuropharm-Retain is designed as a scalable framework rather than a single NMJ blocker activity. Future modules may include antidepressants, antipsychotics, sedative-hypnotics, and other neuropharmacology topics. The structured student and instructor resources also provide a foundation for intellectual property registration and wider educational dissemination.

Acknowledgement

The authors acknowledge the participating medical students and teaching staff of the Faculty of Medicine, Universiti Kebangsaan Malaysia, for their contributions to Neuropharm-Retain.

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ID 71: ProbGAI: Integrating Generative AI into Problem-Based Learning in Embedded Systems Education

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Highlights: ProbGAI addresses the challenge of supporting complex problem-solving in embedded systems, where students differ in foundational knowledge and opportunities for personalized guidance are limited. The innovation integrates Generative AI (GAI) into a structured seven-stage Problem-Based Learning (PBL) framework, positioning AI support at selected stages while preserving students' active role in problem analysis and solution development. Implemented with 116 diploma-level engineering students at a polytechnic in Selangor, the approach demonstrated substantial improvements in Critical Thinking Dispositions (CTD) and Self-Perceived Problem-Solving Ability (SPPSA) based on quantitized reflection analysis. ProbGAI offers a structured and adaptable model for human-AI synergy in engineering education.

Keywords: Problem-Based Learning; Generative AI; Embedded Systems Education; Critical Thinking Disposition; Problem-Solving Ability

Introduction

The embedded systems course is inherently complex, requiring students to integrate knowledge across multiple domains (Elfadil & Ibrahim, 2022; Pasricha, 2022). Project-Based Learning (PjBL) provides authentic engineering experience through group projects, but differences in students' foundational knowledge (Rodriguez-Sanchez et al., 2016) and unequal participation may limit individual learning and mastery. Thus, students need strong Critical Thinking Dispositions (CTD) and Self-Perceived Problem-Solving Ability (SPPSA) to independently address ill-structured technical problems. However, conventional instruction often lacks individualized scaffolding to develop these capabilities. Problem-Based Learning (PBL) can address this need by engaging students in authentic problem-solving, while Generative AI (GAI) can provide personalized guidance, prompts, feedback, and scaffolding. Yet, the structured integration of GAI into PBL for embedded systems education remains underexplored. To address this gap, this research introduces ProbGAI, a web-based platform that integrates GAI into PBL to support the development of students' CTD and SPPSA through structured scaffolding.

Objectives

- To design and develop ProbGAI, a web platform that hosts structured Problem-Based Learning with Generative AI assisted tool (PBL-GAI) to support students' Critical Thinking
- Disposition (CTD) and Self-Perceived Problem-Solving Ability (SPPSA) in Embedded Systems education.
- To evaluate the effectiveness of ProbGAI towards students' Critical Thinking Disposition (CTD) and Self-Perceived Problem-Solving Ability (SPPSA) in Embedded Systems education.

NALI Approach

Novelty

The novelty of ProbGAI lies in moving away from unstructured Generative AI (GAI) usage where AI functions potentially as an unrestricted answer generator. Instead, the platform introduces a structured integrated PBL-GAI framework specifically tailored to the multidisciplinary challenges of embedded systems. This domain-specific design requires students to reason through hardware–software co-dependencies, identify system-level bugs, and evaluate alternative configurations.

Creativity

ProbGAI creatively scaffolds the learning experience by embedding Generative AI (GAI) into selected stage in Problem-Based Learning (PBL) while keeping students actively responsible for core problem analysis and synthesis. In addition, the platform introduces persistent asynchronous reflection through structured peer-sharing sessions. This design allows students to revisit diagnostic discussions, examine peer troubleshooting approaches, and build deeper metacognitive awareness beyond immediate classroom activities.

Innovativeness

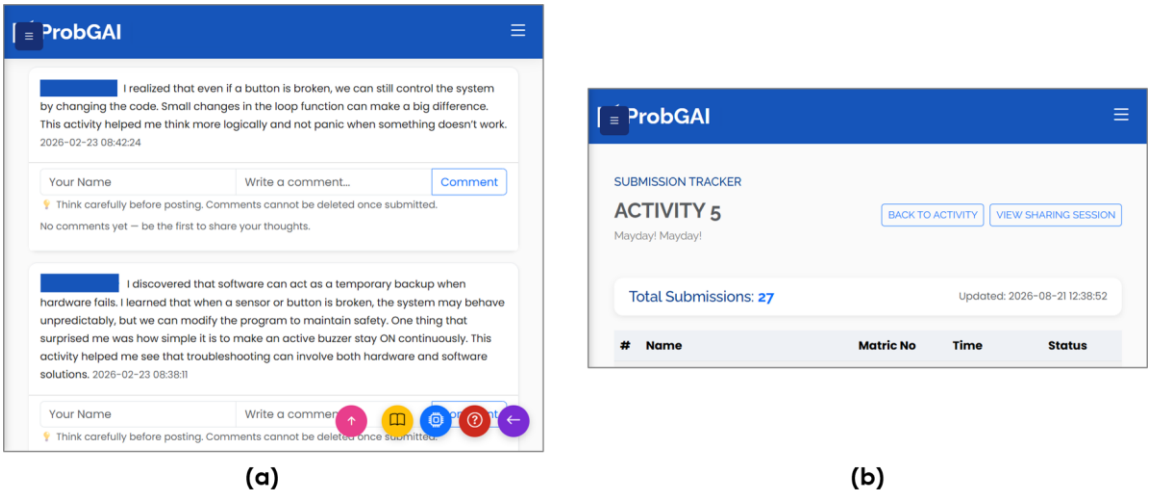
The innovation significantly improves conventional teaching and learning practices by providing automated, stage-by-stage cognitive scaffolding for complex problem-solving. By guiding students through fault isolation, inquiry generation, and system verification, ProbGAI delivers personalized guidance during ill-structured tasks. This structured support prevents cognitive over-reliance on AI while ensuring that students with variety of backgrounds receive adequate scaffolding before undertaking physical projects.

Applicability

The PBL-GAI framework is practical, scalable, and directly applicable across higher education institutions, polytechnics, and TVET colleges. While implemented in embedded systems, the PBL-GAI integration framework is highly modular: instructors can readily adapt problem scenarios, self-study questions, and GAI prompts to other multidisciplinary domains such as the Internet of Things (IoT), robotics, and digital electronics. Furthermore, its lightweight web-based architecture and embedded Wokwi simulation allow seamless institutional adoption without requiring costly hardware kits or complex software installations.

Innovation Description, Process and Implementation

ProbGAI is a web-based educational platform designed to scaffold Arduino-based embedded systems learning by integrating Generative AI (GAI) into a Problem-Based Learning (PBL) framework to prepare students for group-based Project-Based Learning (PjBL). The platform organizes instructional delivery via a central Student Portal into three core modules: (1) Reading Material Module containing seven foundational theoretical topics; (2) Experiment Module integrated with the Wokwi online circuit simulator; and (3) Activity Module presenting eight authentic engineering problem scenarios. Classroom management is supported by a class-based access mechanism using group identifiers for rapid deployment without individual accounts, alongside real-time individual submission tracking (Figure 1b) and peer sharing displays for collective reflection (Figure 1a).



(a) **(b)**

Figure 2: (a) Peer sharing and reflection display in ProbGAI, (b) Activity submission tracking interface in ProbGAI.

The learning process operationalizes an adopted seven-stage PBL cycle (Barrows & Tamblyn, 1980): *(1) Objective Identification* (identify learning goals to explore real-world constraints), *(2) Problem Interaction* (explore the embedded-systems problem in ProbGAI), *(3) Identification of Self-Study Questions* (identify knowledge gaps and technical questions), *(4) Self-Directed Learning with GAI* (use GAI to investigate and understand the problem), *(5) Application of Acquired Information* (evaluate and select possible technical solutions), *(6) Review and Synthesis* (reflect, troubleshoot and generalize learning), and *(7) Evaluation* (share reflections and evaluate the learning experience). This stage-gated setup provides cognitive scaffolding while ensuring students maintain active ownership over problem analysis and solution synthesis.

The innovation was implemented across a 14-week (1 semester) in the *Embedded Systems Application* course at a Selangor polytechnic, involving the entire cohort of 116 engineering students (N = 110 evaluation participants). Effectiveness was evaluated via a mixed-method approach: quantitative pre- and post-test inventories (UF/EMI-CTDI; Ricketts, 2003; and PSI; Heppner & Petersen, 1982; n=81) to measure Critical Thinking Dispositions (CTD) and Self-Perceived Problem-Solving Ability (SPPSA), paired with Directed Qualitative Content Analysis (DQCA) on four open-ended reflection questions across 93

student portfolios. Qualitative data were quantitized across 18 CTD and 16 SPPSA codes into three competency tiers (Low, Moderate, High) and evaluated using Cohen's h to capture behavioral shifts beyond Likert-scale ceiling effects.

Key Findings

Quantitative evaluations using paired-samples t-tests and one-way ANCOVA revealed noticeable post-test ceiling effects on conventional Likert-scale instruments, masking significant measurable variance across groups. For Critical Thinking Disposition (CTD), within-group score changes were not statistically significant (Experimental: $p = 0.390, d = -0.154$; Control: $p = 0.400, d = -0.121$), and between-group differences remained non-significant after controlling for baseline covariates ($p = 0.660, \eta_p^2 = 0.002$). Similarly, Self-Perceived Problem-Solving Ability (SPPSA) showed no significant within-group changes (Experimental: $p = 0.938, d = 0.014$; Control: $p = 0.202, d = 0.185$) or between-group divergence ($p = 0.263, \eta_p^2 = 0.016$), underscoring the limited sensitivity of broad self-perception surveys in detecting subtle, high-level engineering cognitive shifts.

In contrast, Directed Qualitative Content Analysis (DQCA) quantitized across a three-tier reflection rubric captured substantial, high-magnitude behavioral breakthroughs (Cohen's $h > 0.8$). Experimental students achieving high-tier competency in identifying complex hardware–software co-dependencies surged from 0.00% to 71.43% ($h = 2.01$), alongside a significant rise in confidence to trace and repair errors from 0.00% to 80.00% ($h = 2.21$), driven by applying Separation of Concerns (SoC) during troubleshooting (2.86% to 65.71%, $h = 1.55$). Conversely, control students relied heavily on simulation tools as a safety crutch to avoid physical debugging conflicts (5.17% to 58.62%, $h = 1.29$), demonstrating that while closed-ended surveys suffered from ceiling effects, the ProbGAI intervention led to clear, meaningful improvements in authentic diagnostic reasoning and system-level problem-solving.

Impact

The implementation of ProbGAI provides students with a structured learning environment for engaging with complex embedded-systems problems while maintaining active participation in problem analysis and reflection. For educators, the platform provides a structured mechanism for integrating GAI into PBL without relying on unrestricted AI use. At the institutional level, innovation supports the development of AI-integrated learning practices that emphasize student agency, critical thinking, and problem-solving. The combination of quantitized reflections and conventional measures also provides educators with an additional means of identifying learning development that may not be fully captured by Likert-scale instruments.

Recommendations for Classroom Practice

ProbGAI can be integrated into classroom teaching as an engaging, structured learning activity alongside conventional lectures and theoretical instruction. Lecturers can use the platform to introduce authentic engineering problems, guide students through the seven-stage PBL-GAI process and facilitate discussion and reflection while students apply theoretical knowledge to practical problem-solving tasks. The platform can also support blended or fully online implementation when physical laboratory attendance is disrupted by circumstances such as institutional restrictions, environmental conditions, or limited access to campus facilities. In such situations, the integration of learning materials, simulation activities, problem scenarios, GAI-supported inquiry, submissions, and discussion within a single platform provides a structured learning environment and reduces the need for students to navigate multiple disconnected applications.

For effective implementation, lecturers should first align the problem scenarios and self-study questions with the intended course learning outcomes and students' existing knowledge. GAI prompts should be designed to encourage questioning, explanation, and evaluation, while lecturer facilitation remains important for monitoring students' learning and addressing misconceptions. As PBL problems may have multiple technically viable solutions, ProbGAI provides suggested solution pathways and recommended approaches as cognitive starting points for students. These suggestions are intentionally incorporated to guide students' initial thinking and are intended to reduce their tendency to depend directly on GAI-generated solutions. Students are first required to interpret the problem, identify relevant knowledge gaps, and consider possible approaches before evaluating the suggested solutions. The recommended approaches serve as references rather than constraints on students' reasoning, allowing students to challenge, modify, or propose alternative approaches based on their prior knowledge, experience, and interpretation of the problem. During the sharing session, students may present and examine different

perspectives and proposed solutions, justify their decisions, compare alternative approaches, and learn from their peers.

Other relevant information

The ProbGAI instructional design and platform have been officially filed for intellectual property protection under the copyright title *ProbGAI: An Interactive Arduino-Based Embedded Systems Course Learning System Integrating Generative AI into Problem-Based Learning*. The project received international recognition through 1st Place (Gold Award) in the Poster Competition (Social Science – Research Category) at the International Conference on Artificial Intelligence and Its Application (ICON-AI 2025). ProbGAI also offers potential for adaptation and scalability across polytechnics, TVET institutions, and other engineering contexts, including IoT, robotics, and digital logic design.

Acknowledgement

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ID 72: SULAM through Multimodal Tamil Comics: Empowering Student Teachers to Innovate

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Highlights: This innovation addresses the challenges of engaging secondary-school students in Tamil language learning, particularly reading and comprehension, through conventional text-based materials. As part of the BTP3063 course assignment, 56 UPSI student teachers were empowered to apply multimodal theory and AI-supported digital tools to design Tamil comic books as interactive learning resources. The innovation adopts a service-learning approach, in which student teachers extend their classroom learning by applying their knowledge to develop and share multimodal Tamil comics with secondary-school learners. By integrating visual, linguistic and digital modes, conventional Tamil learning materials are transformed into engaging and accessible narratives. Following completion of the comic-book assignment and service-learning activities, student teachers were assessed through evaluation of their comic products, pedagogical application, creativity and digital competencies, while learners' responses and learning experiences were also evaluated. The innovation therefore strengthens student teachers' creativity, digital pedagogical competencies and reflective practice while providing secondary-school learners with more engaging Tamil language learning experiences. Its key contribution lies in integrating service-learning, multimodal theory, AI-assisted content creation, comic-based pedagogy and assessment within Tamil language education.

Keywords: Multimodal Theory; Artificial Intelligence; Tamil Language Education; Digital Comics; Student Teachers

Introduction

The rapid development of artificial intelligence (AI) and digital technologies has created new opportunities for transforming teaching and learning practices in higher education and schools. In language education, learners increasingly require learning experiences that move beyond conventional text-based instruction and incorporate multiple modes of meaning-making, including language, images, characters, color, layout, audio and digital media. This is particularly relevant to Tamil language education, where maintaining learners' engagement and interest in reading and language activities remains an important pedagogical concern (Rizcallah & Parlak, 2025).

Traditional Tamil language teaching materials are frequently dominated by printed texts, exercises and teacher-directed activities. Although such materials remain valuable, they may not always provide sufficient opportunities for learners to engage with Tamil through visually rich, contextualised and interactive learning experiences. At the same time, student teachers require opportunities to develop the pedagogical creativity and digital competencies necessary for teaching in contemporary classrooms (Álvarez-Vanegas et al., 2024).

This innovation therefore introduces a human-AI synergy approach in which UPSI student teachers apply multimodal theory to design Tamil comic books as learning materials for secondary-school Tamil language learners (Wittig, 2024). Rather than positioning AI as a replacement for teachers, the innovation places student teachers at the centre of the design process, with AI-supported digital tools functioning as creative and pedagogical assistants. The student teachers determine the learning objectives, linguistic content, narrative structure and pedagogical appropriateness, while AI-supported tools facilitate the development of visual and multimodal elements (Mahmud & Ismail, 2024).

The project involved 56 UPSI student teachers who developed Tamil comic-based learning materials for selected secondary-school students in Hilir Perak District during the 2027 academic session. The innovation seeks to demonstrate how human pedagogical expertise and AI-supported creativity can work together

to produce meaningful, culturally relevant and engaging Tamil language learning resources (Rodríguez-Gallego et al., 2024).

Objectives

The innovation was developed with the following objectives:

- To develop Tamil comic books based on multimodal theory for secondary-school Tamil language learning.
- To enable UPSI student teachers to integrate AI-supported digital tools into the design and production of Tamil reading materials.
- To enhance student teachers' creativity, digital competencies and pedagogical innovation skills.
- To provide secondary-school Tamil learners with engaging, contextualized and visually supported learning resources.

NALI Approach

Novelty
The innovation uniquely combines multimodal theory, AI tools, and Tamil comic-book creation in teacher education. It empowers 56 UPSI student teachers to become creators of engaging Tamil learning materials for secondary-school learners. Unlike conventional text-based resources, the approach integrates visuals, storytelling, language and AI-assisted creativity, while maintaining human control over pedagogical and linguistic decisions.

Creativity
The innovation incorporates creativity through the integration of Tamil storytelling, comic characters, visual illustrations, dialogue, colour, sequencing and multimodal elements to present language content in an engaging format. Student teachers creatively transform conventional Tamil learning materials into meaningful comic narratives that reflect learners' contexts and interests. AI-supported tools are used to generate and refine story ideas, characters and visual elements, while student teachers critically select and adapt the outputs. This creative process encourages experimentation, imagination and collaboration, producing attractive, culturally relevant and pedagogically purposeful Tamil learning resources for secondary-school learners.

Innovativeness
The innovation introduces an improved approach to Tamil language teaching by combining multimodal pedagogy, AI-supported technology and comic-based learning. Instead of relying mainly on conventional text-based materials, student teachers create interactive and visually engaging Tamil comics that integrate language, images and storytelling. AI tools enhance the efficiency and creativity of the development process, while teachers maintain control over content accuracy and pedagogical decisions. This approach improves learning-material development, promotes student engagement, strengthens future teachers' digital competencies, and provides a more meaningful and learner-centred approach to Tamil language education.

Applicability
The innovation has strong potential for adaptation, replication and scalability across different educational settings. The comic-based approach can be adapted to various Tamil language topics, proficiency levels and learner needs, while the human-AI workflow can be applied by teachers and student teachers in other schools and institutions. The approach can also be extended to other languages and subjects requiring multimodal learning. As AI tools continue to develop, the innovation can be updated with emerging technologies, supporting its long-term sustainability and continued relevance in digital education.

Innovation Description, Process and Implementation

1. Overall Innovation Concept and Description
The innovation, SULAM Through Multimodal Tamil Comics: Empowering Student Teachers to Innovate Tamil Language Learning, integrates SULAM, multimodal theory, AI, comic-based pedagogy and teacher education to create engaging Tamil language learning resources for secondary-school learners. The project involved 56 UPSI student teachers who designed Tamil comics for selected secondary-school students in Hilir Perak. As future teachers, they transformed curriculum content into engaging narratives using Tamil text, illustrations, characters, facial expressions, gestures, colour, typography and visual sequencing. AI tools supported brainstorming, storytelling, character development, visual creation and

dialogue refinement. However, student teachers critically evaluated and adapted AI-generated outputs for language accuracy, curriculum alignment, cultural appropriateness and learner suitability. The innovation follows a human-led, AI-supported approach, empowering student teachers to develop creativity, digital and AI literacy, and pedagogical design skills while providing secondary-school learners with engaging, contextualized Tamil learning materials.

2. Design and Development Process

The innovation followed seven stages: needs identification, content selection, narrative planning, multimodal design, AI-assisted creation, human evaluation, and refinement. The 56 student teachers identified secondary Tamil learners' needs and transformed curriculum content into engaging comics using Tamil text, visuals, characters, expressions, colour and storytelling. AI tools supported idea generation, dialogue, character development and visual creation. All AI outputs were critically reviewed for language accuracy, curriculum relevance, cultural appropriateness and learner suitability before finalizing the comics.

3. Implementation and Teaching-Learning Flow

The innovation was implemented with 56 UPSI student teachers and selected secondary-school students in Hilir Perak. Student teachers were guided in multimodal pedagogy, comic creation and responsible AI use, then developed and refined Tamil comics based on learning objectives. The comics were used with school learners to support reading, vocabulary, comprehension and engagement, followed by feedback and reflection for improvement.

The overall teaching-learning flow can therefore be represented as:

Learning Need → Learning Objective → Multimodal Planning → Story and Comic Design → AI-Assisted Creation → Human Evaluation → Final Comic → Classroom Implementation → Learner Response → Reflection and Improvement

The innovation was implemented with 56 UPSI student teachers and selected secondary-school students in Hilir Perak. Student teachers were guided in multimodal pedagogy, comic creation and responsible AI use, then developed and refined Tamil comics based on learning objectives. The comics were used with school learners to support reading, vocabulary, comprehension and engagement, followed by feedback and reflection for improvement.

Key Findings

Present the evidence and outcomes resulting from the implementation of the innovation. This may include both quantitative and qualitative findings such as performance improvements, user feedback, enhanced learning outcomes, adoption rates, and other relevant indicators. These results should clearly demonstrate the originality, significance, effectiveness, and overall impact of the innovation.

Impact

The innovation creates impact at student, educator and institutional levels. For secondary-school students, AI-supported Tamil comics provide a more engaging, visual and contextualized learning experience that encourages reading, participation and interaction with Tamil language content. For the 56 UPSI student teachers, the innovation strengthens creativity, digital literacy, AI competency and pedagogical skills by transforming them into active creators of learning materials. For UPSI, the project supports technology-enhanced teacher education, innovation and human-AI synergy in pedagogy. In the long term, the model can be replicated across Tamil language topics, schools and other language-learning contexts, contributing to sustainable and innovative educational practices

Recommendations for Classroom Practice

Educators can integrate the innovation by first identifying specific learning objectives and learner needs before developing comic-based materials. Teachers should select appropriate AI tools to support story development, visual creation and content generation, while maintaining human control over accuracy, cultural relevance and pedagogical suitability. The approach can be adapted to different proficiency levels by adjusting vocabulary, sentence complexity, visual support and story length. Student teachers can also work collaboratively to develop and evaluate comics before classroom use. For sustainability, educators can reuse the TAMIL-MAI framework across different Tamil topics and adapt it for other languages and subjects.

Other relevant information

The innovation, titled "TAMIL-MAI: A Human-AI Multimodal Innovation for Tamil Comic-Based Learning," has potential for wider adoption in Tamil language education and teacher education. The developed comic resources can be further refined, compiled and adapted into digital learning materials for use across different schools and learning levels. The TAMIL-MAI framework also has potential for replication in other languages and subject areas. Future development may include establishing a digital repository of AI-supported multimodal learning resources and exploring opportunities for intellectual property (IP) protection and educational commercialization.

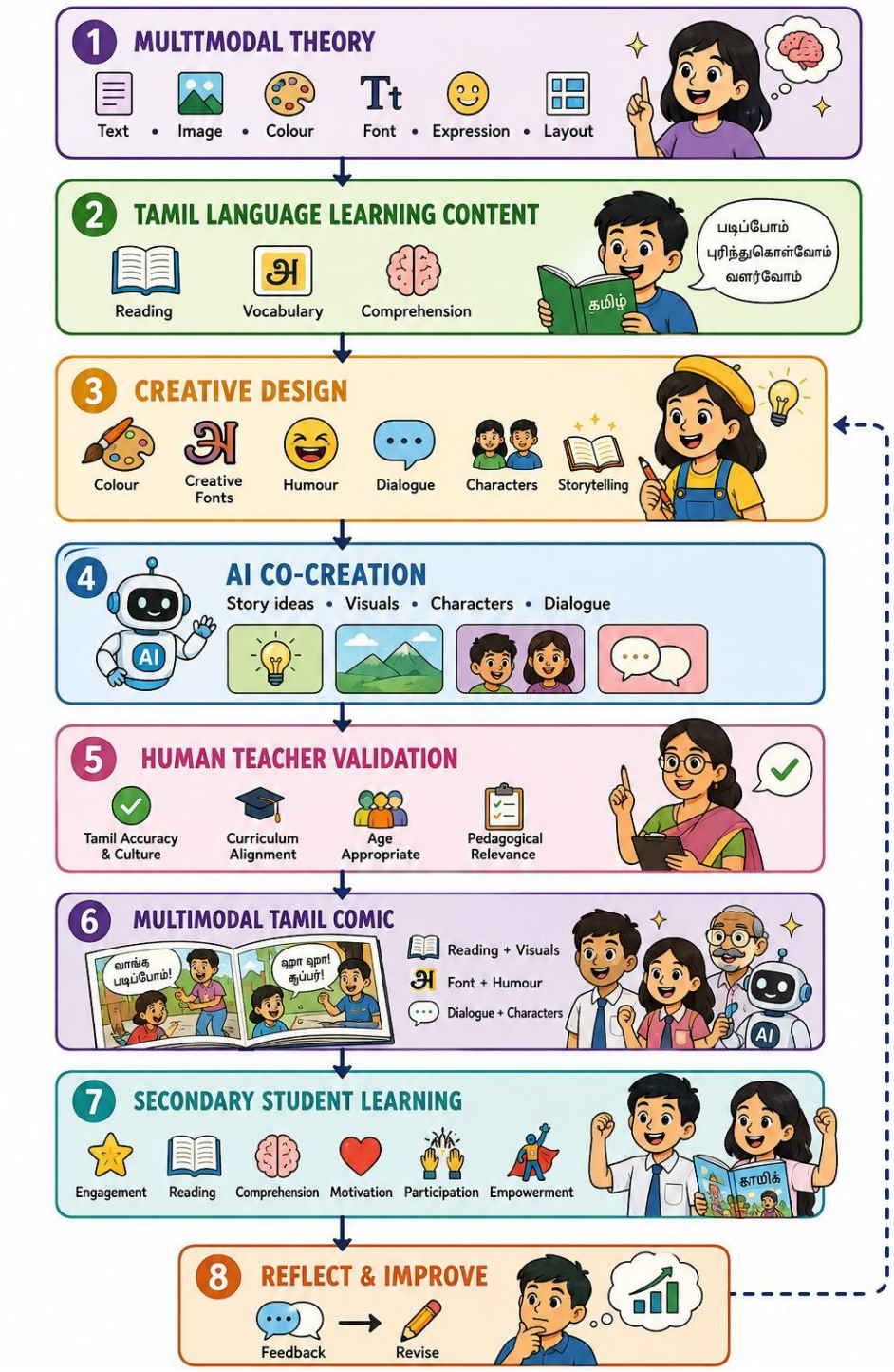


Figure 1: SULAM through Multimodal Tamil Comics: The Processes

Acknowledgement

The authors gratefully acknowledge the support and assistance provided by the Pusat Pengurusan Akademik (PPA), Universiti Pendidikan Sultan Idris (UPSI), in supporting the development and implementation of this service-learning innovation.

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ID 73: A Persuasive Design Framework for Actionable AI-Driven Learning Analytics Dashboards

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Highlights: This innovation addresses the insight-to-action gap in higher education learning analytics dashboards (LADs), where predictive systems identify student risk but fail to guide behavior. We propose a Persuasive Design Framework that integrates Sensemaking, MSLQ, PSD, and the Fogg Behaviour Model to turn predictions into actions. Operationalised as a web prototype, the framework was validated by domain experts (CVI = 1.00) and evaluated by students, achieving an excellent usability score (SUS = 89.38) and high perceived actionability (6.47/7). The framework uniquely operationalises Fogg's behavioral prompts directly as interface-level requirements to drive student academic action.

Keywords: Actionable Analytics; Learning Analytics Dashboard; Persuasive Design; Fogg Behaviour Model; Human-AI Synergy

Introduction

The rapid adoption of data-driven systems in higher education has propelled the growth of student-focused Learning Analytics Dashboards (LADs) (Paulsen & Lindsay, 2024). By integrating multi-source data to translate complex educational logs into visual progress indicators and predictive metrics, learner-facing dashboards aim to support self-monitoring and self-regulated study behaviours (de Vreugd et al., 2024). However, engaging students meaningfully with these visualisations remains a persistent challenge, and research on how students actually interact with these platforms in diverse educational contexts remains limited (Alcock et al., 2024). Most contemporary LADs suffer from a structural limitation known as the insight-to-action gap (Susnjak et al., 2022). Systems are predominantly confined to descriptive activity tracking or terminal predictive alerts (such as display-only risk scores), leaving students to determine remedial actions entirely unaided (Masiello et al., 2024).

To ground this empirically, a qualitative user study utilising semi-structured interviews and co-design sketching was conducted with eleven undergraduate Software Engineering students at Universiti Teknologi Malaysia (UTM) (Mohan et al., 2025a). Thematic analysis revealed that 100% of participants used their existing portal exclusively for passive monitoring and administrative transactions (such as downloading slides and checking grades). Crucially, not a single participant could recall an instance where the e-learning system successfully guided, scaffolded, or prompted a concrete academic action, exposing a universal deficit in action-oriented design. To systematically close this gap, this study proposes a Persuasive Design Framework) for actionable, AI-driven LADs (see Figure 1) (Mohan et al., 2025b).. The framework co-locates predictive outputs with interpretive explanations and executable action pathways (Susnjak et al., 2022) by synthesising Sensemaking Theory (Weick et al., 2005), the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & Zusho, 2015), Persuasive Systems Design (PSD) (Oinas-Kukkonen & Harjumaa, 2009), and the Fogg Behaviour Model (FBM) (Fogg, 2009) into a continuous cognitive-behavioural pathway: the Student Insight-to-Action Flow (Observe → Interpret → Reflect → Decide → Act) (de Vreugd et al., 2024).

Objectives

- To encourage the active, self-regulated participation of students by enabling direct, intuitive interaction with AI-driven performance forecasts and prioritised academic action pathways within their daily learning workspace.
- To assist in the student's cognitive and interpretive understanding of complex academic predictions, personal risk factors, and study behaviours through transparent, explanatory feedback and interactive "what-if" performance simulations.
- To enhance the highly personalised and goal-oriented learning experience of students through conversational AI study assistant guidance and interactive, behaviour-prompted study planning tools.

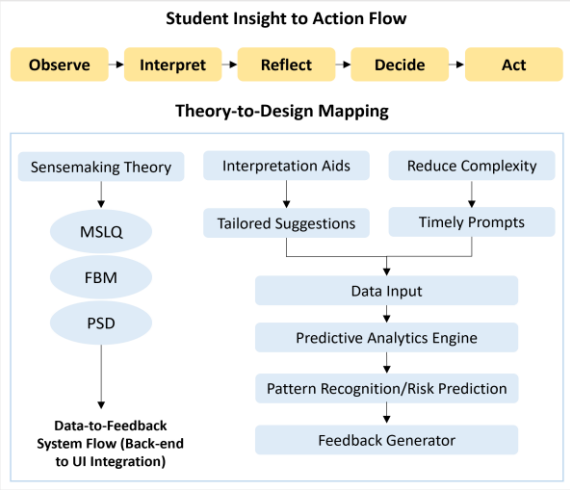


Figure 1: The Persuasive Design Framework

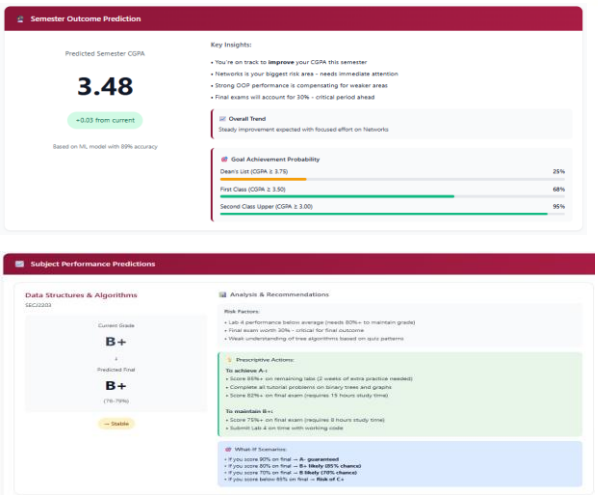


Figure 2: Dashboard Prototype

NALI Approach

Novelty

Unlike commercial systems that display static risk alerts but delegate the intervention to human advisors, this framework uniquely operationalises behavioural activation theory directly within the learner's interface. It establishes a design requirement where every automated predictive forecast is directly co-located with an interpretive explanation and a concrete, executable action element, ensuring analytical insights and the means of acting upon them occupy the same interactive context.

Creativity

This innovation's creativity lies in its systematic integration of four distinct theoretical domains: Sensemaking Theory, the Motivated Strategies for Learning Questionnaire (MSLQ), Persuasive Systems Design (PSD), and the Fogg Behaviour Model (FBM), into a continuous cognitive-behavioural pathway. This model successfully bridges the gap between psychological theory and interactive user interface design.

Innovativeness

This product introduces four active, interface-level mechanisms that move beyond passive descriptive tracking: (1) the AI-Recommended Actions module attaching tailored action lists to predictive alerts; (2) the Predictive Subject Performance panel pairing grade forecasts with underlying risk factors and "what-if" simulations; (3) the AI-Powered Smart Study Planner scheduling recommended tasks directly onto the student's personal calendar; and (4) the conversational AI Study Assistant for real-time, on-demand study guidance.

Applicability

The framework is structured as a three-layered architecture (Data Integration, Analytics Processing, and User Interface Layers). This modular approach ensures that the framework's core design obligations and visual patterns can be integrated seamlessly into existing commercial or institutional learning management systems (LMS) such as Moodle or Blackboard.

Innovation Description, Process and Implementation

The proposed Persuasive Design Framework serves as a structured system blueprint to guide students from analytical feedback to active study adjustments. In this work, the framework is operationalised as a high-fidelity web prototype implemented via HTML, CSS, and JavaScript (see Figure 2). The design and development of the framework followed a rigorous five-phase Design Science Research (DSR) model, spanning problem grounding, user requirement gathering (co-design sketching with eleven Universiti Teknologi Malaysia Software Engineering students), framework formulation, prototype instantiation, and dual-pathway validation.

To structure student engagement, the framework's interface logic is operationalised through a five-stage cognitive-behavioural pathway known as the Student Insight-to-Action Flow:

- Observe: Students gain perceptual access to clear visual performance trends and AI-predicted outcomes on their main dashboard
- Interpret: Sensemaking is scaffolded by pairing each prediction with descriptive, underlying causal risk factors to support model transparency
- Reflect: MSLQ-informed prompts encourage students to evaluate their own motivation, self-efficacy, and self-regulatory strategies
- Decide: The system delivers tailored, prioritised recommendations ("what to do next") through the AI-Recommended Actions module
- Act: Fogg's prompt construct is operationalised as an AI-Powered Smart Study Planner, enabling students to instantly convert recommendations into scheduled, time-bound calendar entries within their active workspace

This system-level implementation ensures that data processing, predictive analytics, and behavioural prompting are tightly coupled within a unified interface context.

Key Findings

The proposed framework and web prototype were validated utilising a dual-method evaluation approach:

- Expert Panel Validation (N = 3): Evaluated by nationwide specialists in Human-Computer Interaction (HCI) and educational technology, the framework achieved a perfect scale-level Content Validity Index (S-CVI/Ave = 1.00) across all eight design dimensions, with an overall mean score of 4.58 out of 5.00 (SD = 0.50).
- Student Usability Testing (N = 8): Usability evaluations with undergraduate Software Engineering students returned an outstanding mean System Usability Scale (SUS) score of 89.38 (SD = 9.04). This represents Grade A "Excellent" usability, which is statistically, significantly superior to the global benchmark of 68 ($Z = 2.55$, $p = .005$, $r = .90$).
- Perceived Actionability and Decision Support: Using a 7-point Likert instrument (Cronbach's alpha = .931), students rated the dashboard's overall actionability at 6.47 out of 7.00 (SD = 0.52). Crucially, the student's perceived capability to start acting immediately scored a high mean of 6.75 out of 7.00 (SD = 0.46).

Impact

The proposed Persuasive Design Framework provides immediate and long-term value across three key dimensions:

- Student Engagement and Empowerment: The product reconceptualises students as autonomous academic agents. By converting abstract, anxiety-inducing predictive risk scores into prioritised, step-by-step study recommendations, it scaffolds student self-regulated learning (SRL) strategies
- Teaching Effectiveness and Support: By serving as a pedagogically grounded "first line of support", the dashboard alleviates the manual diagnostic burden on educators. Instructors and advisors can optimise face-to-face sessions, dedicating personal attention to highly complex student cases
- Institutional Scalability: The modular three-layered system architecture ensures seamless, cost-effective integration within existing Learning Management Systems (LMS). This supports university retention and digital-learning goals by delivering scalable, data-informed decision-support tools.

Recommendations for Classroom Practice

To successfully adapt and replicate this design framework in modern digital learning environments, educators and system developers should implement three core strategies. First, a layered information architecture utilising progressive disclosure must be adopted to display high-level AI performance forecasts first, offering deeper diagnostic analytics and causal factors only on demand to prevent student cognitive overload. Second, automated academic predictions must never be presented in isolation; instead, they should be paired with explanatory transparency and interactive outcome simulations to build learner trust and scaffold active cognitive sensemaking (Weick et al., 2005). Finally, actionable recommendations and study-planning tools must be embedded directly within the students' active learning workspace as immediate, behaviour-triggering prompts (Fogg, 2009; Susnjak et al., 2022), thereby converting passive analytical insights into immediate, scheduled study habits and preventing the loss of behavioural momentum.

Acknowledgement

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ID 74: A Digital, Immersive, and Collaborative Learning Ecosystem for Traditional Silat Sendeng Martial Heritage

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Highlights: Cultural heritage plays a crucial role in developing learners' understanding of national history and identity. While heritage education can be enriched through physical practice, complex disciplines like traditional Silat Sendeng posed preservation challenges due to a lack of interactive, spatial digital platforms. An interactive digital ecosystem utilising touchless hand gesture interaction, 3D animation, and conversational AI was developed to create a more immersive and somatic learning experience. An evaluation with university students showed that the system successfully enables users to somatically control 3D martial movements using intuitive gestures, enhancing learning engagement compared to conventional reading.

Keywords: Gesture interaction; Somatic learning; Heritage education; MediaPipe Hands

Introduction

Seni Silat Sendeng is a traditional Malay martial art carrying deep cultural, philosophical, and historical significance to Malaysia's intangible cultural heritage. As an oral and practical tradition, its transfer of knowledge has conventionally relied on physical training halls and in-person mentorship. However, this heritage faces a critical risk of deprecating among younger generations who seek more digital, interactive, and self-regulated modes of learning. Traditional digital learning mediums, such as static text, images, or standard passive video playback, lack the necessary spatial interactivity to accurately convey the complex 3D joint articulations and somatic details of martial arts, failing to satisfy the cognitive and physical engagement needs of digital-native students. This gap highlights the critical value of somatic learning, where physical movement, bodily control, and sensory-motor reflection form the core of the educational experience (Höök, 2018; Loke and Schiphorst, 2018).

Modern educational methodologies may harness human-computer interaction (HCI) and smart technology to create accessible, self-regulated digital environments. Leveraging computer vision-based gesture recognition and interactive 3D simulations has been shown to reduce cognitive load while significantly boosting engagement by giving students active agency over their learning materials (Dede, 2009). In alignment with the NALI 2026 theme of Human-AI Synergy in Pedagogy, this work presents the design, development, and evaluation of an integrated Silat Sendeng Showcase application. The ecosystem establishes a touchless interface that allows learners to somatically control and study 3D animations, converse with an AI chatbot, and compete in collaborative multiplayer arenas without requiring costly motion-capture hardware or immersive virtual reality headsets.

Objectives

- To encourage active, somatic participation of learners by enabling direct, touchless interaction with 3D martial arts models using intuitive hand gestures.
- To assists learner's spatial and cognitive understanding of complex physical manoeuvres, skeletal joint rotations, and historical cultural philosophy of traditional Silat Sendeng.
- To enhance the collaborative and personalized learning experience of learners through AI-driven conversational guidance and gamified multiplayer peer-to-peer assessment.

NALI Approach

Novelty

The introduction of MediaPipe hand tracking through a standard webcam provides a novel, low-cost approach to traditional cultural heritage education. Unlike static text and passive video, this touchless interface allows learners to engage somatically with complex martial movements, creating a more interactive and immersive learning experience.

Creativity

The creativity of the application lies in its integration of visual, conversational, and collaborative learning within an authentic 3D Malay training hall. AI-assisted motion capture produces accurate Silat Sendeng

animations, while adjustable camera views enable learners to examine joint movements, body positioning, and complete stances from multiple perspectives. This visual exploration is complemented by a Gemini Agent chatbot that responds to open-ended questions about the history and philosophy of Silat Sendeng using a verified knowledge base, thereby supporting immediate feedback and self-directed inquiry. In multiplayer mode, learners can also practise five martial gestures while observing an opponent's movements as real-time ghost landmarks, linking cooperative play with motor coordination and bodily discipline (Loke and Schiphorst, 2018).

Innovativeness
The application supports learner-centred learning by enabling learners to control 3D martial animations, inspect movements from different perspectives, and progress independently (Martusciello, Muccini, & Bucchiarone, 2025). Its combination of 3D visualisation, AI-supported historical inquiry, and LAN multiplayer activities accommodates different learning preferences and allows students to select the mode most suited to their needs. As self-instructional material, the application can supplement instruction in a physical training hall or support home-based study. Moreover, its reliance on ordinary webcams makes the system affordable and scalable, with potential for future extension to other traditional silat styles and intangible cultural heritage practices.

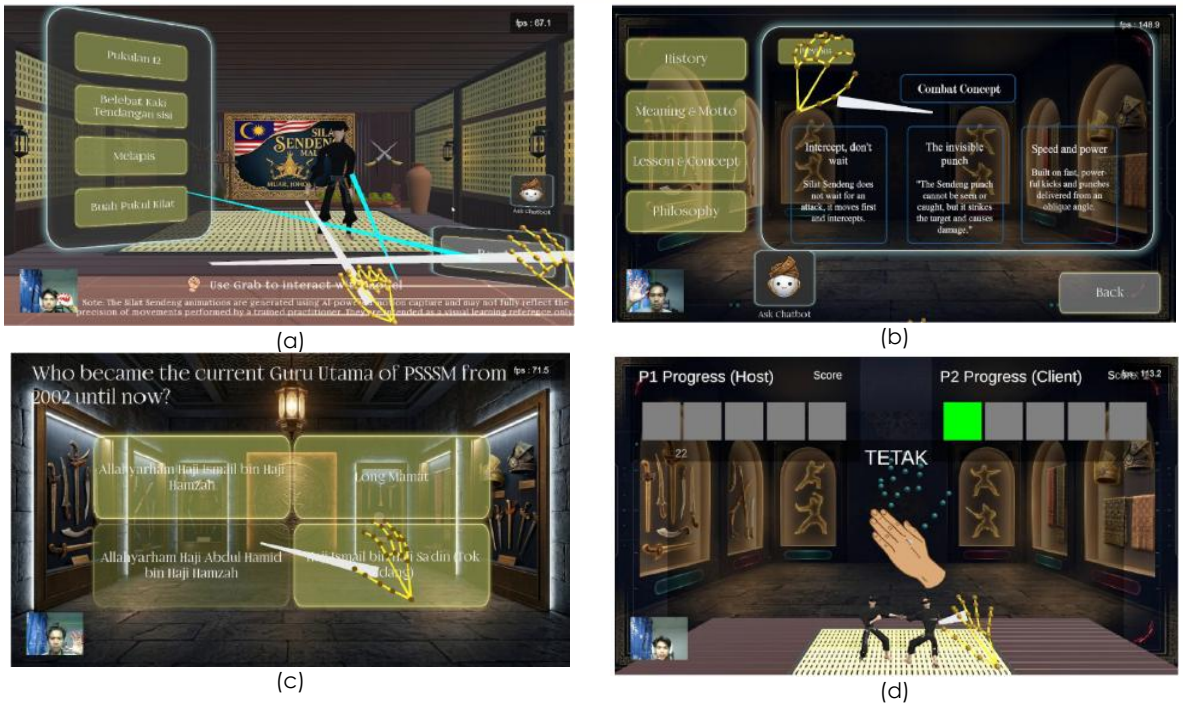
Applicability
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Innovation Description, Process and Implementation

The development of the Silat Sendeng Showcase followed the systematic, iterative five-phase ADDIE (Analysis, Design, Development, Implementation, and Evaluation) instructional design model. Intensive consultations were conducted with Silat Sendeng experts to extract authentic movement data, history, and philosophies. This domain knowledge guided the 3D modeling and motion capture retargeting (using DeepMotion and Blender) of four core Silat Sendeng movements: attacking moves (Pukulan 12 and Belebat Kaki Tendangan Sisi) and defensive moves (Melapis and Buah Pukul Kilat).

Implementation in Unity generated a robust system with four core digital learning scenes (Figure 1), accessible via the gesture commands:

1. **Moveset Scene:** A 3D simulation environment where learners observe high-fidelity motion-captured animations. Using a webcam, the system registers physical fist grab gestures, allowing students to rotate and zoom the 3D model from 360 angle to inspect joint angles and body positioning.
2. **History and Conversational AI Scene:** Features a curated digital showcase of Silat history, meaning, motto, and philosophy. To foster personalized and self-regulated inquiry, a conversational Gemini Agent is integrated via the Gemini API, configured with a hardcoded knowledge base from the Seni Silat Sendeng Malaysia (PSSSM) registry, allowing users to ask natural questions and receive real-time answers.
3. **Multiplayer Quiz Scene:** A LAN-connected, gamified trivia game built using Unity Netcode for GameObjects. Two players on the same network compete in answering Silat history questions, synchronized automatically in real time.
4. **Gesture Battle Scene:** A multiplayer somatic arena where players compete physically by emulating five specific martial hand gestures (*Cakar, Patuk, Tengkur, Tampa Rimau, and Sandar*) in front of their webcams, validating physical competency and motor-skill coordination.



(a) (b) (c) (d)

Figure 1: Screenshots of the developed application (a)Moveset Scene (b)History and Conversational AI Scene (c) Multiplayer Quiz Scene (d) Gesture Battle Scene

Key Findings

The evaluation of the application involved fourteen university students (mean age = 23.4 years) to assess usability and pedagogical engagement. The pre-test questionnaire revealed that 78.6% of participants had never utilised a digital platform to learn martial arts or cultural heritage, and 28.6% had no prior experience with gesture-controlled software, establishing a highly representative baseline of digital-native learners. Prior to the hands-on session, each participant received a brief tutorial demonstrating the touchless navigation inputs (pinching and grabbing) and the five specific Silat Sendeng gestures. Following a self-paced, multi-modal exploration of the five core software scenes, participants completed a post-test questionnaire. This instrument compiled the standardised 10-item System Usability Scale (SUS) (Brooke, 2013) alongside three linear-scale statements (anchored from 1 for "strongly disagree" to 5 for "strongly agree") and an open-ended feedback prompt.

The overall usability analysis yielded a mean SUS score of 54.5 (SD = 10.6), which corresponds to an adjective rating of "OK" and sits at the lower boundary of the marginal acceptability range (Bangor, Kortum, & Miller, 2009). Qualitative comments from the open-ended questionnaire echoed this tension, revealing that usability was constrained by a notable learning curve associated with the precise pinch gestures required for button selection. Environmental factors also introduced physical barriers, with one student noting that "bad lighting caused the system to have difficulty detecting my hand." Additionally, a physical-habit mismatch occurred where a student remarked: "I tried to pinch, but my hands normally use the middle finger instead of the pointing finger."

Crucially, these minor usability hurdles did not diminish the students' enthusiasm, and the educational and engagement metrics demonstrated success. The participants unanimously agreed (100% agreement, mean score = 4.71 out of 5.00) that the interactive digital ecosystem made learning Silat Sendeng far more interesting than conventional reading materials. Additionally, 92.8% of respondents reported that the somatic gesture-based interaction made the experience significantly more enjoyable, with a high willingness to use the application again (mean = 4.57 out of 5.00). Many praised the interactive elements, stating that "the gesture-based control is the most unique experience of this system". To address the pinch sensitivities, participants provided constructive, user-led solutions, suggesting: "improving the ray tracking so the user can select their desired button or module more easily without accidentally pressing a random button." Overall, the findings confirm that the application achieves its objectives of delivering an engaging, highly motivating cultural learning experience while maintaining low-cost hardware accessibility.

Impact

1. For Learners (Empowerment & Active Learning): Learners gain full agency, transforming them from passive observers into active somatic explorers. The integration of the conversational Gemini Agent allows students to conduct personalized knowledge-seeking at their own pace, while peer-to-peer multiplayer gaming motivates active retention and collaborative learning.
2. For Cultural Heritage Preservation: The system demonstrates a scalable, low-cost model for preserving intangible, somatic Malaysian cultural heritage. By capturing and validating movements digitally, it preserves the art for future generations in an accessible format.
3. For Educational Institutions (Inclusive & Affordable Tech): By utilising standard consumer webcams and laptops, this ecosystem bypasses the immense financial barriers associated with modern high-end virtual reality or motion-capture laboratories, enabling local schools and universities to easily deploy next-generation immersive environments.

Recommendations for Classroom Practice

For classroom integration, the application can support a blended approach in which students explore 3D movements and historical quizzes before class, reserving face-to-face sessions for physical refinement. Its multiplayer quiz and gesture battle can also serve as gamified peer assessment of historical knowledge and basic gesture performance. To ensure reliable hand tracking, classrooms should provide uniform lighting and include a brief calibration exercise during student onboarding.

Acknowledgement

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ID 75: Empowering Local Product Advertising via Human-AI Pedagogy in Canva Web Design

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Highlights: This innovation introduces a Human-AI pedagogical approach to empower rural micro-entrepreneurs through AI-assisted website development. Implemented during Nusantara Buddy 2026 (NusaBuddy'26) at FELDA Bukti Ramun, the exposure engaged 10 community participants in co-creating a promotional website using Canva AI with guidance from UTM student facilitators. The approach combined participants' local and entrepreneurial knowledge, human facilitators, and AI-assisted design to produce a published website promoting local products and the FELDA community while developing participants' initial understanding of practical AI applications.

Keywords: Human-AI Pedagogy; Digital Entrepreneurship; Community-based Learning; Canva AI; Digital Empowerment

Introduction

Rural micro-entrepreneurs play a crucial role in driving community-level economic growth, yet they frequently face severe hurdles in digital marketing, brand visibility, and technological adoption (Prasetyo, 2017). Traditional capacity-building workshops often struggle to bridge the digital literacy divide, leaving rural business owners reliant on traditional, localized sales channels (Wulandari et al., 2022).

Digital platforms provide micro-entrepreneurs with unprecedented opportunities to transcend traditional geographical boundaries and access wider consumer markets (Widiastuti et al., 2023). By offering cost-effective tools for content creation, targeted advertising, and online storefront deployment, these technologies level the playing field for small-scale ventures that typically lack substantial marketing capital (Rashid et al., 2021). However, the effective adoption of digital solutions among rural business owners is often hindered by a pronounced digital literacy gap, complex software interfaces, and limited technical confidence (Pal et al., 2026).

To address this digital disconnect, this project presents an innovative pedagogical framework as an initiative introduces a collaborative learning model. It is designed to empower rural micro-entrepreneurs through AI-assisted digital marketing and website creation. Integrating intuitive web design tools like Canva alongside structured Human-AI collaborative scaffolding directly mitigates technological adoption barriers, enabling rural micro-entrepreneurs to transform local cultural offerings into competitive, digitally visible commercial brands (Widiastuti et al., 2023).Executed during the Nusantara Buddy 2026 (NusaBuddy'26) community outreach program at FELDA Bukit Ramun, this educational intervention engaged 10 local community participants in co-creating an interactive e-commerce promotional platform. Rather than replacing human creativity, the approach establishes a three-way synergy combining the participants' intrinsic local entrepreneurial knowledge, guided support from Universiti Teknologi Malaysia (UTM) student facilitators, and Canva AI design tools (Luckin & Cukurova, 2019; Siddiqui, 2025).

Through hands-on co-creation, participants successfully developed and published a dedicated website to advertise local products and showcase the FELDA community, while simultaneously building foundational digital literacy and practical confidence in AI application (Baidoo-Anu & Owusu Ansah, 2023). Ultimately, this Human-AI pedagogical model transforms community service learning into a sustainable, scalable mechanism for digital inclusion and rural economic empowerment.

Objectives

The innovation was implemented to:

- Enable community participants with no prior website-development experience to participate in the development of a functional website using an AI-assisted web-design platform.
- Develop participants' initial awareness and practical understanding of how AI-supported digital tools can contribute to the promotion of local products and businesses.

- Establish a replicable Human-AI community-learning approach that combines university student facilitation, local entrepreneurship knowledge and AI-assisted digital content development.

NALI Approach

Novelty

The novelty here is in the pedagogical interaction among community learners, university student facilitators and AI. In this approach, participants' existing knowledge of their products, businesses and community formed the primary content of the learning. AI supported the transformation of this knowledge into digital content, while student facilitators bridged the gap between participants and technology.

Creativity

The activity creatively created digital skills training with participants' existing entrepreneurial activities. This is achieved through having participants prompted to consider how an online platform could benefit their businesses, what information potential customers would need, and how their products and FELDA Bukit Ramun could be represented digitally. The website created from this activity served as the learning output, a local-business promotional platform and a digital representation of the FELDA community.

Innovativeness

The innovativeness is simplifying the pathway from local knowledge to digital publication through Human-AI collaboration. Participants were not required to have prior knowledge of programming or web-development skills, but instead with guided content-development, prompting, generation, review and refinement through Canva's AI-assisted design environment. This was achieved with the help of student facilitators by demonstrating the technology, guidance through process, assistance and helping participants evaluate how AI-generated content could be adapted to their actual business needs.

Applicability

This approach is applicable to anyone with little specialized technical knowledge and can be adapted for other FELDA settlements, rural communities, micro-entrepreneurs, community outreach programmes, entrepreneurship education and service-learning activities. This innovation can also be replicated for different business sectors or community contexts because the learning content must come from the learners themselves.

Innovation Description, Process and Implementation

This innovation was implemented through a four-hour face-to-face learning session involving 10 community participants at FELDA Bukit Ramun. UTM students served as facilitators during the activity with instructional design following a guided, hands-on and output-oriented learning approach (Figure 1).



Figure 1: Community members participating in Human–AI web design workshop handled by student facilitators to commercialize local FELDA products.

The process began by introducing participants to the role of websites and digital platforms in promoting businesses and local products. Participants were encouraged to consider how having an online presence could benefit their businesses and what information should be communicated to potential audiences. The participants were introduced to Canva and its AI-assisted website-design capabilities. Facilitators demonstrated how AI could support the preparation, organisation and presentation of digital content. Participants contributed information based on their own products, businesses and local knowledge, while the facilitators assisted them in interacting with the technology and refining the generated content. The learning process can be represented as the following diagram (Figure 2).

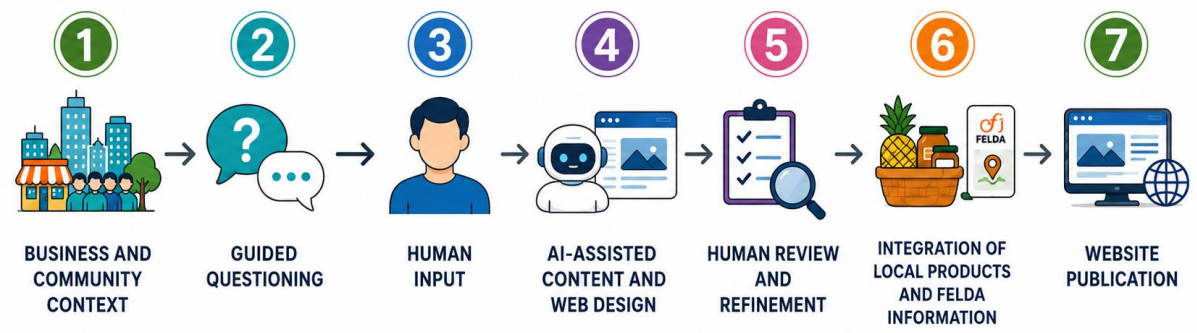


Figure 2: Learning process framework for human–AI synergy in digital learning, from business and community context to website publication.

This has resulted in the development and publication of one integrated website representing the participating local businesses while simultaneously introducing information about FELDA Bukit Ramun. The completed website served as both the learning outcome and a tangible demonstration of how Human-AI collaboration could be used for community digital promotion (Figure 3).

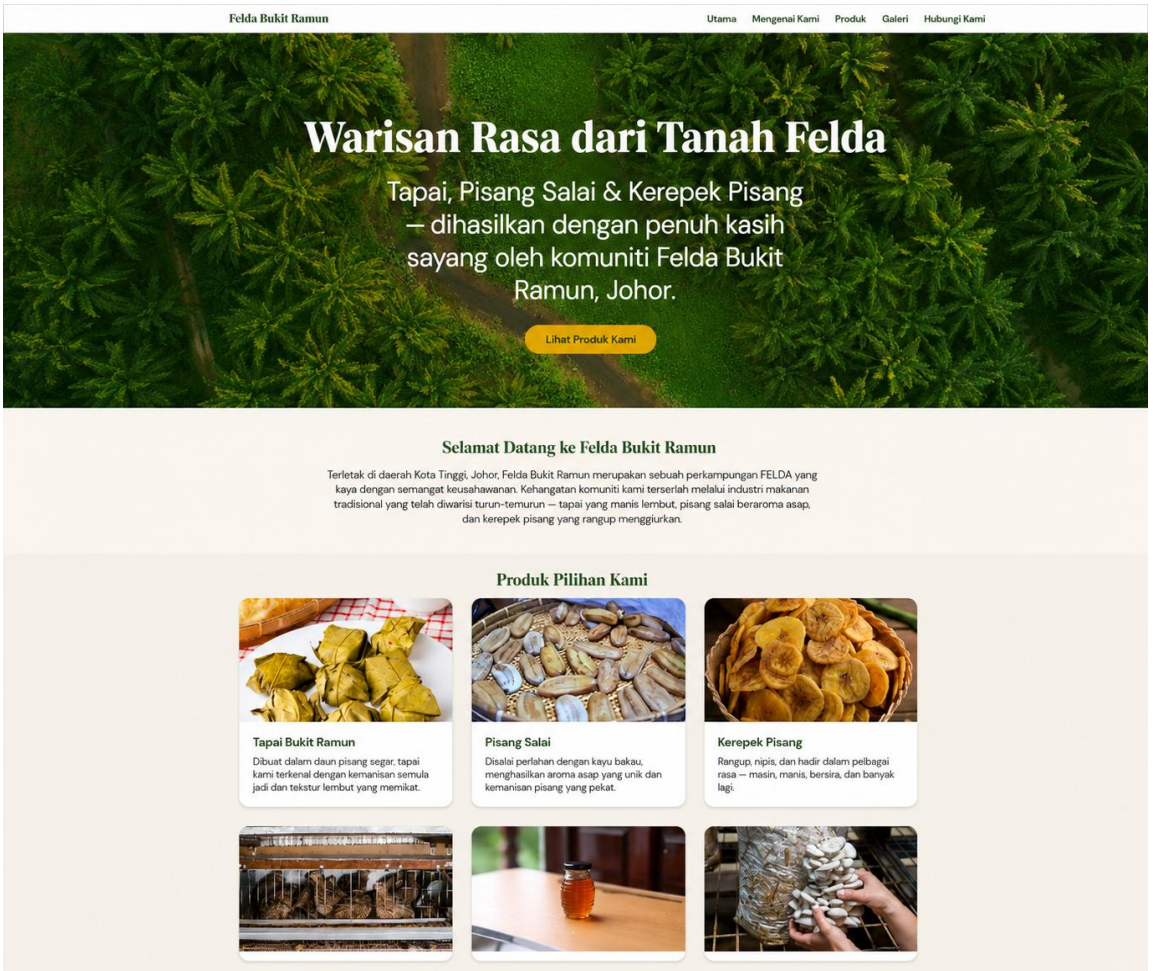


Figure 3: E-commerce website co-creation integrating local product data via Human–AI pedagogy

Key Findings

The 10 community participants of different local entrepreneurial activities have no prior knowledge in website development but were able to engage with an AI-assisted web-development process through structured guidance from UTM student facilitators.

The output here was a published website integrating various local products with information promoting FELDA Bukit Ramun. The activity demonstrated that a short, guided Human-AI learning intervention could enable novice community learners to participate meaningfully in digital content and website development without requiring prior programming knowledge.

It was also observed that participants gained initial exposure to the practical application of AI beyond general awareness of the technology. During the activity, AI was connected directly into communicating information about their businesses and presenting local products digitally.

Impact

One of the impacts of such activity was introducing practical AI-assisted digital creation to community participants within entrepreneurial context, allowing them to present and promote local products online.

This innovation also has made FELDA Bukit Ramun gain visibility by having their products, businesses and introducing the FELDA itself within one digital platform. The website published not only served as a promotional output but also an initial digital representation of local entrepreneurship and community identity.

This activity has also created an authentic knowledge-transfer environment in which technological innovation had to be communicated to learners with different levels of digital experience, supporting the development of facilitation, communication, community engagement and responsible AI-use competencies.

Recommendations for Classroom Practice

The Human-AI pedagogical approach can be adapted to classroom and experiential-learning activities in entrepreneurship, marketing, communication, information technology, community engagement and other related disciplines. Educators or facilitators should begin with an authentic problem or learner-owned context, then allowing learners or participants to determine the purpose, information, audience and desired outcomes before AI is used to assist content or design generation. This practice can be achieved with the proposed workflow shown below (Figure 4).

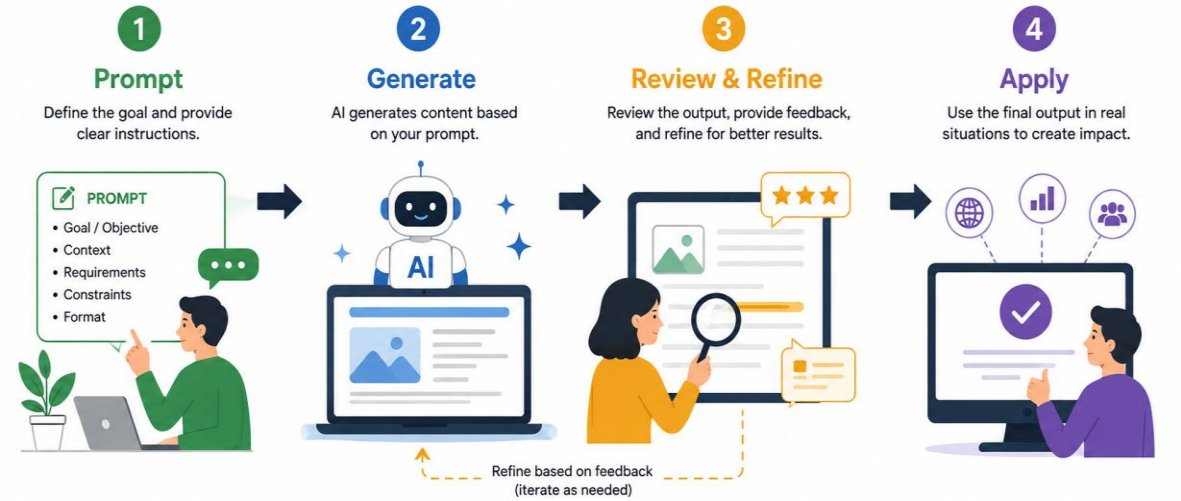


Figure 4: Proposed workflow for classroom practice, illustrating the iterative Human–AI learning process used to develop and improve AI-assisted digital outputs.

Human review should remain an essential stage to ensure that AI-assisted outputs accurately represent the intended information and local context. Small-group facilitation and step-by-step are encouraged for learners with limited digital experience. The final activity should result in authentic output, such as a website, promotional page, digital campaign or community information platform, so that learners can observe the direct relationship between AI-assisted learning and real-world application.

Acknowledgement

We express our sincere gratitude to the Majlis Felo Kolej Rahman Putra (KRP), UTM for providing the financial support for this project and our NALI participation. We also extend our appreciation to the committee of Nusantara Buddy 2026 (NusaBuddy'26) which comprising our students from Universiti Teknologi Malaysia (UTM) and Universitas Airlangga (UNAIR) as well as the local community of FELDA Bukit Ramun for their invaluable collaboration and active participation.

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ID 76: SpeedTrials2D: Improving the Collaborative Assignments and Projects Approach through Online Gamification in Real-Time Software Engineering

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Highlights: Physical robotics competitions for teaching Real-Time Software Engineering (RTSE) course are constrained by hardware access, laboratory capacity and inconsistent hardware conditions. SpeedTrials2D strengthens Collaborative Assignments and Projects (CAP) by transferring authentic RTSE challenges into online autonomous-driving Competition-Based Learning (CBL). It integrates game mechanics such as rules and leaderboards, game characteristics such as uncertainty and increasing difficulty, and game dynamics such as competition and cooperation. Among 182 students, positive CBL perceptions averaged 4.18/5. Programming resilience remained high across the 2024 physical CBL (M = 4.13) and 2026 online CBL (M = 4.20), indicating continuity while improving accessibility, repeatability and scalability.

Keywords: Collaborative assignments and projects; Competition-based learning; Online gamification; Programming resilience; Real-time software engineering

Introduction

Real-time software engineering (RTSE) is difficult to learn through lectures alone because correctness depends on timing, concurrency, responsiveness and stability under changing conditions. The Collaborative Assignments and Projects (CAP) approach addresses this challenge through shared problem solving, practical artefact development and collaborative assessment. Competition-based learning (CBL) makes real-time constraints observable through goals, rules, challenge, feedback and performance, while gamification organises participation through selected game-design elements (Burguillo, 2010; Deterding et al., 2011). The earlier NALI innovation enhanced CAP by integrating programming resilience, problem-based learning and face-to-face mobile-robot CBL (Sa'adon et al., 2023). However, reliance on shared hardware limits access, repeatability, cohort scalability and control over challenge conditions. The present innovation improves CAP through SpeedTrials2D, an online autonomous-driving game in which teams develop a concurrent Python controller, respond to controlled faults and compete through progressive demonstrations, qualifying rounds and a live final. The central purpose is therefore to demonstrate how online gamification extends CAP while preserving authentic collaboration and real-time problem solving.

Objectives

- To improve the CAP approach through accessible and scalable online gamification for collaborative real-time software engineering learning.
- To evaluate programming resilience and students' perceptions of learning, engagement, transfer and confidence after the online implementation.

NALI Approach

Novelty

SpeedTrials2D is an online autonomous-driving programming game in which student teams develop concurrent Python controllers for timed challenges and dynamic faults. Its novelty lies in embedding the game within the CAP pedagogy and assessment process rather than using it as a stand-alone activity. It replaces dependence on shared robots and tracks with a controlled digital environment while preserving authentic problem-solving, teamwork, artefact development and individual accountability.

Creativity

The creativity of SpeedTrials2D lies in embedding gamification into the CAP teaching and learning process. The autonomous-driving narrative transforms abstract concepts such as timing, concurrency and synchronisation into visible vehicle performance. Progressive challenges scaffold students from guided practice to independent problem-solving, while repeated trials encourage experimentation and learning from errors. Live scores, penalties and leaderboards provide immediate feedback. Team programming,

Discord mentoring, GitHub collaboration and reflection combine cooperation within teams with constructive competition between teams.

Innovativeness

SpeedTrials2D converts CAP from a physical competition into a continuous, evidence-informed learning process. Students test, diagnose and refine their solutions under standardised conditions. Lecturers monitor progress through GitHub records, demonstrations and technical explanations, enabling timely feedback on both performance and reasoning. Connecting team results with individual evidence also strengthens fairness, assessment transparency and academic accountability.

Applicability

SpeedTrials2D is designed for online delivery, while the improved CAP pedagogy can be adapted for face-to-face, blended or online learning. Its structure can be replicated using different scenarios, technologies and assessment criteria in programming, robotics, cybersecurity, software testing, optimisation and data science. Reusable challenge templates, documented assessment procedures and facilitator guidance can support scalability, institutional adoption and long-term sustainability.

Improve CAP Approach with Online Gamification

The implementation begins with a challenge briefing and team-role allocation, followed by guided development, iterative testing, demonstrations, formative feedback, qualifying rounds, live competition and reflection. Lecturers and technical mentors provide instructional and technical support, while software artefacts, GitHub records, individual videos, reports and live explanations document learning. Figure 1 presents this pedagogy-centred CAP architecture by connecting its learning foundations, participants, collaborative activities and assessment evidence within one teaching and learning process.

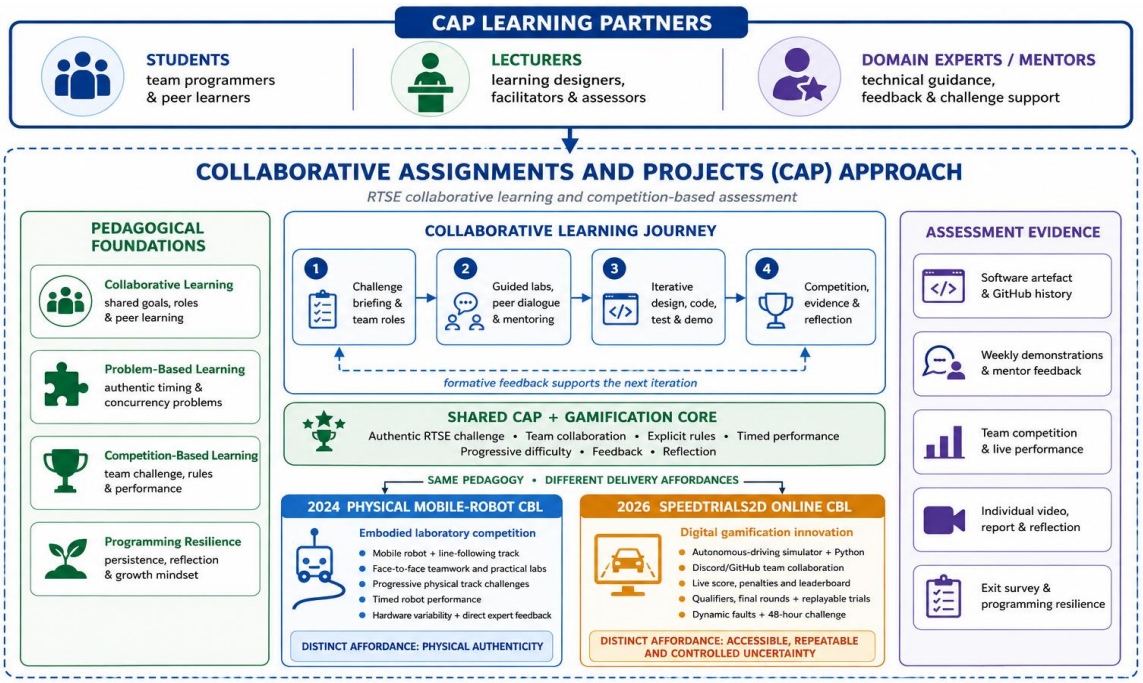


Figure 1: Improvement of the CAP approach through SpeedTrials2D online gamification.

Figure 2 compares the 2024 physical mobile-robot CBL and the 2026 SpeedTrials2D online CBL. Both implementations share the CAP approach, which emphasises authentic RTSE challenges, teamwork, explicit rules, timed performance, progressive difficulty, feedback, evidence and reflection. Following Nurul and Mohamad (2018), the gamification framework comprises three categories: game mechanics, such as rules, time limits, levels, points, penalties and leaderboards; game characteristics, including fun, uncertainty, increasing difficulty and engagement; and game dynamics, including competition, achievement, motivation and cooperation. These shared educational and gamification elements are adapted to physical and online learning environments.

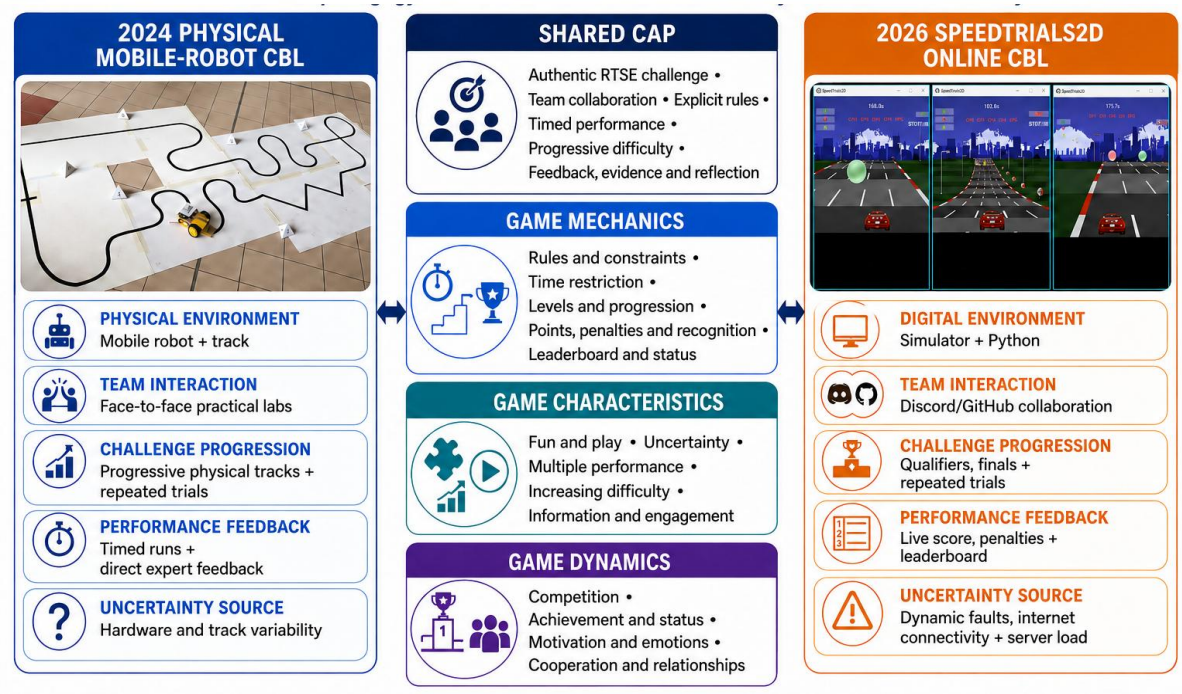


Figure 2: Comparison of physical and online gamification within the CAP approach.

Key Findings

The innovation was evaluated through the 2026 SpeedTrials2D exit survey involving 182 students. The survey included the validated 12-item Programming Resilience Scale for University Students (Fu et al., 2021) and ten items assessing perceptions of CBL, including learning, engagement, problem-solving transfer and confidence. Responses were collected using a five-point agreement scale and analysed using descriptive statistics and Cronbach's alpha. Programming resilience was also compared with an independent 2024 physical mobile-robot cohort (n = 97) using Welch's t-test and Hedges' g. As the anonymous cohorts were unmatched and participated in different years, the comparison indicates educational potential but does not establish causation or superiority.

Table 1: Evaluation evidence for the improved CAP approach.

EVALUATION INDICATOR	RESULT	EVIDENCE OF TEACHING AND LEARNING IMPACT
Programming resilience	M = 4.20, SD = 0.68; α = .964	Students reported strong persistence, perceived value and adaptive beliefs during programming tasks.
Positive CBL perceptions (Q1–Q9)	M = 4.18, SD = 0.70; 78.8% positive responses; α = .974	SpeedTrials2D was positively perceived as supporting learning, engagement, knowledge transfer and confidence.
Problem-solving and knowledge transfer	M = 4.22; 80.8% positive responses	Strongest outcome, indicating perceived application of RTSE knowledge beyond competition performance.
Learning speed and depth	M = 4.17; 79.0% positive responses	Students perceived that the learning activities supported efficient and deeper understanding.
Interest and active engagement	M = 4.17; 77.2% positive responses	Gamified challenges and visible progress encouraged active participation.
Learning confidence	M = 4.14; 76.9% positive responses	Students reported greater confidence in completing RTSE learning activities.

The 2026 findings showed positive student responses. As presented in Table 1, programming resilience recorded a mean of 4.20/5 (SD = 0.68), while positive CBL perceptions averaged 4.18 (SD = 0.70), with 78.8% positive responses. Problem-solving and knowledge transfer achieved the highest result (M = 4.22; 80.8% positive responses). Students also reported positive perceptions of learning, engagement and confidence, suggesting that SpeedTrials2D supported collaborative programming and the application of real-time software engineering knowledge. Programming resilience was high in both the 2024 physical CBL cohort (M = 4.13) and the 2026 online CBL cohort (M = 4.20). The difference was not statistically significant (p = .492, Hedges' g = .09), indicating similar self-reported resilience levels across the two

cohorts. However, the findings remain limited by their self-reported nature and the non-equivalent cohort design.

Impact

SpeedTrials2D provides students with accessible and repeatable opportunities to practise real-time programming, collaborate with peers, receive immediate feedback and strengthen problem-solving resilience. Educators benefit from a structured CAP process with consistent challenges and clear evidence of individual and team performance. Institutions gain a scalable online approach that reduces dependence on specialised hardware, laboratories and equipment maintenance. The improved CAP model can also be adapted by technical mentors and curriculum designers for different courses and learning contexts, supporting wider adoption and long-term sustainability.

Recommendations for Classroom Practice

Competition results should contribute only a limited portion of the grade, while GitHub records, individual videos, technical explanations and reflections should be used to assess individual learning and team accountability. Rehearsal sessions, simulator checks and flexible participation arrangements can reduce device, connectivity and scheduling barriers. The improved CAP approach can be adapted to different subjects and learner levels by changing the scenarios, technologies, rules and assessment criteria. Reusable templates and facilitator guidelines can support replication and sustainability, while physical-robot validation may be added where facilities are available.

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ID 77: AI Storybook: From AI Literacy to Creative Teaching Practice

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Highlights: AI Storybook: From AI Literacy to Creative Teaching Practice introduces HATCH-AI, a structured Human-AI Synergy process that guides pre-school educators in developing AI-assisted digital storybooks. HATCH-AI phases, educators collaborate with AI while maintaining creative, educational and ethical judgement. The overall programme score increased by 16.12%, with AI competency showing the highest improvement at 27.91%. The developed storybooks achieved an overall quality agreement rate of 79.52%, with Age Safety rated highest at 84.40%. HATCH-AI transforms AI literacy into creative and educationally relevant teaching practice.

Keywords: Human-AI synergy; AI-enhanced teaching; Creative pedagogy; Ethical AI; Digital storytelling

Introduction

The rapid evolution of artificial intelligence (AI) is catalyzing transformations in educational ecosystems, particularly reshaping learning experiences within early childhood education (Durrani et al., 2024). Preschool educators increasingly need the skills to integrate AI into teaching and learning (Yafie et al., 2024). However, some educators still have limited understanding of how AI can be applied in teaching (Anggraini, 2025). Generative AI offers opportunities to support the development of creative and flexible learning materials (Ağmaz, 2023). Therefore, the AI Storybook Workshop was developed to help preschool educators use AI to generate story ideas and create digital storybooks using Canva AI.

Objectives

- To develop a structured process for AI-assisted digital storybook creation.
- To assess the effectiveness of AI-assisted digital storybook development in enhancing AI capabilities.
- To evaluate the quality and educational usefulness of the AI-generated storybooks.

NALI Approach

Novelty

Introduces a Human–AI Storybook Development Model where AI supports idea and content generation, while educators evaluate and adapt the content based on learning objectives, cultural relevance, and pre-school children's safety.

Creativity

Applies AI prompt-writing techniques that enable educators to transform simple ideas into creative, engaging, and visually appealing digital storybooks for pre-school children.

Innovativeness

Transforms AI literacy into creative teaching practice by enabling educators to develop adaptable, educationally useful, and ethically informed digital teaching resources.

Applicability

The model can be adapted and replicated by other preschool educators to develop digital storybooks for different learning objectives, themes, and classroom contexts.

Innovation Description, Process and Implementation

Innovation

Applies a Human-AI Synergy approach where educators and generative AI work collaboratively to develop AI-assisted digital storybooks for pre-school learning. AI supports content generation, while educators provide creative, educational, cultural, and ethical judgement.

Tools and Learning Activities
Canva AI is used for prompt-based text and illustration generation. Educators receive hands-on training in generative AI, prompt-writing techniques, story development, visual generation, and ethical AI use before developing a complete digital storybook.

Process Workflow

Phase 1: Human Ideation (H)
Educators define the learning objectives, target age group, story theme, characters, setting, moral values, and cultural context.

Phase 2: AI Co-Creation (A)
Educators use prompts to collaborate with AI in generating storylines, text, characters, illustrations, and page layouts. This reflects the practical Canva AI activities described in your programme.

Phase 3: Thoughtful Evaluation (T)
Educators critically assess the AI-generated content for accuracy, clarity, readability, age appropriateness, cultural sensitivity, ethics, and educational suitability.

Phase 4: Collaborative Refinement (C)
Educators revise prompts, regenerate unsuitable content, edit text and illustrations, and improve the storybook until it meets the intended educational requirements.

Phase 5: Human Validation & Application (H)
Educators finalise the storybook, validate its suitability as a teaching resource, and prepare it for use in pre-school learning contexts. The completed storybooks are then assessed for qualities such as clarity, language, creativity, learning support, age safety, ethics, moral values, and relevance.

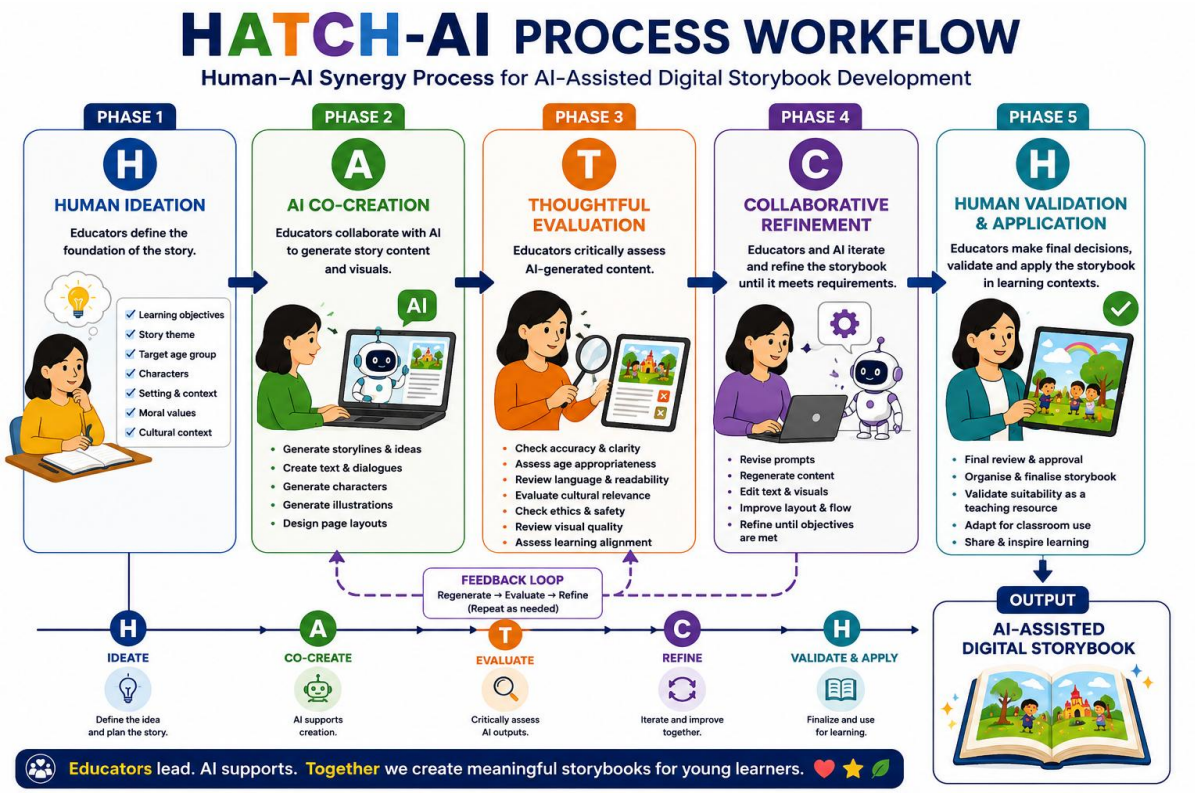


Figure 1: AI storybook process workflow.

Implementation Strategy

- Conducting hands-on Canva AI workshops covering prompt-writing techniques, text and illustration generation, and ethical AI use.
- Applying the Human-AI Synergy model to develop AI-assisted digital storybooks.
- Conducting pre- and post-assessments to evaluate changes in educators' AI competency, creativity, and ethical AI use.
- Evaluating the completed storybooks for their quality and educational usefulness.

Key Findings

A one-group pre- and post-assessment design was used to examine changes in educators' AI competency, creativity, ethical AI use, and other related constructs. The pre-assessment was administered before the programme to establish participants' baseline levels of perception, competency, creativity, ethics and trustworthiness, professional relevance, and technology sustainability. The same constructs were assessed after the programme to identify changes following the intervention. In addition, a separate survey was administered to parents and AI experts to evaluate the quality and educational usefulness of the AI-assisted digital storybooks developed using Canva AI.

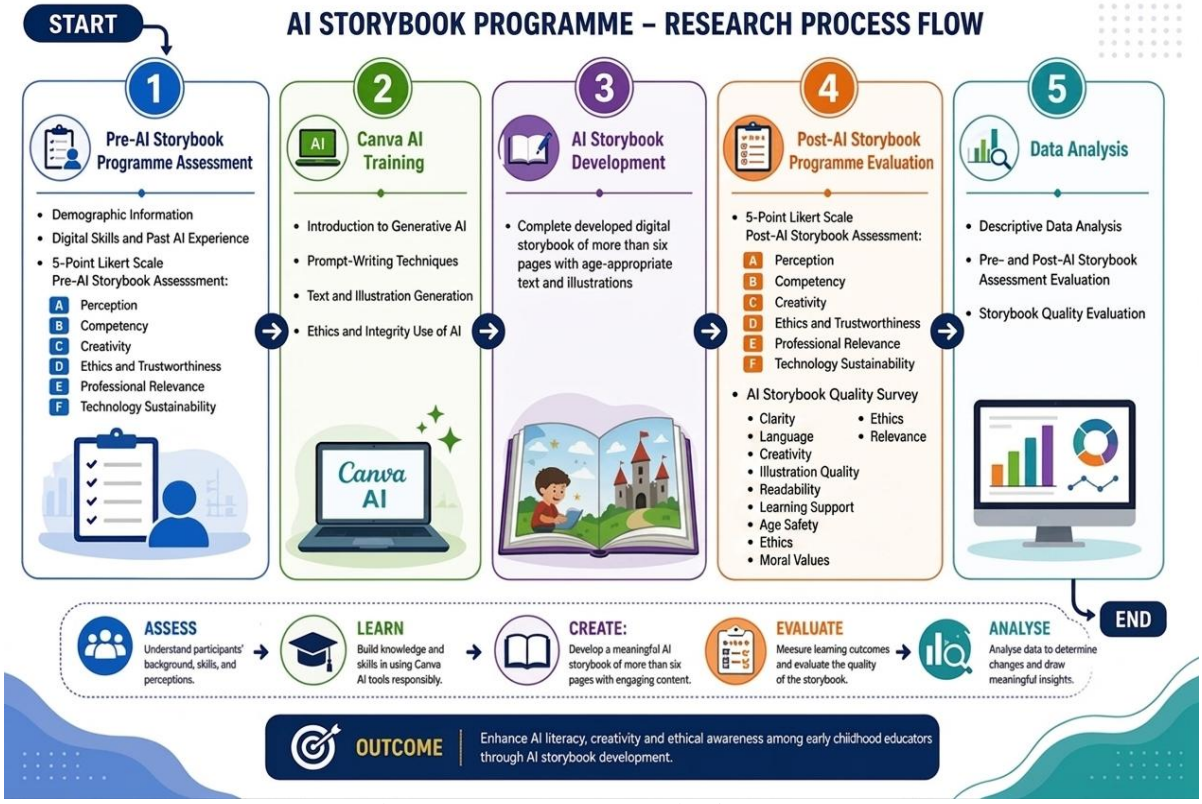


Figure 2: AI Storybook evaluation flowchart.

Quantitative Impact

Number of participants: The study involved 44 participants, comprising 31 pre-school educators who completed the pre- and post-assessments, and 13 parents and AI experts who participated in the AI Storybook Quality Evaluation.

The overall programme score increased by 16.12%. The largest improvement was recorded for AI competency (27.91%), followed by ethics and trustworthiness (20.47%) and creativity (14.46%). The storybooks also received positive evaluations, particularly for age safety (84.40%), language suitability (81.54%), learning support (80.22%) and creativity (80.22%).

Table 1: Quantitative evaluation of AI Storybook programme.

CONSTRUCT	MEAN SCORE		PERCENTAGE INCREASE (%)
	PRE - AI STORYBOOK ASSESSMENT	POST - AI STORYBOOK ASSESSMENT	
Perception	3.83	4.26	11.11
Competency	3.21	4.11	27.91
Creativity	3.75	4.29	14.46
Ethics and Trustworthiness	3.47	4.18	20.47
Professional Relevance	3.74	4.18	11.64
Technology Sustainability	3.63	4.11	13.14
Overall Programme	3.61	4.19	16.12

Table 2: Quantitative evaluation of AI storybook quality.

CONSTRUCT	MEAN SCORE (/5)	AGREEMENT RATE (%)
Clarity	4.02	80.44
Language	4.08	81.54
Creativity	4.01	80.22
Illustration Quality	3.95	78.90
Readability	3.70	74.07
Learning Support	4.01	80.22
Age Safety	4.22	84.40
Ethics	4.01	80.22
Moral Values	3.95	78.90
Relevance	3.81	76.26
Overall Quality	3.98	79.52

Impact

- For Students: Provide engaging and age-appropriate digital storybooks with the potential to support reading, vocabulary development and moral learning.
- For Educators: Strengthen AI competency, creativity and ethical AI use in developing relevant and engaging teaching resources.
- For Institutions: Support pre-school goals by expanding access to high-quality learning materials and improving educator digital competency.

Recommendations for Classroom Practice

Educators can use the Human–AI Storybook Development Model to create storybooks for different learning needs and themes. AI helps generate ideas, text and illustrations, while educators review the content to ensure it is suitable, safe and relevant for children.

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ID 78: Ethics as Lifelong Learning in Teaching Advanced Geotechnical Analysis and Design Course

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Highlights: To address the pedagogical gap between academic ethics instruction and complex real-world practice, this study evaluates an innovative co-taught symposium framework in an Advanced Geotechnical Analysis and Design course at Universiti Teknologi Malaysia. Replacing traditional lecturing, academic faculty co-taught with senior professional engineers to deliver guided, authentic case studies, interactive Q&A sessions, and ethical parameter evaluations across five semesters. Longitudinal performance data showed a steady increase in student achievement, reaching up to 80% in ethical course learning outcomes. Student feedback confirmed enhanced cognitive understanding, heightened social responsibility, and a commitment to lifelong ethical inquiry in civil engineering practice.

Keywords: Team-pair teaching; Engineering industry experts; Guided ethics in lifelong learning

Introduction

A key pedagogical hurdle in fostering an ethically responsible mindset among engineering students is helping them realize that they bear an ethical obligation to begin with (Kopec et al., 2023). Furthermore, engineering education frequently struggles to clearly differentiate between the individual and collective dimensions of professional practice (Franssen et al., 2018). Hence, integrating ethics throughout engineering education requires shifting away from rigid, single-answer calculations toward open-ended inquiry. As Professor Ibo van de Poel highlights, learning to ask critical questions is often more important than finding a single correct answer (Smuga-Fries, 2014). While early college coursework teaches sequential problem-solving, senior-level engineering challenges rarely have fixed endpoints, placing responsibility on students to define reasonable parameters. Scholars writing in Teaching Ethics emphasize that curriculum design must address the moral responsibilities of engineers by moving beyond technical compliance (Zhu et al., 2024). By evaluating designs through broader systemic lenses—questioning whether a project is genuinely needed, how construction impacts local populations spatially, or whether long-term monitoring is required—students learn that ethical training deepens their understanding of a product's full life cycle. Take an example in the civil engineering field, a foundation of building must be built continuously across the curriculum, starting with small-scale discussions in foundational courses like physics and expanding into project-based environments where students can actively experiment with real-world decision-making. Exposing students to diverse cultural and historical perspectives equips them with adaptable analytical frameworks—much like understanding diversion ground behavior following site conditions —allowing them to treat ethics not as a rigid rulebook, but as a core design tool for navigating engineering's profound impact on humanity.

Recent research highlights a persistent gap between academic ethics instruction and the actual social, technical, and industry dilemmas practitioners face on the job (Van Grunsven et al., 2024; Hsu et al., 2025). To bridge this disconnect, our courses intentionally pair academic faculty with industry players for co-teaching and team teaching every single semester. Bringing active industry professionals directly into the classroom exposes students to real-time, evolving industry challenges—such as emerging technologies, environmental accountability, and complex stakeholder trade-offs—that cannot be captured by static textbooks alone. This collaborative pedagogical model demonstrates that ethical reasoning is not a temporary academic requirement to be completed upon graduation, but an ongoing, reflective practice that must adapt throughout an engineer's career—enhancing engineering ethics as a continuous, lifelong learning process.

Objectives

The objectives of the study is to evaluate the effectiveness of team-teaching approach with industry players via co-taught symposium approach with a guided case study exposure on acknowledging the ethics in engineering as a lifelong learning for Civil Engineering students of Universiti Teknologi Malaysia that enrolled in the Advanced Geotechnical Analysis and Design course. The specific objectives are as follows:

- to enhance students' understanding via cognitive level assessment of student in ground

improvement topics that associate to the ethics in engineering
- to measure motivations and social responsibility of students related to ethics in engineering leading to long life learning in preparing the students for working in Civil Engineering field

NALI Approach

Novelty
The distinctive feature is the systematic pairing of academic teaching with senior industry practitioners in a symposium-style learning environment. Ethics is embedded within authentic geotechnical design decisions rather than delivered as an isolated theoretical topic. Students are required to connect technical parameters and safety margins with professional responsibility, societal impact and the need for long-term monitoring.

Creativity
The learning design combines conceptual teaching, blended exploration, authentic case-study exposure, student design presentations and structured panel questioning. Cases include hillside slope failures, urban deep-excavation risks and ground-improvement experience in tropical conditions. This creates a learning setting in which students defend engineering choices while simultaneously examining ethical dilemmas such as community impact, spatial justice and environmental degradation.

Innovativeness
The approach improves the previous lecture-dominated delivery by introducing repeated interaction with experienced Professional Engineers/Professional Engineers with Practising Certificate (PE/PEPC), guided inquiry and reflective decision-making. Industry contributors have at least 10 years of relevant field experience and exposure to major infrastructure, regulatory compliance, ground improvement, slope stability and/or tunnelling projects.

Applicability
The model can be adapted to other civil engineering subjects that involve open-ended design, risk, safety and stakeholder decisions. Its core components—academic preparation, expert case sharing, guided questioning, student justification and reflection—can be replicated using different discipline-specific cases and can be delivered face-to-face, blended or online according to institutional needs.

Innovation of Team-Teaching Approach with Industry Expert via Co-taught Symposium and A Guided Case Study Exposure

Initially, the content of the Advance Geotechnical Analyses and Design was delivered using a traditional method which is one way lecturing. However, as the university is demanded to produce graduates that have excellent and diverse skills in generic and higher-order thinking aspects, the assessment of the students' performance for this course was upgraded. But the students showed low achievement as the assessment was changed, which indicates the necessity to improve the teaching and learning method to be aligned with the assessment. Therefore, the team-teaching approach with industry players via co-taught symposium approach with a guided case study exposure was introduced in the course with the intention to improve the students' understanding on ethics. Table 1 presents the associate course learning outcomes and the programme learning outcomes that associate with the ethics. Even though the topic highlighted for the ethics is solving the earth retaining problem, the approach taken in the class was not limited to the specific topic, as the earth retaining itself can be associated with various topics such as ground improvement, retaining wall at hilly slope,earthdam, reinforcement in trench in tunneling and so on.

Table 1: Course learning outcomes and programme learning outcomes of advance geotechnical analysis and design course associate with ethics for long life learning.

NO.	COURSE LEARNING OUTCOME
CLO4	Demonstrate comprehensive ethical practices and responsibility to the society with high values and professionalism in solving earth retaining problem
PLO4 OR PLO11	Ethics and professionalism skills

The implementation of this co-taught symposium activities was carried out among first year master civil engineering students who enrolled in the Advanced Geotechnical Analyses and Design course for five (5) different semesters. Note that this course was offered at alternate semesters, hence the data collected are presented in alternate offered semesters in Figure 1. For the first and second semesters (semester 2 of 20192020 and semester 2 of 2020/2021), the teaching and learning approach used in the class is mainly lecturing, while, for 3 other semesters, the co-taught symposium with industry players approach is used in

the class. The performance of the students was compared and analyzed based on the teaching and learning approach used in the class. Note that, semester 2 of 2021/2022 is a fully online class due to COVID'19 pandemic.

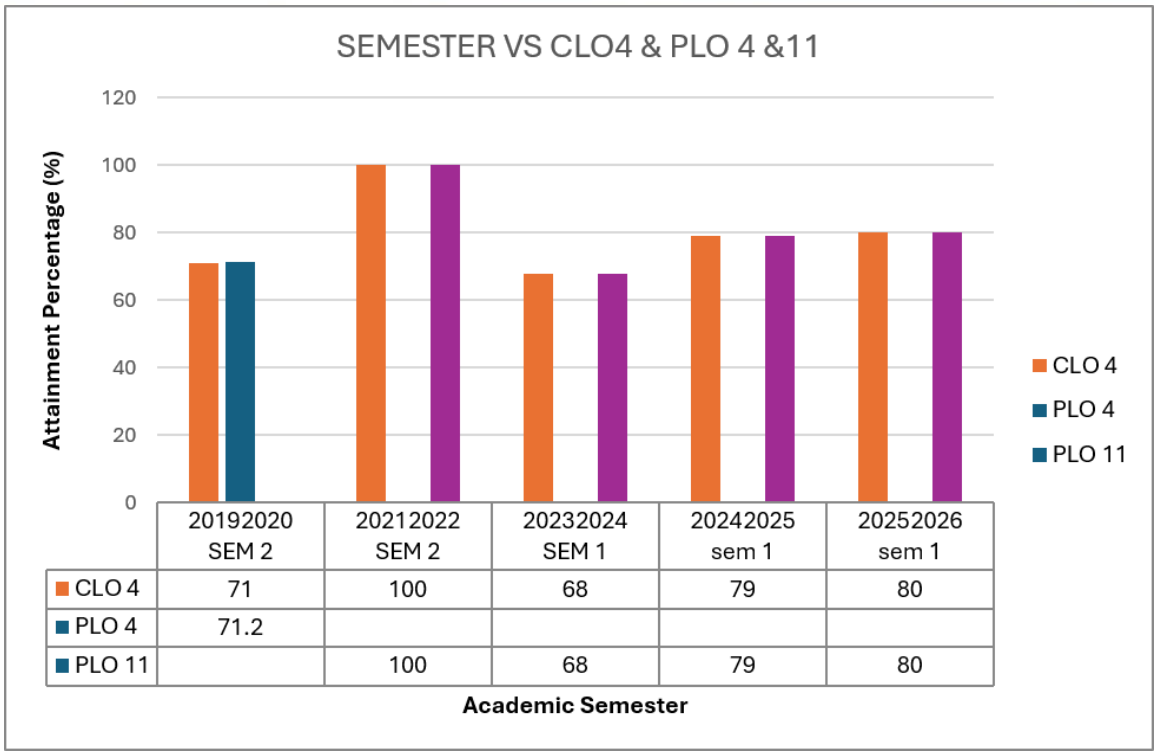
In specific, two main activities involved in the approach, i) industry partner criteria and ii) having symposium-style delivery with guided case studies exposure to enhance the ethics understanding in classes. In order to ensure high pedagogical quality, the industry players are selected based on strict professional criteria. The team teaching is a Senior Geotechnical Engineer with Professional Engineers (PE / PEPC) with a minimum of 10 years of field experience in geotechnical engineering, heavy infrastructure, or environmental remediation. They also has vast experiences and active involvement in high-stakes public infrastructure projects and regulatory compliance which covers vast case study from the ground improvement to the slope stability and/or tunnelling experience.

For the execution, the traditional lecture format is replaced with an interactive, co-taught symposium format held during the semester. The sessions with the industry players were usually planned at the third and fourth week and sometimes at the tenth of eleven weeks based on the several topics associated, in line with the assigned project tasks. During the session, a series of conceptual design and analyses was first delivered by the lecturer, followed with a blended learning approach for students to explore the topics and then continued with a series of guided case study exposure via the symposium from the industry partners. Industry partners introduce authentic, un-sanitized project case studies—such as hillside development slope failures, urban deep-excavation risks, and ground improvement experience in tropical countries. Students are guided to analyze technical stability alongside non-technical ethical dilemmas, including community displacement, spatial justice during construction, and long-term environmental degradation. Rather than receiving passive solutions, students present their preliminary design parameters to the academic-industry teaching team during symposium panel sessions. Industry experts push students through structured Q&A sessions to justify their design choices, questioning whether safety margins adequately protect surrounding populations and if long-term monitoring systems are ethically required.

Through this practical immersion, students move beyond formulaic calculations to grasp the individual and collective responsibilities of engineering practice—transforming ethics from an abstract academic concept into an active, professional lifelong skill.

Key Findings

Figure 1 shows the percentage of students achieving marks exceeding 65% in Advance Geotechnical Design and Analyses course for course learning outcomes 4 (CLO4) that are associated with PLO4 and/PLO11 of ethics for 5 different semesters. The figure indicates a moderate achievement of 71% of CLO4 and 71.2% of PLO4 in semester 2 of 2019/2022 which was conducted in the traditional T&L approach. Next, the semester 2 for 2021/2022 is a fully online class approach conducted in synchronous and asynchronous classes with limited active learning approach that depicts highest achievement in CLO and PLO4 with 100%, respectively. Then the following semester of Semester 1 of 2023/2024 showed a slight decrease in CLO4 and PLO4 with 68% as this is the first semester of co-taught symposium approach on ethics. Two consecutive semesters in Semester of 2024/2025 and Semester 1 of 2025/2026 show steady increment in the achievement with 79 to 80% indicating the development and implementation of the approach is stable and students start to gain the understanding better.



	20192020 SEM 2	20212022 SEM 2	20232024 SEM 1	20242025 sem 1	20252026 sem 1
CLO 4	71	100	68	79	80
PLO 4	71.2				
PLO 11		100	68	79	80

Figure 1: Average percentage achieved marks for course learning outcomes 4 (CLO4) associate with program learning outcomes 4 or 11 (ethics) in advance geotechnical analyses and design course throughout the offered semester.

Significant improvement of students' performance can be seen from Figure 1 especially in the last two semesters of Semester 1 of 2024/2025 and 2025/2026. In measuring the cognitive, motivation and social responsibility of students from the T&L approach on ethics as part of lifelong learning, a set of questionnaire surveys has been conducted. Pre and post surveys in five Likert scales have been asked to measure the effectiveness of the approach. Student reflection then gathered for continuous future improvements. One of the questions highlights whether the knowledge-sharing sessions with the external industry experts enhanced their understanding of current geotechnical engineering practices or not. The students respond that from these activities, the sharing from industry on the practical experiences and cutting-edge technologies has opened their perspectives beyond the textbooks and class assignment. From this T&L approach also, encourage them to continuously update their professional knowledge and competencies. One of the students mentions that he now knows the need of questioning more, reading more and evaluating resources before making any engineering decisions. Hence, from this feedback, one can summarize that from the innovative T&L approach, students are guided to think out of the box, to check for the ethical decisions and to practice these as part of long-life learning.

Impact

For students, the innovation links geotechnical calculations with the consequences of professional decisions, supporting cognitive learning, ethical awareness, social responsibility and self-directed professional development. For educators, the academic–industry format expands the range of authentic cases available for discussion and enables questioning that cannot be reproduced through static lecture material alone. At programme level, the approach provides direct support for ethics and professionalism outcomes through observable design justification, discussion and reflection. Its longer-term contribution is the development of graduates who view ethical inquiry and knowledge updating as continuing responsibilities throughout engineering practice.

Recommendations for Classroom Practice

Educators adopting the approach should select industry partners with substantial current professional experience, align case studies with course projects, brief experts on the intended CLO/PLO and ethical focus, and use structured questions that require students to justify both technical and societal consequences. Sessions should be positioned after students have sufficient conceptual preparation but before final project decisions. Short pre/post surveys and reflections can be retained to support

continuous improvement. For stronger future evaluation, consistent survey instruments and comparable semester-level measures should be maintained across implementations.

The innovative learning approach by pairing the class T&L method with industry player experiences herein show significant impact to improve the students' performance in cognitive, motivation and social responsibility especially in ethics for lifelong learning in Advance Geotechnical Design and Analysis course. Integration of problem-based learning, independent inquiry, reflection and industry-academic knowledge sharing motivates students to become self-directed, reflective and future-ready geotechnical engineers committed to continuous professional growth.

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ID 79: StudyPal: Human–AI Synergy for Adaptive Mastery-Based Learning in Higher Education

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Highlights: StudyPal reimagines conventional score-based, end-point learning-outcome monitoring as a human-supervised mastery ecosystem that reveals learning gaps, progression and intervention priorities. Five-year attainment data from 1,391 Programming Technique II students showed all four monitored CLO/PLO measures below 70% in Semester II, Session 2025/2026. Its prototype orchestrates specialised AI agents for personalised guidance, assessment, remediation, and mastery checks. Student and Mentor Dashboards enable transparent Human–AI collaboration, while educators retain academic authority. Preliminary pilot feedback indicated early perceived value: 93% satisfaction, with 79% identifying Assessment/Quiz as the most useful feature. Unlike one-size-fits-all platforms, StudyPal unites adaptive support, educator-governed evidence, and timely intervention.

Keywords: Mastery-based Learning; Multi-agent AI; Adaptive learning; Learning analytics; Human–AI synergy

Introduction

Digital learning has widened access, yet progression is often represented through completed activities and end-point scores rather than demonstrated mastery. Assessment may identify weaknesses without ensuring remediation, while large cohorts constrain individualised support. Adaptive learning, AI-supported assessment and personalised tutoring address parts of this problem but frequently operate as separate functions rather than a continuous mastery-learning process (Liu et al., 2024; Ma, 2025; Wang et al., 2023). The need is reflected in five-year data from 1,391 Programming Technique II students, with all four monitored CLO/PLO measures below the 70% benchmark in Semester II, Session 2025/2026. StudyPal addresses this gap through a human-supervised, multi-agent ecosystem connecting personalised guidance, assessment, remediation and mastery verification. Its Student and Mentor Dashboards reveal learning gaps, progression and intervention priorities, while educators retain authority over outcomes, thresholds and academic decisions. Consistent with pedagogically grounded, role-adaptive AI (Banh et al., 2026; Liao, 2026), StudyPal combines scalable personalisation with learner agency, educator oversight and academic accountability

Objectives

- To develop a human-supervised, multi-agent AI learning environment for adaptive sequencing, continuous learning-outcome knowledge tracing, personalised mentoring and adaptive reassessment.
- To implement a closed-loop mastery-learning cycle in which diagnosed learning gaps lead to targeted practice, remediation, reassessment and evidence-based progression.
- To evaluate StudyPal among undergraduate learners based on mastery progression, engagement, satisfaction and perceived usefulness, including its value in supporting lecturer intervention.

NALI Approach

Novelty

StudyPal's novelty lies not in generative AI alone, but in transforming AI-supported learning into a human-supervised mastery-decision ecosystem. Unlike conventional learning management systems that primarily organise content and record completion, or general-purpose chatbots that respond only when prompted, StudyPal continuously connects learner evidence with personalised support, assessment, remediation and progression. Specialised AI agents contribute distinct pedagogical functions, while educators govern learning outcomes, mastery thresholds and academic decisions. The 2026 version extends the StudyPal entry recognised at NALI 2025 through continuous learning-outcome knowledge tracing, configurable mastery thresholds, Student and Mentor Dashboards, and an explicit Human–AI decision loop.

Creativity
StudyPal creatively integrates mastery learning, Bloom's Taxonomy, generative AI and learning analytics into a connected pedagogical journey. Instead of relying on one chatbot, specialised AI agents work together to diagnose learning gaps, recommend appropriate resources, generate targeted practice, support reassessment and interpret mastery evidence. Its dual-dashboard design presents the evidence from two complementary perspectives: students see their progress, learning gaps and next actions, while educators see intervention priorities. This arrangement positions AI as an adaptive pedagogical partner without transferring academic authority away from educators.

Innovativeness
StudyPal improves conventional digital learning in three interconnected ways. First, assessment becomes part of a closed-loop mastery-learning cycle: evidence of non-mastery initiates targeted support and reassessment rather than remaining an end-point score. Second, AI support is activated by diagnosed learning needs instead of depending solely on student-initiated prompts. Third, continuous learning-outcome knowledge tracing connects personalised learning with curriculum expectations and timely educator intervention. StudyPal therefore functions as educator-governed, AI-enabled pedagogical infrastructure for mastery-oriented decisions—not merely as a chatbot, content platform or automated assessment tool.

Applicability
StudyPal is designed for adaptation beyond Programming Technique II to other outcome-driven courses and educational settings. Educators can configure learning outcomes, prerequisite relationships, Bloom's Taxonomy levels, mastery thresholds, assessment activities and curated resources without redesigning the underlying AI workflow. Its modular structure can complement institutional learning management systems and is particularly relevant to large cohorts where sustained individualised monitoring is difficult to provide manually. Reusable course configurations, role-based dashboards, educator governance and evidence-informed refinement support replication, scalability and long-term sustainability.

Innovation Description, Process and Implementation

StudyPal is a functional, human-supervised, multi-agent AI platform designed to transform activity-based digital learning into adaptive mastery-based progression. It integrates a Student Dashboard, Mentor Dashboard and Learner Cognitive Model with five specialised agents: Assessment, Learning Path, Adaptive Mentor, Progress Monitoring and Regenerative Assessment to coordinate personalised guidance, learning activities, assessment, remediation and mastery verification. Educators configure the learning outcomes, Bloom's Taxonomy levels, resources, assessment expectations and mastery thresholds, while retaining authority over interventions, progression and academic decisions.

Figure 1 show StudyPal employs a closed-loop Human–AI methodology in which educator-defined learning outcomes, resources, assessment expectations and mastery thresholds guide the learning process. Student interactions generate evidence that updates the Learner Cognitive Model, enabling specialised AI agents to diagnose gaps and coordinate personalised support, assessment and remediation. Reassessment determines whether further support or progression is recommended, while Student and Mentor Dashboards make mastery evidence and intervention priorities visible; enables scalable personalisation while preserving educator oversight, transparency and academic accountability.

Table 1 summarises StudyPal's evidence-informed development pathway, from identifying the educational need through five-year attainment data to designing and testing its Human–AI learning environment. The functional prototype was subsequently implemented in an authentic undergraduate course, with implementation observations and preliminary student feedback informing further technical and pedagogical refinement.

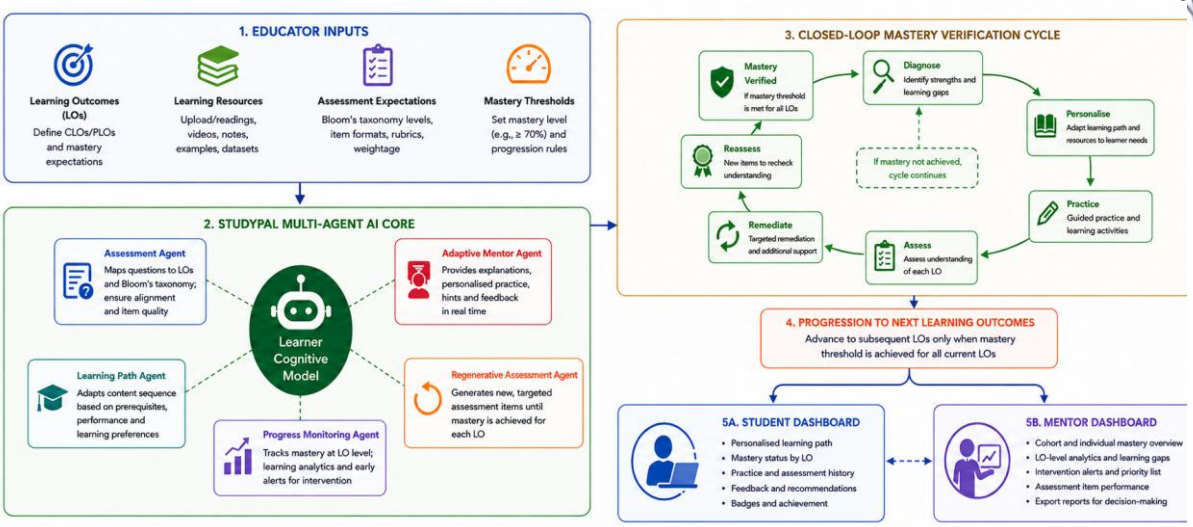


Figure 1: StudyPal Human–AI closed-loop mastery-learning architecture integrating educator inputs, coordinated multi-agent support, continuous learner modelling, targeted remediation and educator-reviewed mastery decisions.

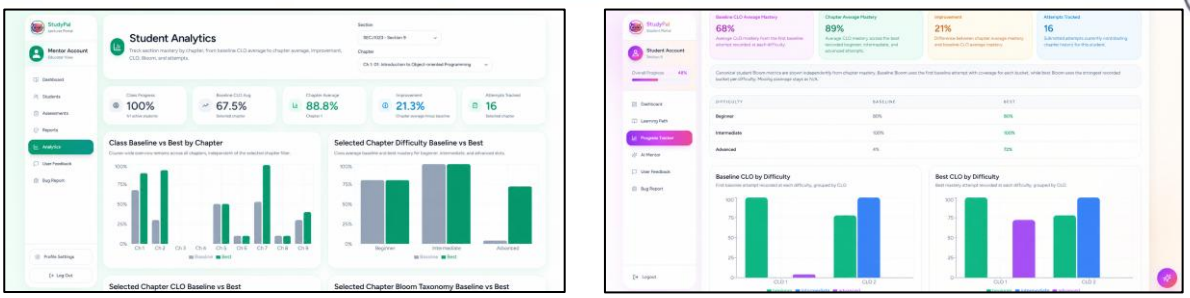
Table 1: StudyPal design, development and implementation pathway.

STAGE	EVIDENCE AND IMPLEMENTATION
Problem identification	Five-year CLO/PLO records involving 1,391 Programming Technique II students were analysed to establish the educational need.
Human–AI design	Mastery progression and Bloom-aligned assessment were integrated with five specialised AI agents under educator governance.
Prototype development	The Learner Cognitive Model, role-based dashboards, learning pathways, AI mentoring and assessments were integrated and tested.
Authentic implementation	StudyPal was introduced as supplementary support in Programming Technique II during Semester II, Session 2025/2026.
Evaluation and refinement	Implementation observations and feedback from 14 student respondents informed usability assessment and iterative refinement.

Key Findings

Across five years, attainment records from 1,391 Programming Technique II students showed that CLO1 (69.50%), CLO2 (65.88%), PLO1 (69.55%) and PLO2 (65.94%) were all below the 70% benchmark in Semester II, Session 2025/2026. In response, a functional StudyPal prototype was implemented in an authentic undergraduate course with progressive learning pathways, AI mentoring, adaptive assessment, attempt reporting, mastery tracking and role-based dashboards. The implementation demonstrated the technical integration of specialised AI agents, the Learner Cognitive Model and educator-governed mastery thresholds within a continuous learning cycle. Figure 2 shows how learner evidence is translated into visible progression, learning gaps and educator-intervention priorities.

Preliminary feedback was obtained from 14 voluntary student respondents. Thirteen (92.9%) were satisfied or very satisfied, producing a mean score of 4.21/5, while 11 (78.6%) identified Assessment/Quiz as the most useful feature. This preference suggests that students particularly valued functions connecting assessment with immediate learning support rather than content access alone. Qualitative responses highlighted immediate explanations, assessment preparation and clearer learning guidance. Together, these findings provide early evidence of functional feasibility, perceived usability and student value, while supporting the relevance of StudyPal's assessment-centred mastery approach. Nevertheless, the small, self-selected sample does not establish causal improvement in mastery or retention. Wider evaluation across larger cohorts and additional learning contexts remains necessary to determine learning effectiveness and sustained adoption.



(a) (b)

Figure 2: Studypal role-based dashboards using illustrative prototype data: (a) mentor dashboard for cohort analytics and intervention priorities; and (b) student dashboard for mastery progression and learning support.

Impact

StudyPal empowers students to recognise learning gaps, receive targeted support and demonstrate mastery through transparent opportunities for remediation and reassessment. It amplifies educators' capacity by transforming learner evidence into timely intervention priorities while preserving human academic judgement. At the institutional level, its outcome-level analytics can strengthen curriculum monitoring, quality assurance and evidence-informed continuous improvement. In the longer term, StudyPal offers a scalable model of Human–AI synergy that redirects educational AI from generating answers towards enabling accountable mastery-based learning.

Recommendations for Classroom Practice

For classroom practice, educators should begin with essential learning outcomes by defining prerequisites, curated resources, assessments aligned with Bloom's Taxonomy and appropriate mastery thresholds. Dashboard analytics should guide lecturer review, while recurring gaps, remediation patterns and student feedback should inform refinement before wider adoption.

Other relevant information

StudyPal received Silver Awards at NALI 2025 and DIGITEX 2026, and a Gold Award at I-TIEC 2026, demonstrating growing external recognition. Its latest functional multi-agent prototype has a copyright application submitted and is subject to wider classroom validation.

Acknowledgement

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ID 80: CHEER-Ai: Reimagining Chemistry through Intelligence and Values

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Highlights: CHEER-Ai integrates information literacy, AI tools, chemistry learning, and UTM's ISES values through a structured Search–Evaluate–Verify–Create learning cycle. Students develop skills to search and evaluate information, verify AI-generated content using reliable sources, and create AI-assisted chemistry learning materials. Survey findings from 67 students showed increased positive ratings of information literacy understanding across two cohorts, from 52.9% to 99.2% and from 31.4% to 75.2%. Students also demonstrated critical evaluation, source comparison, and verification of AI-generated scientific content.

Keywords: Artificial Intelligence; Information Literacy; Human-AI Synergy; Chemistry Education; Responsible AI.

Introduction

The rapid integration of artificial intelligence (AI) in education has changed how students search, evaluate, verify, and create information. While AI provides greater access to knowledge, its use also raises concerns related to misinformation, inaccurate sources, over-reliance on AI-generated content, and academic integrity. These challenges highlight the need for students not only to become AI-literate, but also to exercise critical judgement, uphold ethical values, and take responsibility when using AI for learning (Wang et al., 2024). The CHEER-Ai module is developed as an AI-enhanced learning innovation that integrates information literacy, chemistry learning, and value-based education within one structured module. Its novelty lies in combining selected AI tools with a guided learning process that requires students to actively search, evaluate, verify, analyse, and create information, rather than simply accept AI-generated responses. Tools such as Perplexity, Snopes, ChatGPT, Gemini, and NotebookLM are used according to specific learning purposes, allowing students to compare information, validate sources, and produce more informed academic outputs. The module also reflects UTM's ISES values, where synergy through human-AI collaboration, integrity through source verification, excellence through quality outputs and sustainability through a reusable design. Aligned with the NALI Model, CHEER-Ai promotes human-AI synergy by combining the capabilities of AI with students' critical judgement, ethical values, and responsibility in learning. The innovation therefore goes beyond the use of AI tools by providing a structured, value-driven approach that empowers students to become more critical, responsible, and confident users of AI in chemistry learning (M et al., 2025).

Objectives

- To assess students' ability to search, evaluate, verify, analyse, and create information using selected AI tools.
- To evaluate students' teamwork and collaborative application of information literacy and digital skills through a video-based assignment.
- To evaluate students' engagement, confidence, and ability to apply information literacy concepts using AI tools through the creation of an informative videographic story.

NALI Approach

Novelty

CHEER-Ai combines AI literacy, information literacy, chemistry learning, and ISES values within one structured module. Unlike conventional approaches that use AI mainly for information retrieval, content generation, or personalised learning, it develops a complete search-evaluate-verify-analyse-create process supported by complementary AI and fact-checking tools. Its central novelty is the positioning of AI as a learning partner rather than an authority or replacement for human judgement, with integrity, synergy, excellence, and sustainability (ISES) embedded within the learning process.

Creativity

The creativity lies in converting widely available tools into a coherent chemistry learning experience. Platforms are selected by function-exploration, verification, synthesis or creation-and combined in a Search → Evaluate → Verify → Create learning cycle. Embedding honesty, accountability and human judgement at every stage adds a human-centred dimension beyond technical AI skills.

Innovativeness

CHEER-Ai introduces an AI-enhanced pedagogical model that shifts students from passive consumers of AI-generated information to critical evaluators and responsible creators of knowledge. It integrates generative AI, evidence verification, scientific reasoning, ethical decision-making, and creative communication within chemistry education. This balanced methodology operationalises Human-AI Synergy by combining computational capability with human judgement, scientific accountability, and creativity.

Applicability

CHEER-Ai has been adapted in undergraduate chemistry courses with promising potential for replication, scalability, and sustainability because it relies primarily on accessible digital platforms and a transferable pedagogical framework rather than specialised infrastructure. The SearCH → Evaluate → Verify → Create framework can be applied to different chemistry topics and subsequently adapted to other science and STEM disciplines. Individual AI tools can also be replaced as technology evolves without changing the underlying pedagogy. This makes the module suitable for face-to-face, blended, and online learning environments and provides a sustainable framework for developing responsible AI literacy among students.

Innovation Description, Process and Implementation

CHEER-Ai is a teaching innovation that transfers an established Information Literacy assessment module into Natural Product Chemistry to help students apply information-literacy skills within an organic chemistry (Figure 1). The framework integrates AI tools with human judgement through three stages: searCH & Evaluate to search and assess relevant scientific information using tools such as ChatGPT, Perplexity and Scite; vErify to fact-check chemical information and AI-generated responses using reliable scientific sources and Snopes AI; and cReate to transform verified information into engaging learning materials using tools such as Canva AI, Synthesia, Pictory and ElevenLabs. Students remain responsible for evaluating accuracy, evidence, ethics and scientific quality throughout the process.

The implementation follows a simple Search → Evaluate → Verify → Create workflow. Students first identify and search for information related to natural products and organic chemistry, evaluate the credibility and relevance of the sources, and verify chemical facts and AI-generated information through cross-checking with reliable references. Once the information is validated, students use AI-assisted tools to create educational content such as videos or visual materials, followed by peer and instructor review. This approach demonstrates how information-literacy skills can be transferred from a general assessment module into a discipline-specific chemistry subject, promoting critical thinking, scientific communication, responsible AI use, and evidence-based learning.

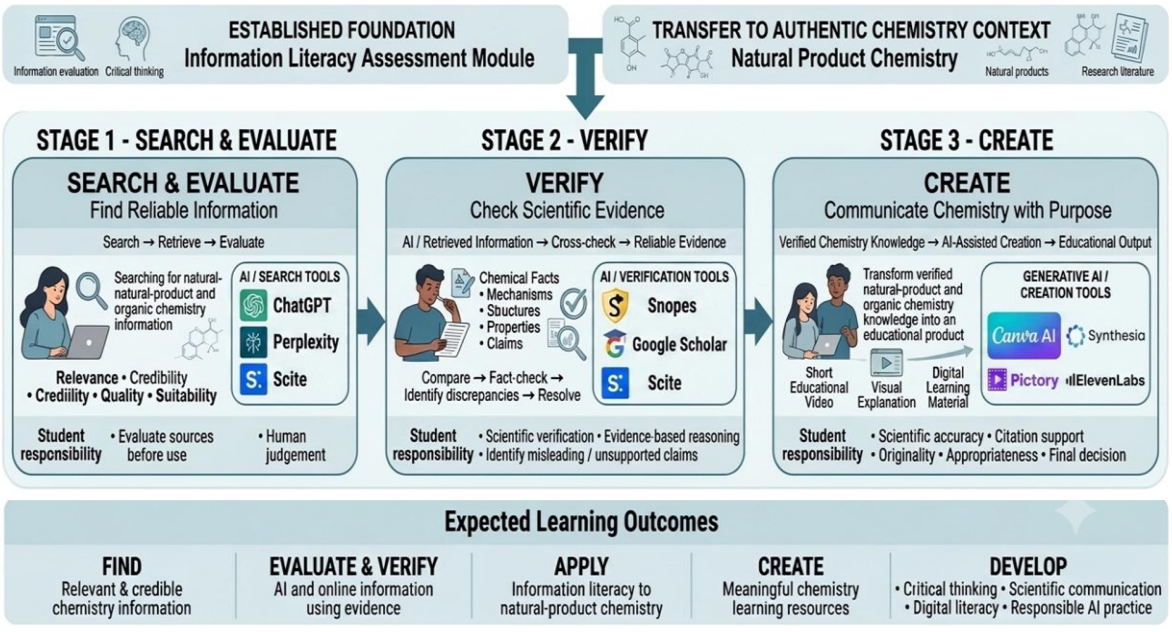


Figure 1: Conceptual model of the CHEER-Ai three-stage learning process (search, verify, create).

Key Findings

The implementation of CHEER-Ai across two undergraduate Chemistry cohorts demonstrated positive changes in information literacy, Chemistry learning, critical evaluation of AI-generated information and student engagement. A total of 67 students participated, comprising 38 students from 1 SSCAH and 29 students from 3 SSCCH. In 1 SSCAH, positive information-literacy ratings (Likert 4-5) rose from 52.9% to 99.2%, and the mean increased from 3.54 to 4.74/5. Category means improved for searching and AI-tool use (3.63 to 4.79), verification and evaluation (3.48 to 4.73), and application to assignments (3.47 to 4.66). The largest gains concerned fact-checking AI output and verifying information with reliable academic sources, indicating improved evaluative practice rather than mere familiarity with generative AI.

In 3 SSCCH, positive Chemistry-learning ratings increased from 31.4% to 75.2%, with the mean score increasing from 3.29 to 4.03/5 (Figure 2a). Improvements were observed in producing Chemistry-related educational content (3.03 to 4.00), organising scientific information (3.28 to 4.10), identifying key concepts for assignments (3.31 to 4.10) and connecting theoretical knowledge with practical applications (3.24 to 4.03). Students also reported strong critical engagement with AI-generated information, with a mean score of 4.21/5 and 81.0% positive responses. In particular, 89.7% agreed that creating AI-assisted content required understanding the Chemistry topic, 86.2% compared AI-generated information with reliable academic sources, and 82.8% checked the accuracy of AI-generated scientific explanations. Engagement and active learning were also positive, with a mean of 4.29/5 and 80.8% positive responses; 86.2% agreed that the activity encouraged active learning and 82.8% reported improved engagement and learning experience (Figure 2b).

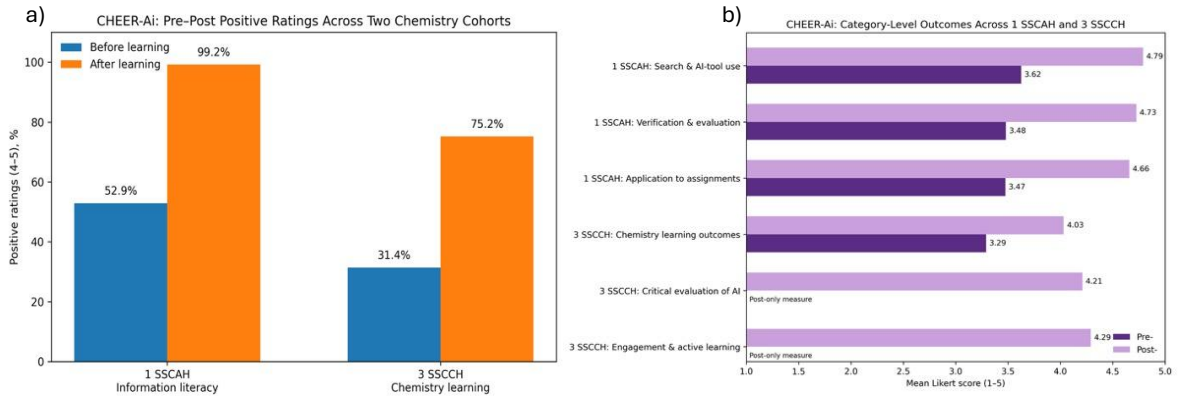


Figure 2: (a) Pre–post positive ratings (Likert 4–5) for information literacy in 1 SSCAH (n = 38) and chemistry learning in 3 SSCCH (n = 29). (b) category-level mean scores across both cohorts; critical evaluation and engagement were assessed post-activity only in 3 SSCCH.

Overall, the two cohorts demonstrate CHEER-Ai's transferability across undergraduate chemistry. The 1 SSCAH findings show improvements in foundational information-literacy and verification skills, while 3 SSCCH demonstrates their application in chemistry learning, scientific communication, critical evaluation, and content creation. CHEER-Ai therefore promotes responsible human–AI collaboration, with students retaining responsibility for evidence, accuracy, and critical judgement. However, as the findings are mainly self-reported, future studies should incorporate objective assessments, assignment rubrics, and evaluations of AI-assisted outputs.

Impact

CHEER-Ai promotes critical thinking and responsible AI use by requiring students to evaluate and verify information before creating digital chemistry content. The process also develops scientific communication and evidence-based learning as students translate validated knowledge into accessible media. At student level, the framework strengthens confidence in selecting sources, detecting unsupported claims, and communicating verified scientific information. For educators, it offers a practical, adaptable approach to AI-supported teaching and assessment while preserving scientific accuracy, academic integrity, and student accountability. At programme level, its reusable, tool-agnostic cycle provides a consistent structure for responsible AI practice while allowing platforms to be updated. This supports face-to-face, blended, and online delivery and adaptation across chemistry and other STEM disciplines.

Recommendations for Classroom Practice

CHEER-Ai can be implemented through the Search → Evaluate → Verify → Create cycle. Students use AI tools to locate information, assess its reliability, verify AI-generated content against credible sources, and create educational materials, followed by peer and instructor review. The framework can be adapted across disciplines, learning objectives, and face-to-face, blended, or online environments. Educators should emphasise critical thinking, academic integrity, responsible AI use, and students' accountability for accuracy. Activities can be adjusted to learners' abilities, while AI tools and verification resources can be updated as technology evolves. This flexibility supports sustainable replication across courses and institutions while strengthening information literacy, scientific communication, and responsible human–AI synergy.

Other relevant information

CHEER-Ai has commercialisation potential as an adaptable information-literacy framework for STEM, the social sciences, humanities and professional development. Possible outputs include training modules, educator workshops, institutional implementation packages and digital learning resources. Its accessible tools, platform-independent pedagogy and updatable design support scalable adoption by educational institutions and training providers while strengthening digital skills, motivation and higher-order thinking.

Acknowledgement

The authors would like to thank Universiti Teknologi Malaysia (UTM) for its support and the students of 1 SSCAH and 3 SSCCH for their participation and feedback, which informed the continuing development of CHEER-Ai.

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ID 81: Constructive Aligned Reflection Assessment (CARA) Instructional Design Framework for Cooperative Problem-Based Learning (CPBL)

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Highlights: Reflection journals are valuable for lifelong learning, but simply asking students to reflect and giving them a rubric does not necessarily develop deep reflection or ensure fair assessment. CARA framework responds to this challenge by integrating constructive alignment, reflection theory, student scaffolding, calibrated assessment, moderation, and phased feedback into one coherent assessment system. This practice impacted on students learning experiences, performance as well as lecturer's assessment practices.

Keywords: Reflection; Constructive alignment; Assessment; Cooperative problem-based learning; Instructional design

Introduction

Reflection is an assessment widely used in engineering education particularly to assess the affective domain outcomes such as professional skills, ethics, sustainability and lifelong learning, etc. However, assessment using reflection is challenging due to the highly subjective. Thus, lack of consistency in marking the assignment across lecturers. Students are unclear about expectations even with guidelines. Reflection journal submission mostly at the end of the semester making the feedback often summative, late, or superficial. The challenge shows the need of structured instructional design and assessment process to support fair and consistent evaluation of students' reflection as well as help students to develop metacognitive reflective thinking throughout the learning process. Thus, this project reports the constructively aligned design, implementation, and evaluation of a structured assessment approach for student reflection journals in an undergraduate engineering course implementing Cooperative Problem Based Learning (CPBL), namely Constructive Aligned Reflection Assessment (CARA) Instructional Design Framework. The students' evidence of learning progression across the semester was also reported to show the effectiveness of assessment design, implementation and grading process towards students learning process.

Objectives

- To develop students' reflective thinking through a theory-informed reflection practice and scaffoldings.
- To enhance lecturer's fairness and consistency in reflection assessment through constructively aligned reflection assessment instructional design framework

Course Overview

Introduction to Engineering and Industrial and Seminar Profession are an integrated courses in first-year Chemical Engineering programme. The course is a foundational programme designed to introduce students to engineering thinking, problem-solving processes, teamwork, and professional skills at the early stage of their undergraduate studies. In the semester under study, the course enrolled a total of 150 students, distributed across five sections.

The course implemented Cooperative Problem-Based Learning (CPBL) as pedagogical framework, structured around a semester-long CPBL project, through which students worked in small cooperative groups to address an open-ended engineering problem situated in an authentic context.

The CPBL project was designed and implemented in three sequential stages across the semester:

- Stage 1 focused on problem familiarization.
- Stage 2 emphasised information gathering, analysis, and interim solution development.
- Stage 3 centred on solution refinement, synthesis, and communication of the proposed engineering solution.

Each stage represented a cooperative problem-based learning cycle where the cycle concluded with an individual reflection journal submission where students need to reflect on both technical and non-

technical aspects of their learning process. The reflection journal required students to critically evaluate their overall learning journey, problem-solving process, teamwork experience, and personal development throughout the CPBL project. Each reflection journal was submitted individually at the end of the respective stage.

NALI Approach in CARA instructional framework

Novelty

The novelty is emphasized on CARA framework itself. The complete instructional design by integrating learning and assessment system rather than treating the reflection journal as an isolated assessment task. CARA applies the principle of constructive alignment to connect the intended learning outcome of developing lifelong learning capability with students' reflective learning experiences, integrating instructional scaffolding, phased assessment, assessor calibration and moderation, and timely feedback within one constructively aligned framework. The framework also has dual emphasis on student reflection literacy and educator assessment literacy. Students are explicitly supported in understanding what constitutes meaningful and deeper reflection, while instructors are trained and calibrated to develop a shared judgement of reflective quality.

Creativity

The creativity of CARA lies in transforming conventional reflection journals into a structured, interactive learning experience. It integrates progressive reflection, instructional scaffolding and timely feedback to develop deeper reflective thinking. Its distinctive feature is the simultaneous development of students' reflection literacy and educators' assessment literacy, supporting lifelong learning through continuous improvement.

Innovativeness

CARA introduces an improvement to conventional reflection journal assessment by shifting the emphasis from assessment of reflection towards assessment for developing reflection. Students therefore undergo repeated cycles of experience, reflection, assessment, feedback and subsequent reflection across the semester. These mechanisms enable CARA to function simultaneously as a learning intervention, an assessment approach and a quality-assurance mechanism for reflective learning.

Applicability

CARA was implemented with 150 first-year Chemical Engineering students across five sections of an Introduction to Engineering course using Cooperative Problem-Based Learning. Although developed within a CPBL environment, the underlying principles of CARA are not dependent on a specific engineering discipline or problem-based learning context. Its modular structure enables educators to adapt the reflective model, prompts, learning activities and disciplinary context while retaining the core CARA principles of constructive alignment, scaffolding, and developmental feedback in other teaching practices or develop other learning outcomes where students are expected to make meaning from their experiences. In the longer term, CARA can provide educators or faculty with a systematic approach for demonstrating and supporting students' development through reflection practices.

CARA Instructional Design and Implementation

As illustrated in Figure 1, CARA comprises five interconnected phases. Phase 1 establishes students' reflection literacy through demonstration-based lecture and guided reflective practice. Phase 2 embeds reflection within authentic learning experiences, where students complete each CPBL project stage before documenting their learning through an individual reflection journal in CPBL's stage 1 problem. Phase 3 focuses on assessment quality assurance through rubric training, blind grading of sample reflections, instructor discussion, consensus building, and rubric refinement to establish shared assessment judgement across sections. Phase 4 transforms assessment results into scaffolding learning activity through phased feedback, including exemplar-based peer assessment, prompt feedback, and general feedback on the first submission. Finally, Phase 5 provides opportunities for students to apply this feedback during subsequent reflection journal submissions with timely individual feedback on second reflection submission, supporting continuous improvement towards deeper reflective writing.

The journal reflection design adopts Gibb's cycle reflective model and level of reflective writing (Chabon & Lee-Wilkerson, 2006) as described in Table 1.

Table 1: Description rubric for level of reflection.

LEVELS OF REFLECTION	SUMMARY OF DESCRIPTION
LEVEL 1: DESCRIPTIVE WITH REFLECTION	Students demonstrate acquisition of new content from significant learning experiences. Journal entry provides evidence of gaining knowledge, making sense of new experiences, or making linkages between old and new information.

LEVELS OF REFLECTION	SUMMARY OF DESCRIPTION
LEVEL 2: EMPATHETIC	Students demonstrate thoughts about or challenges to beliefs, values, and attitudes of self and others. Journal entry provides examples of self-projection into the experiences of other, sensitivity towards the values and beliefs of others, and/or tolerance for differences.
LEVEL 3: ANALYTIC	Students demonstrate the application of learning to a broader context of personal and professional life. Journal entry provides evidence of student's use of readings, observations, and discussions to examine, appraise, compare, contrast, plan for new actions or response, or propose remedies to use in and outside structured learning experiences.
LEVEL 4: METACOGNITIVE	Students demonstrate examination of the learning process, showing what learning occurred, how learning occurred, and how newly acquired knowledge or learning altered existing knowledge. Journal entry provides examples of evaluation or revision of real and fictitious interactions.

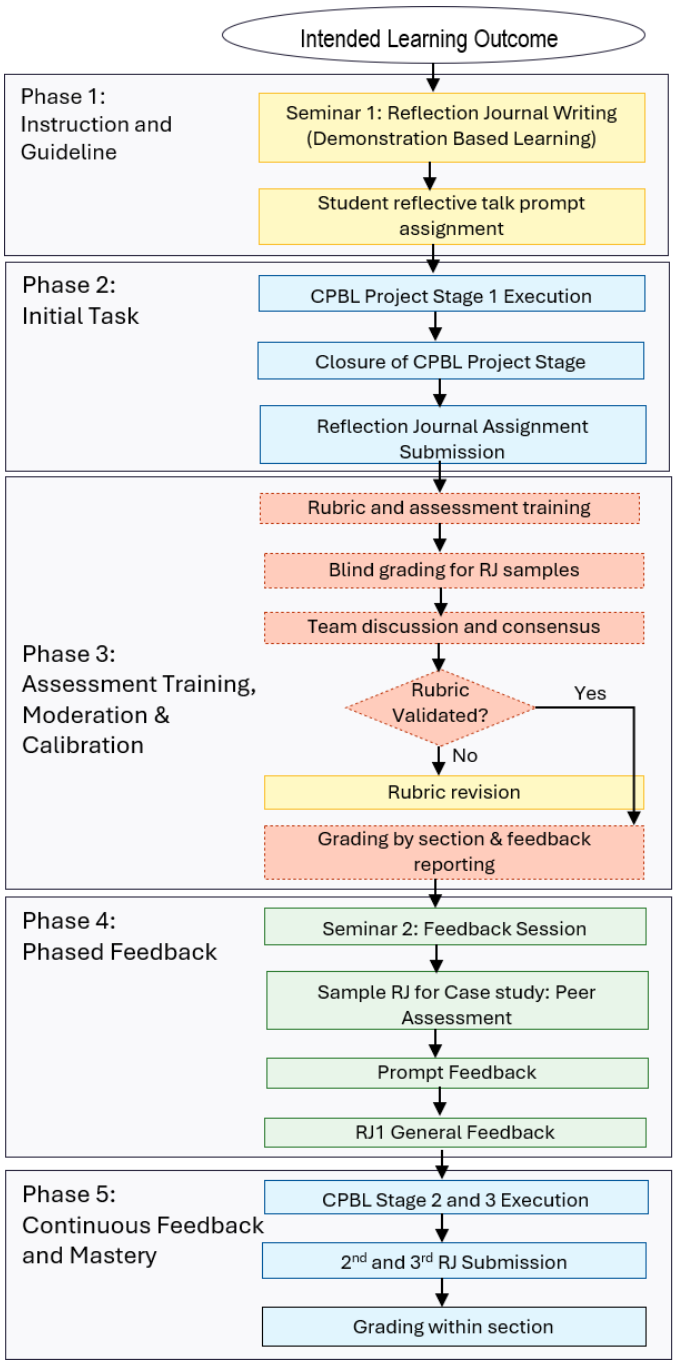


Figure 1: Constructive Aligned Reflection Assessment (CARA) instructional design framework.

Key Findings

Figure 2 demonstrates a progressive shift in students' depth of reflective writing across the three reflection assessment stages. At Stage 1, students' reflections were predominantly at Level 3 (approximately 48%), after went through the first lecture and reflection practice. Following the first cycle of assessment, feedback and reflection scaffolding, the proportion of students demonstrating Level 3 reflection increased to approximately 54% at Stage 2, accompanied by a reduction in lower-level reflection, particularly Level 1. More importantly, Level 4 reflection increased from approximately 16% at Stage 1 to 26% at Stage 2.

The developmental pattern became more pronounced by Stage 3. Approximately 45% of students demonstrated Level 4 reflection, almost three times the proportion observed at Stage 1, while Level 1 and Level 2 reflections declined. Collectively, approximately 90% of students were performing at Levels 3 or 4 by the final stage, compared with approximately 64% at the beginning. The shift is consistent with CARA's developmental approach, in which reflection was not merely assessed but progressively supported through explicit reflection instruction, scaffolding activity and timely feedback. The findings therefore provide preliminary evidence that integrating reflection instruction and assessment within a constructively aligned and feedback-driven system can support students in progressing from lower-level reflective thinking towards more analytical and deeper reflection.

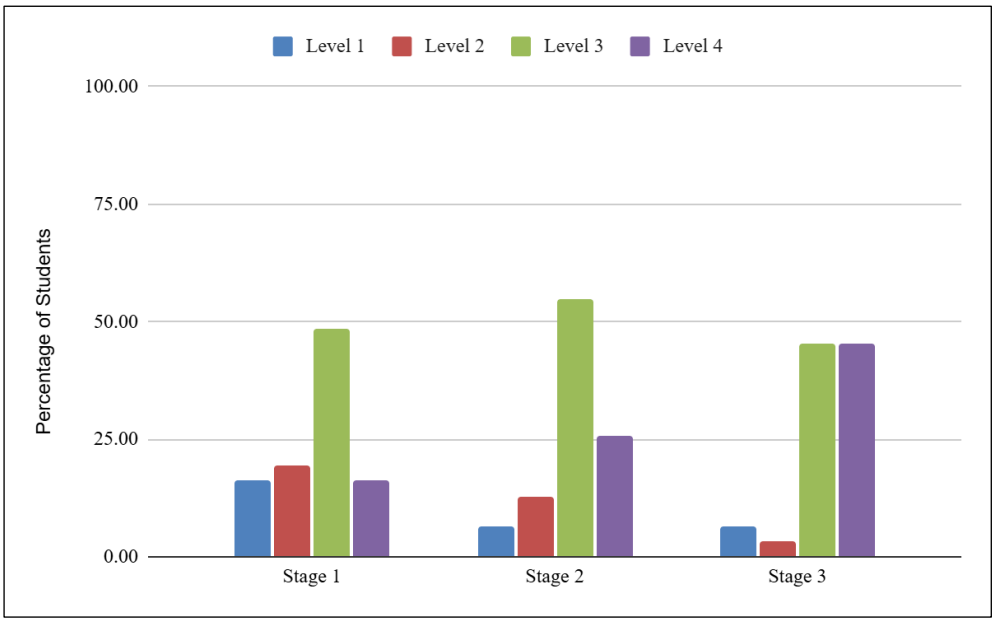


Figure 2: Students' improvement across the CARA assessment cycle.

Impact

Beyond improvement in assessment performance, CARA supported students in developing reflection thinking by evaluating their own learning experiences, respond to feedback, and identify opportunities for further development. These capabilities are particularly relevant to the intended outcome of lifelong learning, where students are expected to continuously evaluate and improve their own learning.

For educators, CARA provided a systematic mechanism for addressing the subjectivity commonly associated with reflection assessment. The descriptive rubric, assessor training, calibration using authentic student work, and moderation discussions established a shared understanding of reflective quality among instructors across the five course sections.

Recommendations for Classroom Practice

CARA can be adapted to learning environments in which students are expected to reflect upon authentic or experiential learning experiences. Educators are recommended to move beyond assigning a reflection journal accompanied only by prompts or a rubric and instead design reflection as a progressive learning and assessment process. Effective implementation should begin by constructively aligning the intended learning outcome with the reflective learning activity, followed by scaffolding

lectures to help students understand both the structure and expected depth of reflection. For a short-term project, multiple reflection opportunities or exercise should be embedded at meaningful stages of the learning experience, not focusing on the project or assignment only which the class can also be meaningful learning experiences.

For courses involving multiple instructors, assessor calibration and moderation are recommended to establish shared interpretations of reflective quality and minimize inconsistencies in judgement. The specific reflection prompts, models and assessment criteria may be contextualized according to the discipline and learning outcomes while retaining CARA's central principles of constructive alignment, reflection scaffolding, calibrated assessment and phased feedback.

Acknowledgement

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ID 82: Design-Switch-Mark Gamification and Flexible Vodcast-Based Authentic Assessment: Human-AI Synergy Complementary Pedagogy Model

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Highlights: This innovation combines two complementary learning modes: Design-Switch-Mark gamification for student-generated, peer-marked classroom challenges, and the flexible Vodcast ecosystem for authentic student assessment and reusable visual explanation. The approach responds to rapidly changing technology by shifting students from teacher-delivered questions to student-designed learning challenges. The approach aligns strongly with NALI Categories 1 and 3 by combining active retrieval, gamification, student-generated artefacts, peer feedback, digital reuse and flexible access. Generative AI is positioned as a collaborative ideation tool rather than a substitute for human reasoning. A reusable Vodcast project extends the learning ecosystem beyond class through student-generated, real-world case-based video artefacts.

Keywords: Authentic Assessment; Design-Switch-Mark gamification; Human-AI Synergy; flexible Vodcast; Student-Generated Learning Artefacts

Introduction

Higher education increasingly requires learning designs that move beyond content transmission towards active participation, critical thinking, adaptability and meaningful use of digital technologies. In view of active learning strategies, however, there is student resistance toward such instructional interventions and digital technology can be used to re-design courses to add active learning techniques and support learning "with", but "not from" technologies [1]. This need is particularly relevant in science and technology education, where students must interpret information, justify decisions and apply concepts to unfamiliar real-world situations. The innovation was developed around a practical problem identified in which technology changes rapidly. Higher education is continuously challenged to prepare students for rapidly changing technologies while preserving human judgement, creativity and critical thinking.

The NALI 2026 theme, "Human-AI Synergy in Pedagogy," explicitly positions AI as a complement to human teaching expertise rather than a replacement for it. The competition also identifies Innovation in Pedagogy, Assessment and Curriculum Design (Category 1) and Digital, Immersive, and Flexible Learning Ecosystem (Category 3) as priority areas. The proposed innovation responds to both categories by combining a student-centred gamification strategy with student-generated learning artefacts such as Design-Switch-Mark gamification and collage, also reusable video-based learning resources such as Vodcast.

Objectives

- To transform active learning from teacher-generated questions into student-generated, syllabus-aligned challenges via the Design-Switch-Mark collaborative gamification.
- To provide an authentic assessment pathway and reusable student-generated video artefacts through a flexible Vodcast project.
- To provide an adaptable complementary pedagogical model that can be adopted across science and other disciplines by integrating AI as a bounded collaborative tool.

NALI Approach

Novelty

The novelty lies in the integration of two deliberately different but complementary learning components. The two components meet at the level of learning design: students generate, solve, critique, explain and create. This integration is not a replacement, but an established pedagogical element into a coherent Human-AI synergy workflow. The novelty positions the distinctive feature as a move from teacher-centred delivery toward learner-generated challenges and communication. The novelty of Design-Switch-Mark gamification is embedded in the transformation of ordinary analytical chemistry academic content into "mystery puzzles". This activity is supported by varied task formats such as crossword mystery, numerical puzzle, word-search challenge, problem or scenario match-up pairing formats. In view of Vodcast novelty here, the model can be applied to chemistry calculations, case analysis, laboratory interpretation, forensic scenarios, engineering problem content. It may take many forms depending on the learning purpose: a presenter may converse indoors or outdoors, speak directly to the camera, use a laptop or

headset microphone without holding a microphone, or use a handheld microphone when sitting indoor or moving through an outdoor or field setting. The presenter may change location or scenery, while relevant photographs, diagrams, animations, screen recordings, demonstrations and short videos are inserted between or alongside conversational segments to make an explanation visible and contextual. Thus, the defining pedagogical feature is not the physical setting or equipment, but the deliberate integration of spoken conversation with purposeful visual communication. This creates a multimodal narrative in which voice, presenter, movement, location and visual evidence work together.

Creativity

First, the Design-Switch-Mark creativity is a three-stage gamified classroom mechanism: One group designs a syllabus-aligned mystery, challenge, puzzle or problem; another group switches roles to solve it; the work is then returned for peer marking and justification. Second, the Vodcast functions as an authentic assessment ecosystem rather than simply a recording. The Vodcast recording provides visual micro-explanation. Students can create video-based explanations around real-world cases, producing a reusable authentic digital learning artefact. Second, the Vodcast project extends this creative process through cinematic visual storytelling, short scenes, real-world objects, sound cues and direct-to-camera explanation. This process is embedded in the use of everyday real-life triggers whereby students are not limited to answering an instruction sheet. For example, everyday objects such as a chocolate, fingerprints, coconut-shake plastic cup, mobile-phone traces, skin cells and DNA can be used to connect abstract scientific concepts to familiar real-world situations. This creative framing is intended to stimulate curiosity before formal explanation and to make students producers of learning content rather than passive recipients. The approach also allows AI-assisted captions, transcription, visual planning, scenario development or other production support, while the presenter/student remains responsible for the meaning, accuracy and final creative decisions.

Innovativeness

In the three-stage gamification of Design-Switch-Mark, the innovation changes the assessment logic from "teacher asks–student answers" to "students design–peers solve–peers justify–students reflect." This aligns with research showing that student question generation can support higher-order thinking, particularly when learners generate, answer and assess questions collaboratively [2]. Gamification is used as a mechanism for productive struggle and feedback, not merely points or competition. Evidence from higher education reviews also indicates that gamification is most useful when game elements are aligned with learning purposes rather than added as decoration [3,4]. Research also suggests that gamified learning can improve cognitive and non-cognitive outcomes [5]. In view of Vodcast, it is intentionally distinguished from a usual podcast. In the Vodcast, communication is deliberately flexible rather than tied to a single studio format. A conventional podcast is generally audio-led and can be without watching a screen; a Vodcast retains the conversational, podcast-style delivery but adds a visual layer [6]. It is not restricted to the familiar image of people sitting on a sofa or around a studio table.

Applicability

The model is designed as a sustainable complementary pedagogical framework rather than a proprietary software platform. The model is adaptable as the three Design-Switch-Mark stages can be applied to other discipline-specific content. The activity formats can be changed without changing the underlying sequence. Meanwhile, the Vodcast component can be delivered through an institutional learning management system (LMS), video platform or repository and can be accessed asynchronously. The Vodcast component is similarly portable because digital video can be accessed repeatedly and used for revision or supplementary learning. Prior higher-education studies report that Vodcasts support understanding, revision and flexible access, while also indicating that Vodcast should complement rather than automatically replace other teaching modes. The modular design supports face-to-face, blended, flipped and flexible learning environments, consistent with NALI Category 3's emphasis on reusable digital resources.

Innovation Description, Process and Implementation

The innovation comprises two connected but non-identical components. Component A is Design-Switch-Mark Gamification. Component B is Vodcast-based authentic assessment and Digital Learning. Human-AI Synergy operates across both components as a governance principle: AI supports ideation and structured data work, while students remain responsible for subject knowledge, reasoning, evidence checking, peer feedback and final communication.

Implementation begins with a syllabus theme and a real-world case. In Component A, students work in groups to design a challenge using a selected format; the challenge is exchanged with another group; the receiving group solves it; the completed work is returned for peer marking; and students explain or

justify their calculations, assumptions or interpretations. In Component B, the lecturer provides Vodcast themes to choose from and students subsequently produce a Vodcast project based on an authentic case. Students can use generative AI for brainstorming or data-framework support but must document their reasoning and verify the final content. The resulting Vodcast becomes a reusable digital artefact for learning and sharing.

Table 1: Distinction between the pedagogy components and NALI category alignment.

Component	Core process	Primary learning function	Student output / learning value	NALI category
Design-Switch-Mark Gamification	Design → Switch → Mark → justify/reflect	In-class active retrieval, student-generated artefacts, challenge design, role switching and peer marking peer feedback, critical reasoning	Student-designed puzzles/cases; peer justification; critical reflection	Category 1
VodCast learning/ assessment	Model → create → explain → share/revisit	Visual learning, authentic communication, reusable digital resource/assessment, flexible	Student-generated video podcast based on a real-world case; communication and digital literacy	Category 3
Human-AI Synergy	AI brainstorms/structures; student verifies/reasons	AI-assisted ideation/data framework with human verification, critical thinking	Better scenario generation while retaining human logic, judgement and critical thinking	Categories 1 & 3

The Design-Switch-Mark is the gamified classroom process, whereas VodCast is treated as a video-based learning/assessment artefact; they are complementary rather than interchangeable.

Key Findings

Evidence from Science, Technology, Engineering, and Mathematics (STEM) education indicates that active learning can improve student performance compared with traditional lecturing [7,8], while systematic reviews and meta-analyses indicate that appropriately designed gamification can support cognitive, motivational and behavioural outcomes [9,10,11]. On the other hand, digital artefacts reported are videos, multimedia materials targeting populations, social media content [12], virtual reality (VR) [13] and Vodcast (video podcast) [14]. A study found that the students valued the inclusion of creative artefacts which is vital for scholarly communication within and beyond the classroom. This includes incorporation of gamified components, facilitation of student-centered learning, and promotion of problem-solving [15]. For NALI exhibition purposes, no numerical improvement in grades, engagement or attainment is claimed here because the innovation is presented as an implementation and design evidence rather than a completed quantitative learning-outcome evaluation. The most important observed design outcome is the shift in cognitive responsibility and a clear change in learner role. Instead of receiving only teacher-authored questions, learners become challenge designers and peer reviewers. This is consistent with evidence that gamified flipped classrooms can positively influence achievement, motivation and engagement, while also reinforcing the need for context-sensitive design. This is supported by the literature searches, also gamified, collage, Vodcast videos and storyboards of student-generated artefacts. Despite that, the digital Vodcast layer addresses the need for reusable, visual learning resources. Research on video production and engagement also suggests that video design characteristics influence learner engagement, supporting the use of purposeful visual storytelling rather than simply recording a conventional lecture [16]. The innovation therefore establishes a reproducible pedagogical sequence and digital artefacts that can be reused in subsequent teaching cycles.

Impact

The innovation changes the role of AI from an answer generator to a collaborative design assistant. In the proposed workflow, students may use generative AI to brainstorm complex scenarios and organise data frameworks but explicitly retains human responsibility for logic and critical thinking. This human-AI division of labour is consistent with the NALI 2026 emphasis on combining AI capabilities with human empathy, critical thinking and educator guidance. For students, the innovation promotes agency, active retrieval, collaborative problem solving, peer feedback and digital communication. For educators, it provides a repeatable structure for converting syllabus content into interactive challenges and reusable Vodcast resources. For institutions, it supports a future-ready learning ecosystem in which classroom activities and digital resources reinforce one another. The approach supports digital transformation and alternative assessment while remaining feasible with common tools such as presentation software, video recording,

an LMS and generative AI. The model also supports lifelong and flexible access because the Vodcast can be revisited outside the classroom, while the gamified activity remains adaptable to face-to-face or blended delivery.

Recommendations for Classroom Practice

- Use Design-Switch-Mark for selected high-value concepts rather than every classroom question; begin with one syllabus-aligned mystery or calculation.
- Require each student group to provide a short rationale for the challenge design and a justification for the peer-marking decision.
- Keep the Vodcast distinct from the gamification activity. Use Vodcast for explanation, authentic case communication and reusable learning resources; use Design-Switch-Mark for interactive challenge generation and peer assessment.
- Define acceptable AI use before the activity. Require students to verify AI-generated information, disclose meaningful AI assistance and provide their own reasoning.

Other relevant information

Preliminary patent landscape check. A web-indexed search using Lens-oriented queries for the exact phrase "Design-Switch-Mark" did not identify an exact prior patent result. Broader searches show that adjacent concepts already exist, including educational gamification and gameful teaching (US10026331B2), gamification peer review/peer scoring (US20150302763A1), adaptive AI-driven learning with gamification (WO2024238370A2), and systems involving student-generated content and assessment (US11804144B2). Therefore, the copyright title: "Design-Switch-Mark gamification and flexible Vodcast-based authentic assessment: Human-AI synergy complementary pedagogy model". The status is submitted (Reference No.: IP/CR/09016)

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ID 83: Cahyo–Naess Learning System (CNLS): A Multiperspective SSI-Based Learning Innovation

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Highlights: CNLS addresses the black-and-white framing of environmental issues through two equally legitimate analytical lenses: Cahyo, representing human needs, energy, industry, and economic development; and Naess, representing ecological integrity, sustainability, and nature's intrinsic value. Its six-stage architecture integrates dilemma engagement, perspective mapping, evidence inquiry, dialogue, decision-making, and reflection. Implementation demonstrated high practicality (88.50–92.50%), 90.00% fidelity, and significantly greater gains in critical thinking and verbal scientific communication than regular instruction.

Keywords: Socioscientific issues; Multiperspective learning; Critical thinking; Scientific communication; Decision-making

Introduction

Environmental change is a socioscientific issue that cannot be addressed by recalling biological concepts alone. Students must weigh scientific evidence, energy demands, livelihoods, health risks, social justice, and ecological sustainability before reaching a decision. Yet complex issues are often reduced to a pro-environment versus pro-development dichotomy, while classroom discussions do not always provide a structure for scrutinising claims, understanding competing interests, and justifying decisions. SSI-based learning should instead connect science with argumentation, values, and responsible action (Sadler, 2011; Zeidler et al., 2019).

Digital storytelling can enhance engagement and provide meaningful context, but narrative media do not automatically foster critical reasoning without an explicit pedagogical design (Wu & Chen, 2020). Cahyo–Naess Learning System (CNLS) was developed to transform a multiperspective narrative into a replicable deliberative learning system. Cahyo and Naess are not merely characters; they operate as analytical lenses that require students to reconstruct the other side's reasoning before evaluating evidence and taking a position. The e-novella *Jelaga di Ujung Lidah* serves as an instructional trigger, whereas CNLS governs the learning process, stage-specific outputs, teacher facilitation, and assessment.

Objectives

CNLS aims to:

- develop a multiperspective understanding of environmental dilemmas.
- strengthen students' capacity to evaluate evidence, construct arguments, communicate scientifically, and make ethically defensible decisions.
- provide teachers with a practical, measurable, and adaptable learning system for diverse socioscientific issues.

NALI Approach

Novelty

The novelty of CNLS lies in the structured integration of dual-lens perspective-taking, evidence mapping, argumentative dialogue, socioscientific decision-making, and reflective reconsideration. Unlike debates that immediately divide students into opposing camps, CNLS deliberately postpones commitment: students must first represent the reasoning behind both the Cahyo and Naess positions fairly. The Cahyo lens examines energy, employment, family welfare, industry, and economic development; the Naess lens examines ecological limits, the distribution of impacts, sustainability, and the intrinsic value of nature. Decisions are assessed not by which side is selected, but by the quality of evidence and reasoning, anticipation of consequences, and responsiveness to counterarguments.

Creativity

CNLS transforms literary conflict into a thinking protocol. A dual-perspective narrative, illustrations, videos, maps, hyperlinks, and QR codes make the dilemma emotionally engaging and contextually grounded. The student worksheet then converts the reading experience into perspective mapping, data analysis, claim-evidence-reasoning construction, four rounds of Cahyo-Naess dialogue, ethical decision-making,

and reflection on changes in position. By combining narrative immersion with argumentative discipline, CNLS positions students not as spectators of a story, but as accountable decision-makers.

Innovativeness

CNLS converts loosely structured reading-and-discussion activities into a six-stage sequence with observable outputs: problem and perspective maps, an evidence map, arguments and counterarguments, a consequence-sensitive decision, and a reflection record. It integrates the narrative, teaching module, student worksheet, teacher facilitation, and critical-thinking and scientific-communication assessment, extending web-based SSI argumentation design (Kruit et al., 2025) beyond technological appeal.

Applicability

CNLS can be implemented through smartphones, laptops, projectors, or printed materials; no proprietary platform is required. Its two lenses remain constant while the dilemma and narrative resource can be adapted to deforestation, mining, nuclear energy, biotechnology, conservation, or climate change. Within the Human-AI Synergy theme, AI may be used optionally to suggest search terms or compare information during evidence inquiry. However, source validation, spoken dialogue, decision-making, and argumentative accountability remain with students and teachers. This AI component is an adaptation pathway, not part of the current empirical evaluation.

Innovation Description, Process and Implementation

CNLS operates through six stages. First, students encounter an authentic environmental dilemma with no predetermined answer. Second, they map interests and assumptions through the Cahyo and Naess lenses. Third, they examine claims against scientific data and source credibility. Fourth, they construct arguments, listen to counterarguments, exchange or test positions, and each student makes an oral contribution. Fifth, groups formulate a decision that addresses benefits, risks, affected stakeholders, and consequences. Sixth, students compare their initial and final positions, identify the most influential evidence, and evaluate the limitations of their decision.

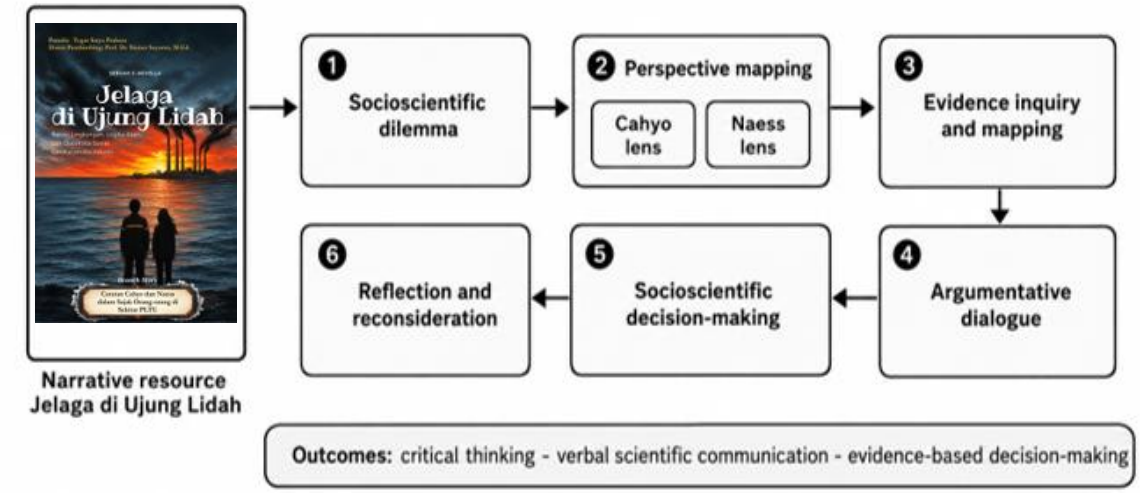


Figure 1: Operational architecture of CNLS

Developed through ADDIE, CNLS was implemented in environmental change lessons at SMA Negeri 1 Wonotunggal, Indonesia (April-May 2026). Its six functions were initially operationalised through five SSI phases; perspective mapping was later made explicit for replication. Validation involved one subject-matter expert and one media expert. A pilot involved one biology teacher and 15 Grade 10 students. Field testing used a non-equivalent pretest-post-test control-group design with 68 students (34 CNLS; 34 controls). Critical thinking was measured by six constructed-response items (maximum = 24); two observers rated verbal scientific communication on central message, organisation, and supporting evidence.

Key Findings

The operational CNLS prototype demonstrated convergent evidence of feasibility, practicality, implementation fidelity, and learning outcomes. Content feasibility reached 82.14% and media feasibility 97.50%. Teacher and student responses were 92.50% and 88.50%, respectively, while implementation

fidelity reached 90.00%. These effects are not attributed to the digital medium in isolation, but to the integration of narrative, SSI stages, student worksheets, dialogue, assessment, and teacher facilitation.

Table 1: Evidence of CNLS implementation and impact on learning.

DIMENSION	KEY RESULT	STRATEGIC SIGNIFICANCE
Feasibility	Content 82.14%; media 97.50%	Content and design are suitable for use
Practicality	Teacher 92.50%; students 88.50%	Understandable and operational for users
Implementation fidelity	36/40 or 90.00%	Six pedagogical functions enacted in class
Critical thinking	N-gain 0.594 vs 0.341; $\eta p^2 = 0.646$	Greater gains with a large effect
Verbal communication	N-gain 0.587 vs 0.345; $\eta p^2 = 0.514$	Greater gains with a large effect
Combined impact	Wilks' $\lambda = 0.297$; $F(2,65) = 76.850$; $p < .001$; $\eta p^2 = 0.703$	Significant multivariate difference with a large effect

Mean critical-thinking scores in the CNLS group increased from 10.03 to 18.32, compared with 10.26 to 14.97 in the control group. Mean verbal scientific communication scores increased from 5.56 to 9.35 in the CNLS group and from 5.00 to 7.41 in the control group. No CNLS student fell within the low critical-thinking N-gain category, whereas 29.41% of control students remained in that category. For verbal scientific communication, 20.59% of CNLS students achieved a high N-gain, compared with 0% in the control group. These findings accord with the potential of collaborative digital storytelling in biology education and the need for explicit structure and facilitation in SSI learning (Bilici & Yilmaz, 2024; Högström et al., 2025).

Impact

For students, CNLS shifts learning from finding an answer to understanding competing rationales, interrogating evidence, speaking in a structured manner, and acknowledging decision limitations. For teachers, it provides a facilitation and assessment sequence that prevents unfocused discussion. For schools, CNLS offers contextual, low-cost, and reusable environmental learning. The available impact evidence is short-term, derived from one school and a quasi-experimental design; claims about sustainability and generalisability therefore require replication across schools, topics, and longer periods.

The impact mechanism can be understood through three learning transitions. First, students move from spontaneous judgement to perspective decentring because they must reconstruct the other side's reasoning before defending their own position. Second, they move from opinion to evidential discipline by examining sources, claim-data relationships, and possible rebuttals. Third, they move from individual answers to public accountability because decisions must be articulated, challenged, and revised. These transitions explain why critical thinking and verbal scientific communication develop as mutually reinforcing outcomes rather than separate activities.

At the empowerment level, CNLS legitimises students' recognition that economic interests and ecological responsibility both require scrutiny rather than simplification. Teachers remain responsible for evidential quality and dialogic safety, but no longer act as the sole arbiters of decisions. This structure supports authentic assessment in the AI era because learning is made visible through perspective maps, argumentation processes, oral defence, and reflection—not merely through a final product that technology could generate.

Recommendations for Classroom Practice

Teachers should select dilemmas that are locally meaningful, provide balanced and verifiable evidence, and assess the quality of reasoning rather than the side selected. Before reaching a decision, students should be required to explain both lenses and make an oral contribution. Implementation can begin with two core lessons supported by pre-reading, perspective-evidence mapping, dialogue, decision-making, and reflection. For AI-assisted adaptation, teachers should require source trails, cross-verification, and oral defence so that AI expands inquiry without replacing human judgement.

Table 2: Quality controls for CNLS replication.

ASPECT	REPLICATION REQUIREMENT	RATIONALE
Fixed	Two lenses, traceable evidence, dialogue, decision, reflection	Maintains CNLS integrity
Adaptable	Topic, narrative, medium, duration, group size	Fits diverse contexts
Minimum fidelity	Explain both lenses; all students speak; decisions use evidence	Avoids simple read-and-discuss
AI extension	Label, trace, verify, and orally defend AI outputs	Maintains human agency

Other relevant information

CNLS is submitted as a Project under Category 1 - Innovation in Pedagogy, Assessment and Curriculum Design. The public instructional resource Jelaga di Ujung Lidah is accessible at https://heyzine.com/flip-book/ccdce3339a.html. The CNLS replication package comprises the e-novella, teaching module, student worksheet, dialogue protocol, and assessment tools; it can be further developed into teacher professional development and a repository of locally grounded socioscientific dilemmas.

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ID 84: Smart Grid: An Innovative Approach to Interactive Coordinate Learning

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Highlights: Smart Grid was implemented to improve Year 5 students' mastery of coordinates, including basic concepts, plotting points, determining horizontal and vertical distances, and solving coordinate problems. Developed using the ADDIE model, it combines Project-Based Learning (PBL) with Scratch as an interactive medium for visual and collaborative exploration. Students who had difficulty learning coordinates constructed knowledge through hands-on activities, group discussions, and Scratch-based digital projects, while developing problem-solving, ICT, and communication skills. Pre- and post-tests measured their mastery before and after the intervention. Scores improved significantly, indicating that Scratch-based Smart Grid was effective in strengthening coordinate concepts and skills. Students also showed greater engagement, confidence, and interest in Mathematics. Smart Grid therefore has potential as a teaching approach that supports coordinate learning and the development of 21st-century skills.

Keywords: Scratch; Smart Grid; Project-based learning; Coordinates

Introduction

This innovation project is a Scratch-assisted Project-Based Learning (PBL) approach designed to help Year 5 students understand coordinate concepts in a more enjoyable, meaningful, and interactive way. Through this project, students learn how to determine and mark the positions of points on a coordinate plane using the X-axis and Y-axis. Students are also able to determine the horizontal and vertical distances between two locations based on a given scale. Recognising the importance of mastering coordinate skills, an innovation was developed. This study aims to improve students' mastery in determining horizontal and vertical distances and solving coordinate problems in real-life situations. To achieve this purpose, several research instruments were used to collect data. The findings were analysed and evaluated to demonstrate that mastery of the coordinate topic can be improved through the use of Smart Grid.

As part of this innovation, students engage in a project-based game in which they work in groups to construct their own ideal city plan. Upon completion, students answer coordinate problem-solving questions related to their ideal city plan. Integration with the Scratch application enables students to create animations, games, simulations, and interactive projects using easy-to-understand programming blocks without having to write complex code. In Mathematics education, Scratch functions as a digital learning tool that helps students understand mathematical concepts in a more visual, interactive, and enjoyable way. In the topic of coordinates, Scratch uses a Cartesian coordinate system that allows students to observe and control the movement of objects based on coordinate values (x, y). Students can plot points, determine the positions of objects, identify changes in coordinates, and calculate horizontal and vertical distances directly through sprite movement on the screen. This experience helps students connect abstract concepts with situations that are more concrete and easier to understand. In the Smart Grid innovation, Scratch is used as an interactive medium to help students master the basic concepts of coordinates, plot points, determine horizontal and vertical distances, and solve coordinate problems more effectively. The integration of Scratch into Mathematics learning not only improves students' academic achievement but also develops the digital and communication skills required in the 21st century.

Objectives

- The objectives of this innovation study are briefly described as follows:
- to improve students' mastery of the basic concepts of coordinates.
- to improve students' ability to solve coordinate problems through enjoyable activities.

NALI Approach

Novelty

Smart Grid is unique in its combination of the 3D physical model "My Ideal City Map" with the Scratch application for coordinate learning. This innovation transforms the abstract concept of coordinates into a concrete, visual, interactive, and contextual learning experience. Students not only use the physical map to plot points and determine distances, but also apply these concepts in a digital Scratch game.

Creativity
Creativity is fostered through the development of a 3D Smart Grid model in the form of a city plan, activities involving the construction and exploration of an "Ideal City", and the development of interactive games and animations using Scratch. Students are given opportunities to create, move, and mark objects based on coordinates, while collaborating, sharing ideas, and solving challenges creatively.

Innovativeness
Smart Grid introduces a teaching and learning approach that integrates Project-Based Learning (PBL), hands-on learning, collaboration, and Scratch digital technology within a single intervention. This approach encourages students to actively explore and construct their own understanding rather than relying solely on teacher explanations and written exercises. The findings indicate improvements in post-test scores as well as increases in students' confidence, interest, engagement, ICT skills, and computational thinking.

Applicability
Smart Grid has high application potential because the physical model can be reused in groups, while the Scratch digital activities can be accessed as reinforcement and enrichment materials involving various everyday situations. The innovation can also be adapted according to students' ability levels, topics, and school contexts. Other teachers can adopt the approach and make improvements according to students' needs. Cyclical implementation through reflection and continuous improvement supports the sustainability of the innovation in teaching and learning.

Innovation Description, Process and Implementation

Research Design Model
The ADDIE model consists of five phases that are structured interactively and systematically. Figure 1.1 presents the conceptual framework of the ADDIE model used in designing the implementation of the Smart Grid innovation.

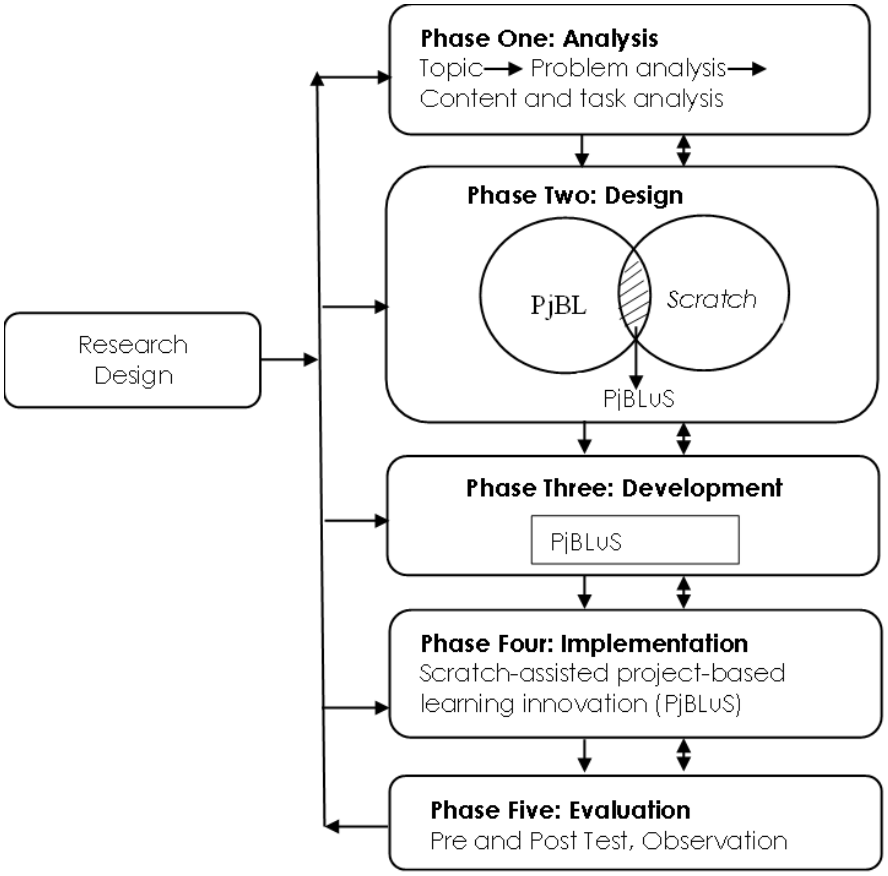


Figure 1: ADDIE model framework for the implementation design of the Smart Grid Innovation

Study Sample
The study sample consisted of 33 Year 5 students from a national primary school in the Johor Bahru district. The students had moderate levels of Mathematics achievement.

Innovation Implementation
During the implementation of the intervention, I taught the students using Smart Grid through project-based learning activities involving the Ideal City plan and Scratch games. The model is student-friendly because it can be erased and reused and can be used collaboratively in groups. The second method involved using the Scratch application to reinforce the concept of coordinates.

Action 1: Project-Based Learning Using the Ideal City Plan
I prepared a 3D Smart Grid model for the concept of coordinates. Through this action, students were able to understand, visualise, and gain direct experience in solving coordinate concept questions more easily, thereby obtaining the correct answers. The activity is shown in Figure 2.

Action Implementation Procedure
The students were divided into several groups of five members each. Each group received a coordinate map. The teacher called out several coordinate pairs in turn, and the students discussed them with their group members to identify the correct positions on the coordinate map. The students then moved markers or marked locations according to the coordinates given by the teacher. This activity aimed to improve students' understanding of coordinate concepts while fostering communication, cooperation, and problem-solving skills among group members.



Figure 2: My ideal city map project (group activity).

Action 2: Project-Based Learning Using Scratch for the Ideal City Plan
I prepared a 3D Smart Grid model for the concept of coordinates together with a game using the Scratch application. Through this action, students were able to carry out reinforcement activities and improve their understanding of the concepts in the topic of coordinates, as shown in Figure 3.

Action Implementation Procedure
The students were provided with a link to develop an ideal city map game using Scratch. This activity aimed to improve students' understanding of coordinate concepts while fostering ICT skills and problem-solving skills in everyday life.



Figure 3: My ideal city map project using Scratch.

Key Findings

Table 1 presents the data collected in score intervals to provide a clearer view of the differences between the pre-test and post-test results.

Table 1: Frequency distribution of pre-test and post-test scores.

STUDENT SCORE	PRE-TEST FREQUENCY	POST-TEST FREQUENCY
1-5	10	0
6-10	10	0
11-15	7	0
16-20	6	2
21-25	0	10
26-30	0	5
31-35	0	10
36-40	0	3
41-45	0	3
46-50	0	0

Based on Table 1, the pre-test frequency distribution was concentrated in the score interval of 16–20 and below, whereas the post-test frequency distribution was concentrated in the score interval of 16–20 and above. In addition, the mode of the scores was analysed. For the pre-test, the modal score intervals were 1–5 and 6–10, each with a frequency of 10. For the post-test, the modal score intervals were 21–25 and 31–35, each with a frequency of 10. These findings indicate a substantial improvement in the mastery of coordinate problem-solving skills among students who participated in the Smart Grid innovation. The researcher also presented the changes in score distribution between the pre-test and post-test more clearly using a frequency polygon graph, as shown in Figure 4.

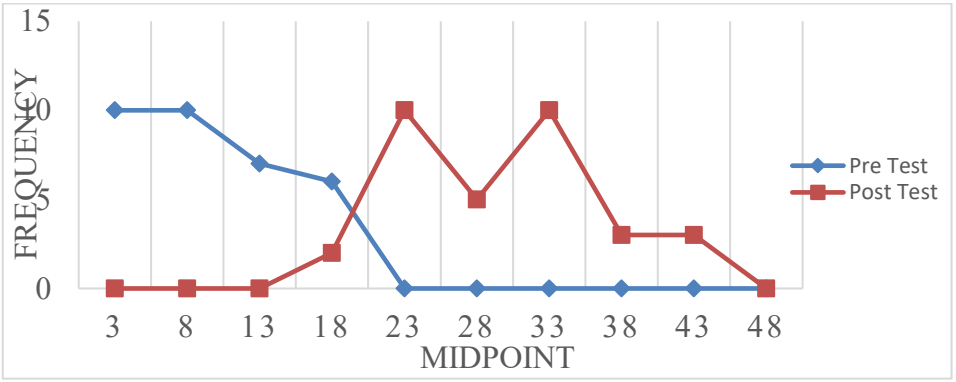


Figure 4: Distribution of students' pre-test and post-test scores

Table 2: Student observation findings

OBSERVATION PHASE	OBSERVATION FINDINGS
Before Intervention	Students lacked confidence and took a long time to answer HOTS coordinate questions. Various errors occurred in calculations and coordinate identification. Mastery of coordinate concepts was still weak.
During Intervention	Students showed high interest and engagement while using Smart Grid in both physical and digital forms (Scratch). They paid attention, worked actively together, helped one another, and increasingly understood coordinate concepts and how to solve HOTS questions.
After Intervention	Students were more confident and able to solve questions individually with greater accuracy. Calculation errors decreased, and mastery of coordinates and HOTS problem-solving skills improved substantially.

Impact

The Smart Grid innovation has had a positive impact not only on students but also on teachers, the school, and the educational community. The innovation improves students' mastery of coordinate concepts, Higher-Order Thinking Skills (HOTS) problem-solving skills, interest, confidence, and engagement, while also developing ICT, communication, collaboration, and computational thinking skills. In addition, for teachers, Smart Grid provides an interactive teaching and learning alternative that can be adapted according to students' levels and needs. At the institutional level, this innovation has the potential to be shared and used by other teachers who face similar difficulties in teaching coordinates. In the future, Smart Grid can potentially be expanded to more classes, schools, and other Mathematics topics through

continuous improvement and the integration of digital technology. The sharing and adaptation of the innovation by other teachers can broaden its impact and support more innovative, collaborative, and student-centred teaching and learning.

Recommendations for Learning Implementation

Teachers are encouraged to integrate Smart Grid into Mathematics teaching and learning through a combination of a 3D physical model, Project-Based Learning (PBL) activities, and the Scratch application. Activities can be conducted in groups to encourage communication, collaboration, and problem-solving, followed by individual activities using Scratch for reinforcement. The implementation can be adapted according to students' levels of mastery, including simplifying or increasing the level of challenge in coordinate and HOTS tasks. Teachers are also encouraged to make observations, evaluate students' work, and use the findings to continuously improve the activities. This innovation can also be replicated by other teachers and schools by adapting the materials, activities, and use of technology according to their facilities and respective contexts. Sharing practices among teachers can help expand the use of Smart Grid and ensure that the innovation remains relevant and sustainable in teaching and learning.

Acknowledgements

Sincere appreciation is extended to Associate Professor Dr. Abdul Halim bin Abdullah, the supervising lecturer, as well as family members and colleagues who provided support and guidance. Appreciation is also extended to the respondents and informants who contributed valuable perspectives and expertise to the success of this study.

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ID 85: Learner Challenge-Selection Patterns in a Congkak-Inspired Adaptive Learning Environment

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Highlights: The development of contemporary e-learning modules and materials increasingly requires adaptive features that respond to individual learners' pace. Therefore, a systematic method is needed to identify patterns in how learners select challenge levels and make task-related decisions. To explore this need, 60 diploma students completed a simple mathematical challenge through I-MathCon, a Congkak-inspired interactive game. Students played Congkak while answering mathematics questions at each step; each pit represented a different question level and associated reward, indicated by the number of beans. Across three rounds, participants made 540 Easy, Medium and Hard selections and completed a short reflection. Hard selections increased from 37.2% in Round 1 to 51.1% in Round 3, while confidence and the desire to challenge oneself were the leading reported influences. The findings provide exploratory evidence for learner-controlled challenge selection supported by future adaptive recommendations.

Keywords: Learner control; Challenge selection; Congkak; Game-based learning; Mathematics education

Introduction

The growing use of digital and e-learning materials has expanded opportunities for self-directed learning, in which students independently explore lessons, manage learning activities and progress through content at their own pace. Although this approach provides flexibility and learner autonomy, students differ in prior knowledge, confidence, learning pace and readiness to attempt challenging tasks. Consequently, a uniform sequence of content or difficulty may not adequately support every learner. Adaptive learning offers a relevant response by adjusting learning pathways, content, task difficulty or instructional support according to information about individual learners. The learner model is therefore a core component of an adaptive e-learning system because it provides information for determining when and how adaptation should occur. However, the learner characteristics used to trigger adaptation are not always supported by sufficient theoretical or empirical justification (Wang et al., 2025). In higher education, adaptive learning commonly relies on indicators such as prior knowledge and performance, although its implementation remains multifaceted and requires further refinement (du Plooy et al., 2024). Identifying observable challenge-selection patterns may therefore provide an additional behavioural signal for learner-controlled adaptive support.

Task difficulty is one instructional feature that may be adapted. Learner-controlled environments allow students to select tasks according to their perceived needs, confidence and preferences, but choosing an appropriate difficulty is itself a self-regulatory demand. Shared-control approaches combine system adaptation with learner choice: the system recommends suitable tasks while the learner retains a meaningful role in the final selection (Corbalan et al., 2008). Research has linked learner-controlled practice difficulty with self-efficacy and prior experience (Hughes et al., 2013), while cautioning that excessive difficulty may constrain exploration (Westlin et al., 2019). I-MathCon applies this problem to a Congkak-inspired mathematics context. Rather than treating selection patterns as fixed learning styles, repeated Easy, Medium and Hard choices are viewed as behavioural signals for a future adaptive digital module.

These exploratory needs analysis examined what levels students selected and why; it did not assess achievement or the effectiveness of an adaptive system.

Objectives

- To identify students' patterns in selecting mathematics questions across different difficulty weightings—Easy, Medium and Hard—over three rounds of I-MathCon.
- To explore the self-reported factors influencing students' challenge-selection decisions.
- To formulate preliminary implications of students' challenge-selection patterns for learner-controlled adaptive support.

NALI Approach

Novelty
Learners can independently choose the level of challenge they are prepared to attempt rather than following a fixed sequence. The novelty lies in the method used to make these decisions observable: I-MathCon serves as a Congkak-inspired tool that systematically captures repeated Easy, Medium and Hard selections. These behavioural patterns can inform adaptive support without assigning unsupported or fixed learning-style labels to learners.

Creativity
The familiar ideas of Congkak holes, seeds and strategic choice are connected to three levels of mathematical challenge. The cycle—choose a challenge, attempt it, receive an outcome and choose again—turns task selection into a visible element of play and creates a culturally recognisable context for reflection.

Innovativeness
The proposed development direction combines learner autonomy with optional adaptive support. Instead of automatically assigning a level, an AI assistant within I-MathCon may recommend an appropriate next challenge while retaining the learner's final choice. This shared-control principle is consistent with evidence that adaptation and learner involvement can be combined in task selection (Corbalan et al., 2008).

Applicability
The three-level structure can be adapted to different mathematical topics, class durations and learner groups. Teachers may replace question banks while retaining the choice–attempt–feedback cycle. The approach can be used as a physical classroom activity, a lightweight digital prototype or a future adaptive application.

Innovation Description, Process and Implementation

The pilot involved 60 diploma students. Each participant completed three rounds; every round contained three sequential selections among Easy, Medium and Hard, producing 540 selection observations. After the activity, participants completed a two-item reflection: a multiple-response question on influencing factors and an open-ended explanation of whether and why their selection approach changed. Frequencies, percentages and within-round trajectories were calculated. Open responses were coded into simple, overlapping descriptive themes. Game scores, accuracy and winners were excluded because the study did not assess mathematics mastery or learning effectiveness.

Key Findings

Finding for Objective 1
Challenge-selection patterns: Table 1 summarises the percentage distribution of challenge selections in each round. Hard selections increased across the rounds, while Easy selections declined. The average difficulty score, coded Easy = 1, Medium = 2 and Hard = 3, increased descriptively from 2.02 in Round 1 to 2.27 in Round 3.

Table 1: Percentage distribution of challenge selections across three rounds.

LEVEL	ROUND 1	ROUND 2	ROUND 3
Easy	35.6% (n = 64)	25.0% (n = 45)	23.9% (n = 43)
Medium	27.2% (n = 49)	33.9% (n = 61)	25.0% (n = 45)
Hard	37.2% (n = 67)	41.1% (n = 74)	51.1% (n = 92)

The most common Round 1 trajectory was Easy–Medium–Hard (19 students, 31.7%), whereas Hard–Hard–Hard became the most common trajectory in Round 3 (20 students, 33.3%), up from 12 students in Round 1. Patterns nevertheless remained heterogeneous, indicating that a single fixed progression would not represent all learners.

Finding for Objective 2
Factors influencing selection: Confidence in answering was selected by 43 students (71.7%) and the desire to challenge oneself by 41 (68.3%). Other factors were perceived difficulty (21.7%), Congkak strategy (18.3%), reward (16.7%), the previous round's outcome (15.0%) and random choice (13.3%). Open responses most often referred to self-challenge, exploring different levels and testing understanding.

Because factors were reported for the activity as a whole, they cannot be treated as causes of particular transitions.

Proposed Design Implications for Objective 3 and Impact

These implications were derived from the pilot findings and informed by previous literature; they were not evaluated as a third empirical finding. Students' Easy–Medium–Hard selection histories may provide an initial behavioural signal for a future learner model, although characteristics used to trigger adaptation require clear empirical justification (Wang et al., 2025). The diversity of observed trajectories supports a shared-control direction in which the system recommends suitable tasks while learners retain a meaningful role in the final selection (Corbalan et al., 2008).

Displaying selection history and providing concise feedback may further support learner monitoring and reflection (Hooshyar et al., 2020). The intended impact is a transparent, learner-controlled environment in which students can calibrate challenge and remain active decision-makers. No claim is made that I-MathCon improved achievement because the pilot did not employ pre/post testing or a comparison group.

Recommendations for Classroom Practice

- Retain visible Easy, Medium and Hard choices at each decision point rather than assigning one fixed level.
- Provide immediate, concise feedback before the next choice and show a simple history of attempted levels.
- Use adaptive recommendations as optional guidance; preserve the learner's final decision.
- Maintain comparable instructions, question pools and reward rules when using selection data for classroom inquiry.

Other relevant information

The findings are exploratory and context-specific. The pilot used descriptive frequencies and short self-reports, so the observed shift towards Hard choices should not be interpreted as proof of increased mastery, confidence or motivation. Likewise, the multiple-response factors describe participants' perceptions across the whole activity and cannot explain each individual transition.

The development roadmap separates design evidence from effectiveness evidence. Phase 1, reported here, establishes challenge-selection patterns and preliminary design requirements. Phase 2 will translate these requirements into a stable I-MathCon prototype and conduct a small usability evaluation focused on navigation, clarity of challenge options and comprehension of feedback. Only after the prototype is stable should a separate study investigate engagement or achievement through an appropriate pre/post or comparative design.

For alignment with the NALI 2026 Human–AI Synergy theme, future intelligent support should remain transparent and learner-centred. An AI assistant within I-MathCon may analyse recent selection history, recommend a next challenge, explain the basis of that recommendation and permit the learner to accept or override it. It may also generate or vary question items for formative testing while preserving topic, intended difficulty and lecturer oversight. These proposed features are future design directions rather than evaluated capabilities of the present pilot.

Acknowledgement

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ID 86: ErgoCheck AI: Smarter Workstations, Better Comfort

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Highlights: ErgoCheck AI transforms an Introduction to Ergonomics assignment into a student-led innovation linking ergonomic evidence, guided AI use, toolkit design, peer implementation, and reflection. It combines workstation and musculoskeletal-discomfort self-checks, AI-assisted microlearning, personalised reminder stickers, and a seven-day practice card. An evaluation of 96 students aged 19–23 showed that workstation ergonomic risk decreased from 73.6% to 29.2%, while reported musculoskeletal discomfort decreased from 51.4% to 36.0%. The innovation translates ergonomic knowledge into observable, personalised action within students' study environments.

Keywords: AI-assisted microlearning; Workstation ergonomics; Student-led innovation; ErgoCheck AI

Introduction

University students often study for long periods on laptops in bedrooms, libraries, and shared spaces not designed as formal workstations. Although ergonomic advice is widely available, awareness does not necessarily lead to action. In Malaysia, 79.1% of undergraduates reported musculoskeletal pain in the past 12 months, with symptoms linked to monitor height, viewing distance, keyboard placement, and chair dimensions (Kong & Ong, 2023). Similarly, most medical undergraduates in another study recognised correct sitting posture, yet 92.2% continued to practise incorrect postures (Malshani et al., 2023). This knowledge-action gap indicates that students need practical guidance at their workstations.

ErgoCheck AI addresses this need by combining self-assessment, concise digital learning, personalised physical reminders, and repeated practice. It was developed as a practice-based course project, enabling student developers to apply evidence-based ergonomic principles and gain experience using AI tools to address a real-world educational challenge. Prior evidence supports both ergonomic interventions and microlearning in higher education (Depreli et al., 2025; Rof et al., 2024).

Objectives

- To transform an ergonomics assignment into a practice-based learning experience through the student-led design, implementation, and evaluation of an AI-assisted toolkit.
- To evaluate short-term within-participant changes in workstation ergonomic risk and self-reported musculoskeletal discomfort after seven days of toolkit use.

NALI Approach

Novelty

Unlike conventional one-off ergonomics lectures or checklists, ErgoCheck AI connects self-assessment, AI-assisted microlearning, personalisation, point-of-action reminders, seven-day practice, and reassessment within one structured learning cycle.

Creativity

Ten colourful reminder stickers transform each student's workstation into an interactive learning surface by placing concise prompts beside the screen, keyboard, mouse, or desk edge where action is needed. The Daily ErgoCheck Card complements these visual cues by enabling students to track their ergonomic practices over seven days. Together, the stickers and card combine personalised environmental reminders with structured self-monitoring to support habit formation and sustained ergonomic action.

Innovativeness

ErgoCheck AI transforms a conventional content-based assignment into a student-led cycle of evidence review, guided AI-supported design, peer implementation, matched outcome evaluation, and reflection. AI supports information organisation and communication, while students verify the content and retain responsibility for decisions.

Applicability

The digital-and-print toolkit was implemented with 96 students, requires no specialist equipment, and can be replicated in large groups using mobile access and printable materials. Its eight-day cycle is

adaptable for orientation, computer-intensive courses, safety teaching, and student well-being programmes.

Innovation Description, Process and Implementation

ErgoCheck AI is an AI-assisted microlearning toolkit that translates ergonomic guidance into an eight-day practice cycle within students' own study environments. It was developed as a practice-based course project. AI tools supported information organisation, concise scripts, and visual concepts, while the student developers remained responsible for checking the content, producing the materials, and interpreting the findings. The digital ErgoCheck AI tool is available at https://app.jotform.com/262351797798477.

The same 96 students aged 19–23 completed the six connected steps: Scan and Assess on Day 0; Learn through an AI-assisted video; Personalise using reminder stickers; Apply the guidance for seven days using the stickers and Daily ErgoCheck Card; and Reassess and Reflect on Day 8. An email reminder prompted participants to repeat both self-checks and complete their reflection on Day 8. Matched pre-test and post-test percentages were compared descriptively.

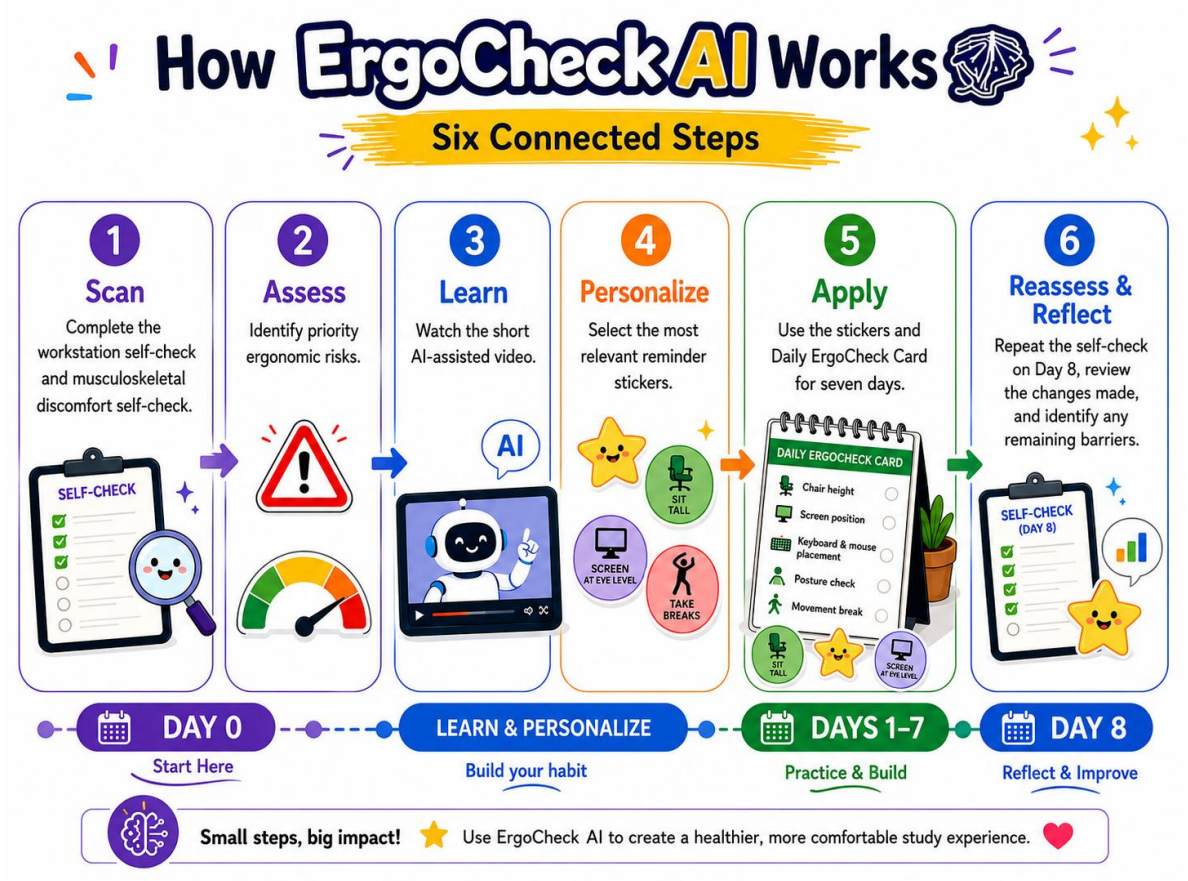


Figure 1: The six connected steps in ErgoCheck AI

Key Findings

A one-group pre-test–post-test implementation involved 96 student users aged 19–23, with matched responses compared descriptively. The item-weighted workstation ergonomic-risk rate decreased from 73.6% at pre-test to 29.2% at post-test—a reduction of 44.4 percentage points or 60.4%. Improvement occurred across all six domains. Average reported musculoskeletal discomfort decreased from 51.4% to 36.0% (30.0%), with improvement across all five body-region groupings (Figure 2).

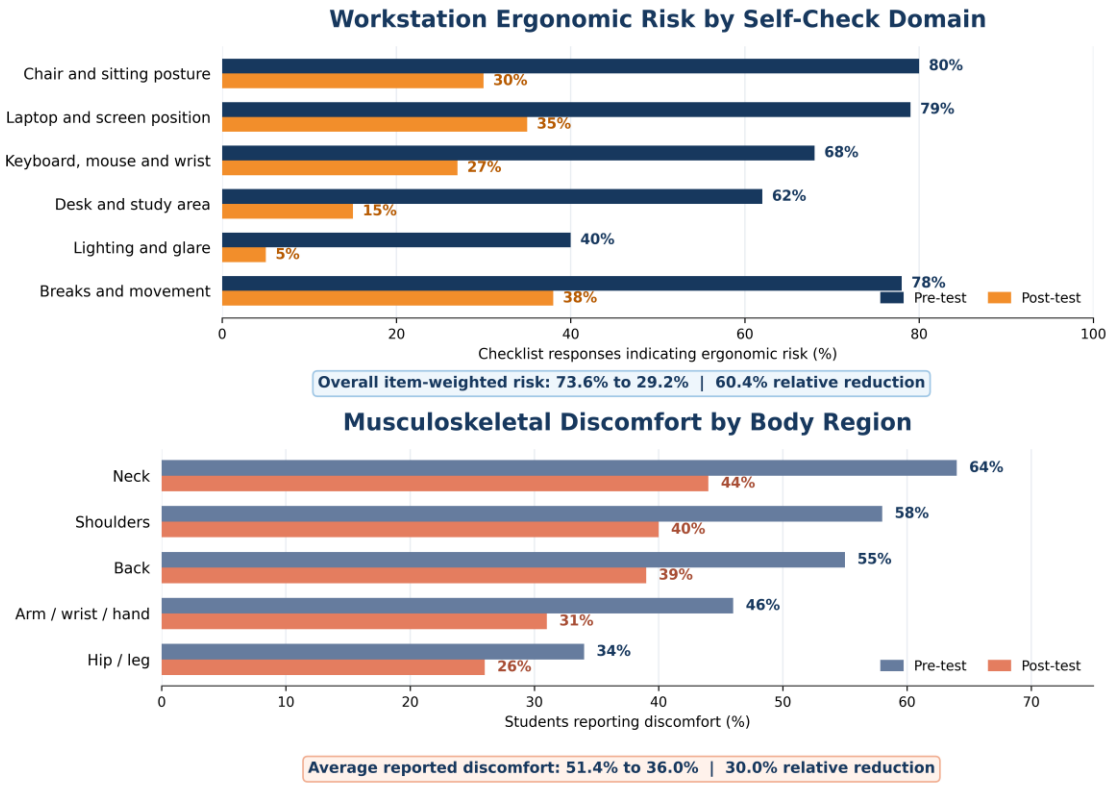


Figure 2: Pre-test and post-test workstation ergonomic-risk and musculoskeletal-discomfort results.

Impact

Student developers applied ergonomic knowledge by designing the toolkit, implementing it with peers, analysing the findings, and reflecting on the process. Project activities and outputs also demonstrated teamwork, communication, evidence-based decision-making, and guided AI use; these outcomes were not measured using a separate pre-test–post-test learning scale.

For the 96 student users, learning was translated into action at their study workstations. Over seven days, they identified risks, selected feasible adjustments, and used reminders to practise them. Feedback indicated that the video was easy to apply, the checklist supported habit building, and the stickers prompted posture checks. Matched self-check results demonstrate promising short-term improvement while preserving learner agency.

Recommendations for Classroom Practice

ErgoCheck AI can be integrated into computer-intensive assignments, student orientation, and health, safety, or well-being activities. Educators can guide students to assess their workstations, select realistic changes, explain their reminder choices, and repeat the seven-day cycle after feedback. The toolkit can also be adapted for multilingual and accessible formats, digital progress tracking, and other workstation contexts.

Other relevant information

The evaluation used a short, uncontrolled one-group pre-test–post-test design with matched responses and self-reported measures. It demonstrates short-term within-participant change but does not establish causality, long-term habit formation, or prevention of musculoskeletal conditions. Future evaluation should include a comparison group, longer follow-up, objective workstation observation, and a student-developer learning rubric. Supplementary materials include the self-checks, stickers, and Daily ErgoCheck Card.

Acknowledgement

The authors acknowledge the Introduction to Ergonomics students who contributed to ErgoCheck AI through their course assignment and the 96 students who participated in its implementation and evaluation.

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ID 87: Sustainbee AI: A Lifelong Learning Ecosystem for Sustainable Stingless-Beekeeping Education

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Highlights: Sustainbee AI is a learning model that connects students from campuses globally and in local communities through modern technology focused on stingless beekeeping. It includes teaching modules, 3D-printed models of bee colonies, a trap for catching stingless bees to start new hives, the Electronic Meliponini Advanced System (EMAS) for managing hive data digitally, the HivegateAI web app for identifying and counting bee species, and an automatic stingless bee honey dehydrator. Analysis of pre- and post-surveys indicates that students increased their knowledge by an average of 36%. Additionally, HivegateAI system promotes advancement of stingless bee knowledge and practical skills. On 7 February 2026, the community strand celebrated its first successful honey harvest from Kelestarian Kelulut dan Alam Lestrari (KEKAL) box hives that were provided in May 2025, demonstrating that the bee colonies were active, the community was effectively managing the hives, and the implementation model was functioning well. The farm-to-market learning pathway incorporates low-temperature dehydration, moisture verification against the processed honey target, EMAS batch traceability, food-grade packaging, and community product presentation. This model integrates human capital, honey quality and standards, biodiversity stewardship, and community enterprise while maintaining the essential roles of educators and beekeepers in decision-making.

Keywords: Human-AI synergy; Lifelong learning; Stingless bees; Sustainable community education; Learning analytics

Introduction

Stingless-bee education is well suited to experiential and lifelong learning because it connects biodiversity, engineering, data literacy, food quality, entrepreneurship and community stewardship. However, conventional short courses often separate biological theory from farm records, species identification, evidence-based decision making and product standards. Learners may remember procedures without developing the transferable capacity to observe a colony, interpret data, justify an intervention and improve practice over time.

Sustainbee AI addresses this gap through a local-international-community learning ecosystem. It extends the Kolej Dato' Onn Jaafar (KDOJ) stingless-bee co-curricular initiative and the 2025 KEKAL community module with EMAS (Electronic Meliponini Advanced System), low-impact bait traps, 3D-printed colony models and HivegateAI. The innovation aligns with NALI 2026 Category 2 through responsible human-AI collaboration and with Category 5 through community and adult education, upskilling and practice-based lifelong learning. Human expertise remains the decision authority: AI organises observations and provides feedback, while educators, experienced beekeepers and learners validate meaning and choose action.

Objectives

- To develop an integrated learning cycle that moves learners from visualisation and hands-on practice to digital recording, AI-supported interpretation and reflective action.
- To strengthen measurable biological, technical, digital, quality-assurance and entrepreneurial competencies among local, international and community learners.
- To create a scalable sustainability pathway that protects biodiversity, supports MS 2679:2017 good meliponiculture practice and MS 2683:2017 honey-quality awareness, and enables responsible community income generation.

NALI Approach

Novelty

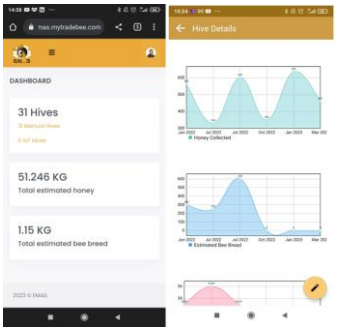
The innovation combines living colonies, a physical 3D cross-section, field practice (Figure 1 (a)), longitudinal hive records and AI analytics in one learning loop. Unlike a stand-alone app or workshop, each technology has a pedagogical role: the 3D model makes hidden colony structures discussable as shown in Figure 1(b); traps teach ethical propagation as shown in Figure 1(a); EMAS turns observations and harvests into traceable records as illustrates in Figure 1(c); and HivegateAI makes species evidence and IN/OUT traffic visible for inquiry as depicted in Figure 1(d). This creates a human-AI co-learning environment rather than an automated substitute for teaching.



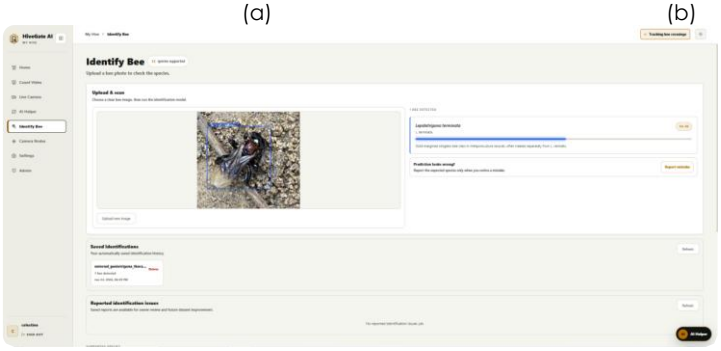
(a)



(b)



(c)





(d)

Figure 1: (a) Hands-on workshop based on sustainable training module (b) Human-guided observation links a 3D colony model with the living apiary and international participants (c) EMAS user dashboard and graph views (d) Hivegate AI: Species identification with directional IN/OUT counting.

Creativity

Learners rotate between model, apiary and digital evidence. They explain brood and food-storage structures using the 3D model, construct or inspect a bait trap, register the hive in EMAS, compare human observations with AI outputs and defend a management recommendation. Local students contribute engineering and data skills, international learners contribute comparative experience, and community adults contribute contextual and indigenous practice knowledge. Reflection closes the cycle so experience becomes reusable knowledge.

Innovativeness

The enhanced 2025-2026 version adds HivegateAI and 3D-printed teaching objects to the established EMAS and farm-practice module. HivegateAI was developed through a 2026 UTM undergraduate project and supports 12-class species identification, directional bee counting, historical records, downloadable reports and an AI helper. Its interface exposes confidence and allows error reporting, enabling critical AI literacy and transparent discussion of model limitations. EMAS complements this by recording hive identity, history, environment and harvest information for learning analytics and traceability.

Applicability

The modular design can be delivered as co-curricular learning, a final-year engineering project, a short course, a community workshop or an adult reskilling programme. Low-cost traps and reusable 3D models reduce dependence on opening live colonies. EMAS supports both manual and sensor-derived entries, while HivegateAI accepts ordinary images and videos through a web interface. The same learning outcomes and paired pre/post measures can therefore be applied in universities, residential colleges, schools, community farms and beekeeper associations with different levels of connectivity and equipment.

Innovation Description, Process and Implementation

The learning process has five connected phases. (1) SEE: learners use colony diagrams and a 3D-printed model to identify the brood chamber, brood cells, food-storage pots, entrance and structural supports. (2) BUILD: they examine hive placement, forage, pest prevention and ethical colony propagation using a bait trap. (3) SENSE AND RECORD: learners register a hive, record condition and harvest data, and interpret temperature, humidity, activity and yield in EMAS. (4) INTERPRET WITH AI: they upload a bee image or entrance video to HivegateAI, compare the result with human observation and discuss confidence, error, bias and dataset limitations. (5) ACT, PROCESS AND REFLECT: teams implement a justified intervention or enterprise action and, after harvest, extract cleanly, dehydrate below 40 degrees Celsius, measure moisture, pack in food-grade containers, label the batch/date/colony, record the evidence in EMAS and review market feedback. Implementation spans campus instruction, international engagement and the KEKAL community setting at Felda Tenggaroh 7.

Key Findings

Published pre/post evidence from a 20-participant international-student workshop showed gains across all three measured competencies (Yunus et al., 2023). The mean gain was 35.7 %, reported as 36 % points.

Table 1: Published pre/post student evidence (n = 20).

MEASURED COMPETENCY	PRE (%)	POST (%)	GAIN (PP)
Distinguishing insect features	60	92	+32
Stingless-bee anatomy	30	85	+55
Hive-baiting and colony behaviour	75	95	+20

The 2026 HivegateAI provides product-based evidence of how AI can strengthen participants' skills and interest. HivegateAI turns field images into guided species-identification activities, while EMAS turns farm practice into an organised, traceable learning record. Their contributions align directly with the six domains of sustainable stingless bee entrepreneurship (Hiu, 2026; Yunus, 2025).

Table 2: Questionnaire-aligned learning contributions of EMAS and HivegateAI.

STINGLESS BEE ENTREPRENEURSHIP DOMAINS DOMAIN	HOW EMAS AND HIVEGATEAI STRENGTHEN LEARNING
Stingless-bee ecology	HivegateAI makes species differences visible, helping participants connect observable traits with bee biology and anatomy while increasing interest in stingless-bee diversity.
Farm preparation	EMAS keeps supplier, log/hive, equipment and initial-colony records together, making farm establishment more traceable and easier to review.
Colony care	EMAS organises inspection, maintenance, colony-activity and pest/disease-control histories; HivegateAI entrance observations provide prompts for closer human inspection.
Honey and bee-bread harvest	EMAS maintains harvest date, colony/batch, yield, moisture, dehydration, bottling and cleaning records, strengthening continuity and standards awareness.
Colony propagation	Stingless-bee traps and EMAS support planning, installation, maintenance, transfer, topping, new-colony monitoring and propagation records.
Product sales	EMAS batch traceability connects packaging and product introduction with consumer feedback and sales records, supporting marketing learning and quality improvement.

These findings describe technology-enabled learning contributions of EMAS and HivegateAI aligned to the sustainable stingless bee entrepreneurship

Verified Community and Post-Harvest Outcome

On 7 February 2026, the KEKAL follow-up documented the first successful harvest from log hives supplied in May 2025 (Kolej Dato' Onn Jaafar, 2026). The success demonstrates colony survival, effective community care and practical implementation of the KEKAL model. The harvest entered a controlled post-harvest learning workflow: clean extraction; low-temperature dehydration below 40° Celsius; pre/post moisture measurement; an acceptance target below 22% for processed honey under MS 2683:2017; food-grade packing; date, batch and colony labelling; EMAS harvest/moisture traceability; and community product handover and promotion. Successful packaged-product introduction and community market engagement was carried out after the first successful harvest as shown in Figure 2. Initial/final moisture readings and sales revenue were not supplied, so neither a verified compliance pass nor quantified commercial sales is claimed (Shamsudin et al., 2019; Yunus, 2025).



Figure 2: Post-harvest quality control and market readiness: low-temperature dehydration and packaged-product community handover.

Impact

The ecosystem builds biological understanding, fabrication, instrumentation, AI literacy, teamwork and entrepreneurial judgement. Authentic assessment combines explanations, field decisions, digital records and AI critique. For communities, adult education improves propagation, traceability, post-harvest quality and market readiness. The verified two-hive first harvest extends the programme from training participation to farm-to-market outcome evidence: maintained colonies produced a tangible batch that could be processed, packed, presented and traced. The living laboratory supports knowledge transfer; forage awareness and low-impact propagation strengthen pollinator stewardship; and standards-oriented records support consistent honey quality, consumer trust and responsible value creation.

Recommendations for Classroom Practice

- Begin with the 3D model, then require learners to identify the same structures in field observations.
- Rotate team roles: beekeeper-observer, EMAS recorder, AI analyst, standards checker and reflective reporter.
- Assess the reasoning chain - evidence, AI output, human verification, decision and reflection.
- Use stable anonymous identifiers and report only verified matched pre/post responses.
- For every harvest, log batch ID, colony, initial/final moisture, dehydration temperature and time, net mass, outlet or sales, and buyer feedback; report only fields supported by records.

Other relevant information

Sustainbee AI can scale as a short course, stackable community module and cross-disciplinary project platform. EMAS and HivegateAI can add multilingual guidance, more species, solar field capture and verified QR traceability. Its commercialisation proposition is a replicable education-and-support package: curriculum, reusable models, software access, assessment instruments and community mentoring. Future evaluation should pair competence gains with verified farm-to-market indicators such as colony survival, harvest mass, moisture reduction, compliant batches, product units, sales channels, revenue and repeat buyers.

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ID 88: AI-Orchestrated Collaborative Case-Based Learning Framework

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Highlights: Traditional higher education assessments face immense pressure from generative AI, which easily automates written answers and masks true student understanding. This innovation introduces a framework that transforms AI from a passive text-generator into an interactive, simulated stakeholder. Students collaborate in groups to negotiate and justify solutions to dynamic, AI-generated case scenarios. Evaluation data reveals a substantial positive impact on student engagement, critical thinking, and collaborative reasoning. Distinctly, this approach shifts the educational focus from mere answer production to active solution justification and evaluative reflection.

Keywords: AI-mediated learning; Collaborative learning; Case-based learning; Active learning; Student-centred learning.

Introduction

Traditional tutorial and assignment-based learning activities in higher education are increasingly challenged by the rapid advancement of generative artificial intelligence (AI) technologies (Francis et al., 2025; Weng et al., 2024). Tools such as ChatGPT are capable of producing high-quality explanations, case analyses, and written assignments within seconds, making conventional answer-oriented learning activities less effective in evaluating authentic student understanding and reasoning processes. As a result, students may become overly dependent on AI-generated outputs, while lecturers face difficulties in assessing students' actual cognitive engagement, collaborative reasoning, and decision-making abilities.

Traditional classroom activities commonly focus on the submission of final answers or written outputs, which may no longer accurately represent students' actual understanding in the era of generative AI (Weng et al., 2024). Consequently, there is a growing need to redesign learning activities that move beyond answer production and instead emphasise collaborative discussion, solution justification, reflective learning, and active engagement (Francis et al., 2025). Student-centred learning approaches suggest that meaningful learning occurs when students actively participate in knowledge construction through interaction, discussion, and problem-solving activities. Simultaneously, AI technologies offer opportunities not only for content generation but also for facilitating dynamic, interactive, and adaptive learning environments.

Objectives

To address this gap, the present innovation proposes an AI-Orchestrated Collaborative Case-Based Learning Framework that integrates AI as a simulated stakeholder within collaborative classroom activities. Instead of functioning as a direct answer provider, the AI system generates contextualised case scenarios, acts as a decision-making client or stakeholder, and evaluates student-generated solutions based on predefined criteria such as feasibility, practicality, creativity, clarity, and contextual appropriateness. Students work collaboratively in groups to analyse the case, discuss possible solutions, justify recommendations, and refine their ideas based on AI-mediated feedback. Meanwhile, the lecturer assumes the role of learning designer, facilitator, and AI orchestrator who guides the overall learning process.

The proposed framework consists of six key stages. First, the lecturer defines the learning outcomes, discussion objectives, and evaluation criteria. Second, the AI system generates a contextualised case scenario related to the lesson topic. Third, students discuss the case collaboratively in groups and formulate proposed solutions. Fourth, each group presents and justifies its recommendations. Fifth, the AI system evaluates and compares the proposed solutions, explains strengths and limitations, and identifies preferred recommendations based on predefined criteria. Finally, students reflect on the AI feedback, defend their reasoning where necessary, and revise their proposed solutions.

NALI Approach

Novelty

The novelty lies in repositioning Generative AI from a passive content-generation tool into an active, simulated stakeholder. Unlike conventional AI-assisted learning, the framework uses AI as an inquisitive client who challenges students to justify their proposed solutions (Humburg et al., 2024).

Creativity

The creative element lies in designing an interactive learning environment where AI acts as an inquisitive client rather than an answer provider. Students engage in simulated stakeholder interactions that encourage critical thinking, creative problem-solving and reflective reasoning.

Innovativeness

The framework transforms conventional, answer-oriented tutorial activities into interactive learning experiences focused on solution justification and reflective reasoning. It promotes active learning by challenging students to evaluate, defend and refine their proposed solutions.

Applicability

The framework has been applied across multiple undergraduate business modules, demonstrating its adaptability to different learning contexts. Its flexible design allows educators to customise AI interactions, learning tasks and assessment activities across disciplines.

Innovation Description, Process and Implementation

Refer to Figure 1, this study adopts an AI-orchestrated collaborative case-based learning framework consisting of six sequential stages. First, the lecturer defines the learning outcomes, discussion objectives, and evaluation criteria to provide students with a clear learning structure and expectations. Second, the AI system generates a contextualised case scenario related to the lesson topic, positioning AI as a simulated stakeholder or client seeking solutions to a specific problem. Third, students collaborate in groups to analyse the case, discuss possible recommendations, and formulate proposed solutions based on their understanding and reasoning. Fourth, each group presents and justifies its proposed solution through classroom discussion and peer interaction. Fifth, the AI system evaluates and compares the proposed solutions, highlighting strengths, limitations, and preferred recommendations according to predefined criteria such as feasibility, practicality, clarity, creativity, and contextual appropriateness. Finally, students reflect on the AI-generated feedback, defend their reasoning where necessary, and revise their proposed solutions to strengthen understanding and learning outcomes.

This systematic process transforms traditional tutorial activities into an interactive, collaborative, and AI-mediated learning environment where students actively participate in problem-solving and reflective learning. In this framework, the lecturer functions as the learning designer, facilitator, and AI orchestrator who guides the overall learning process and validates learning outcomes.

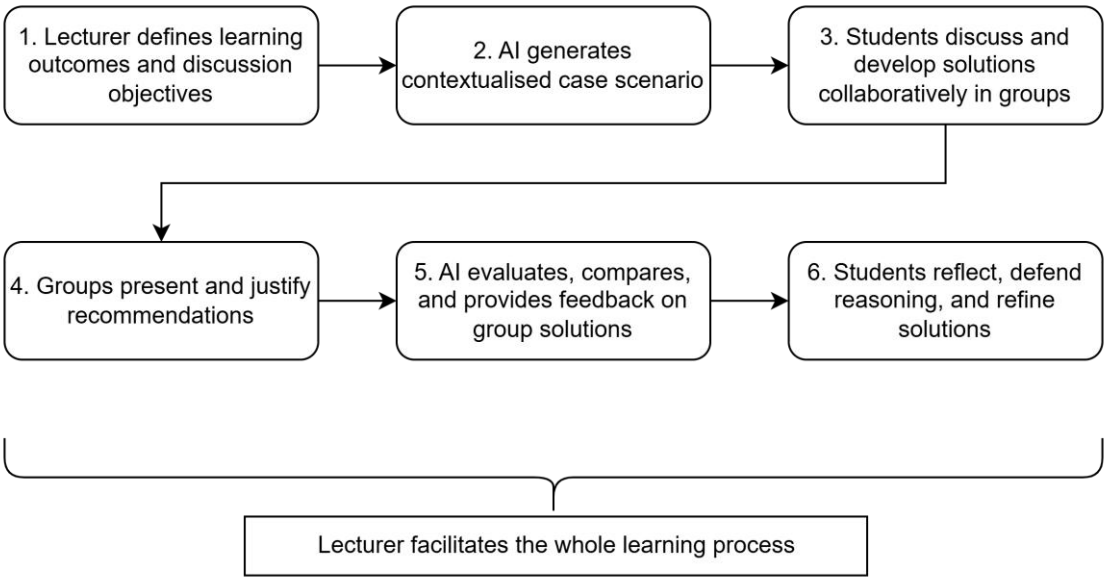


Figure 1: AI-orchestrated collaborative case-based learning framework.

The proposed framework was implemented in several undergraduate business and management classes to evaluate its effectiveness in enhancing student engagement and collaborative learning. Upon completion of the learning activities, a structured survey was distributed to students to gather their feedback and perceptions regarding the framework. A five-point Likert scale was adopted in this study, where one (1) denotes "strongly disagree" and five (5) denotes "strongly agree". The survey assessed key dimensions including student engagement, collaborative learning, perceived usefulness, critical thinking, and overall satisfaction with the learning experience. The collected data provides valuable insights into the strengths, effectiveness, and future improvement opportunities of the proposed AI-mediated collaborative learning framework.

Key Findings

Referring to Table 1, the survey findings indicate highly positive student perceptions toward the AI-Orchestrated Collaborative Case-Based Learning Framework. Under the dimension of student engagement, students reported that the framework encouraged them to participate more actively during classroom discussions (Mean = 4.03), increased their involvement in group learning activities (M = 3.92), and enhanced their interest in lesson participation (M = 4.00).

In terms of collaborative learning, respondents agreed that group discussions improved their understanding of the case scenarios (M = 3.93), encouraged the sharing of ideas and perspectives (M = 3.92), and strengthened collaborative problem-solving abilities (M = 3.97).

For perceived usefulness, students indicated that the AI-generated case scenarios were relevant and engaging (M = 4.07), while the AI feedback helped them evaluate and improve their solutions more effectively (M = 4.17). Students also agreed that the AI evaluation process enabled them to compare different approaches and identify stronger justifications for decision-making (M = 4.14). Under the dimension of critical thinking, students reported that the framework encouraged them to justify recommendations carefully (M = 3.97), reflect on the strengths and weaknesses of their solutions (M = 4.01), and think more deeply about problem-solving strategies (M = 4.04).

Collectively, these findings suggest that the proposed framework successfully transformed conventional tutorial activities into a more interactive, collaborative, and reflective learning experience. The integration of AI as a simulated stakeholder and evaluative learning facilitator enhanced classroom interaction, promoted active participation, and strengthened collaborative reasoning among students. The findings further demonstrate the framework's potential as an innovative pedagogical approach aligned with the NALI philosophy of student-centred and AI-enhanced learning.

Table 1: Students' feedback.

NO.	QUESTION	MEAN
	Student Engagement (Bhatt & Muduli, 2024)	
1	I participated more actively during classroom discussions using this learning framework.	4.03
2	The AI-generated case scenarios increased my interest in the lesson activities.	4.04
3	This learning framework encouraged me to contribute more ideas during group discussions.	3.92
	Collaborative Learning (Qureshi et al., 2023)	
4	Group discussions helped me understand the case scenarios more effectively.	3.93
5	The learning activities encouraged meaningful sharing of ideas among group members.	3.92
6	The framework improved my collaborative problem-solving skills.	3.97
	Perceive usefulness (Yeung et al., 2025)	
7	The AI-generated case scenarios were relevant and engaging for learning.	4.07
8	The AI feedback helped me improve the quality of my proposed solutions.	4.17
9	Comparing group solutions with AI evaluation enhanced my understanding of the topic.	4.14
	Critical Thinking (Schönberger, 2024)	
10	The framework encouraged me to justify my recommendations carefully.	3.97
11	The AI evaluation helped me reflect on the strengths and weaknesses of my solutions.	4.01
12	The learning activities encouraged deeper thinking about problem-solving strategies.	4.04

NO.	QUESTION	MEAN
	Overall Satisfaction (Al-Fraihat et al., 2025)	
13	I am satisfied with the AI-orchestrated collaborative learning experience.	3.93
14	I would like to experience more classes using this framework.	3.92
15	This learning approach is more engaging than traditional tutorial activities.	3.95

Impact

The AI-Orchestrated Collaborative Case-Based Learning Framework successfully transforms traditional tutorial and assignment activities into a more interactive, collaborative, and reflective learning experience. By integrating AI as a simulated stakeholder and evaluative learning facilitator, the framework encourages students to actively participate in problem-solving discussions, justify recommendations, and reflect on the strengths and limitations of their proposed solutions.

The findings indicate that the framework enhanced student engagement, collaborative learning, critical thinking, and overall satisfaction with the learning process. The AI-generated case scenarios and evaluative feedback further contributed to richer classroom interaction and deeper understanding of lesson content. Unlike traditional answer-oriented learning activities, the proposed framework emphasises reasoning processes, collaborative discussion, and reflective learning, making it more aligned with the evolving educational landscape in the era of generative AI.

This innovation demonstrates strong alignment with the NALI philosophy by promoting student-centred learning, active participation, and meaningful AI integration within higher education classrooms. Its flexibility and adaptability across different disciplines and learning contexts further highlight its potential for broader implementation in future teaching and learning practices.

Recommendations for Classroom Practice

This innovation extends constructivist learning theory, originally proposed by (Piaget, 1952) and later expanded by (Vygotsky & Cole, 1978), by integrating AI as an interactive facilitator within collaborative learning environments. Piaget's constructivist theory emphasises that learners actively construct knowledge through engagement and interaction with learning experiences. Meanwhile, Vygotsky's sociocultural theory highlights the importance of social interaction, collaboration, and guided support in the development of higher-order thinking skills.

The proposed AI-Orchestrated Collaborative Case-Based Learning Framework operationalises these principles by positioning AI as a simulated stakeholder that facilitates problem-solving, discussion, and reflective learning. Rather than functioning solely as a content-generation tool, the AI system creates dynamic learning environments where students collaboratively analyse problems, justify recommendations, and refine solutions through interaction and feedback. This approach promotes active participation, collaborative reasoning, and reflective learning while strengthening students' decision-making and problem-solving abilities.

The framework also contributes to emerging discussions on AI-enhanced pedagogy by shifting the role of AI from answer generation toward learning orchestration and evaluative facilitation. The proposed innovation aligns closely with the NALI framework by combining AI integration, active learning, collaborative interaction, and student-centred pedagogy into a structured and scalable learning model suitable for higher education environments.

Other relevant information

The proposed AI-Orchestrated Collaborative Case-Based Learning Framework demonstrates promising commercialisation potential as an innovative AI-enhanced teaching and learning solution for higher education institutions and training providers. The framework could be developed into a structured educational package consisting of AI prompt libraries, case-generation templates, instructional guidelines, classroom implementation modules, and assessment support materials.

Additionally, the framework may be integrated into existing Learning Management Systems (LMS) or developed as a standalone AI-supported collaborative learning platform that facilitates classroom interaction, case-based discussions, and AI-mediated feedback processes. Its adaptability across multiple disciplines, particularly in business, management, and social science education, further enhances its scalability and marketability.

Given the growing global interest in AI-integrated pedagogy and student-centred learning innovation, the proposed framework offers strong opportunities for future expansion, institutional adoption, and commercial development within both academic and professional training environments.

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ID 89: Intensive English Program (IEP) as an Immersive and Innovative English Language Learning Ecosystem

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Highlights: The Intensive English Programme (IEP) at Universiti Teknologi Malaysia addresses the challenges international students face in developing the English proficiency and communicative competence required for university study. Moving beyond conventional classroom-based language instruction, IEP creates an immersive learning ecosystem that integrates structured language development, collaborative projects, digital and self-directed learning, authentic communication, and cultural experiences. Through sustained engagement in English across academic, social, and experiential contexts, students develop greater confidence, autonomy, and communicative competence. The programme demonstrates an innovative, holistic approach to language learning by transforming English from a classroom subject into a lived learning experience.

Keywords: Intensive English programme; Immersive language learning; English language learning ecosystem; Experiential learning; International students

Introduction

International students entering higher education require more than adequate English language proficiency; they also need the confidence and ability to use English meaningfully across academic, social, and intercultural contexts. Conventional classroom-based language instruction, however, may provide limited opportunities for authentic communication and independent language use. Recent studies highlight the value of holistic and self-directed approaches that extend language learning beyond formal classroom settings (Doo & Zhu, 2024; Kim et al., 2025). At the same time, generative artificial intelligence (AI) has created new opportunities for language learners by supporting vocabulary development, translation, idea generation, language accuracy, and independent learning (Liu et al., 2024; Annamalai et al., 2026).

Responding to these needs, the Intensive English Programme (IEP) at Universiti Teknologi Malaysia (UTM) is designed as an immersive English language learning ecosystem that integrates structured language instruction with collaborative projects, cultural experiences, self-directed learning, authentic human interaction, and AI-supported learning. Central to the ecosystem is Human–AI synergy, where AI functions as a learning mediator to support students in preparing, developing, and refining their language, while meaningful learning is activated through human communication, collaboration, and real-world experiences. This integration transforms English from a classroom subject into a language that students actively learn, apply, interact with, and reflect upon throughout their IEP learning journey.

Objectives

- To develop an integrated English learning ecosystem that extends language learning beyond the classroom through collaborative projects, cultural activities, and self-directed learning activities.
- To provide learners with meaningful opportunities to learn English by using AI as a mediator in collaborative projects, cultural activities, and self-directed learning activities.
- To enhance learners' English language development and confidence through collaborative projects, cultural activities, and self-directed learning activities.

NALI Approach

Novelty

The novelty of the Intensive English Programme (IEP) lies in its immersive learning ecosystem, which extends English learning beyond conventional classroom instruction through interconnected language classes, self-directed learning, Connect & Communicate activities, collaborative projects, cultural experiences, and reflective practices. A distinctive feature is the IEP Buddy System, embedded within Connect & Communicate and Collaborative Projects, where each international IEP student is paired with a local UTM student to facilitate authentic peer interaction, meaningful English communication, and intercultural

exchange. Together, these components create a continuous environment in which students learn, practise, and use English across academic, social, and cultural contexts.

Creativity
Creativity is embedded in the way IEP transforms different learning spaces and experiences into opportunities for meaningful language use. Classroom instruction is complemented by Connect & Communicate and Collaborative Projects, including the Cultural Showcase, where students from diverse countries such as China, Yemen, Sudan, Somalia, Bangladesh, and Indonesia use English to present and share their traditions, customs, and cultures with their peers. Learning is further extended through a Cultural Trip to Melaka, where students are exposed to Malaysian culture and history while using English in authentic contexts. As they explore the city, students actively apply newly acquired vocabulary to describe places, objects, cultural practices, and their experiences, while also using English during activities such as batik painting, cultural dances, and interactions with local communities. Video reflections, reflective writing, and language games further reinforce learning through communication, experience, creativity, and reflection.

Innovativeness
IEP introduces an innovative pedagogical approach by integrating face-to-face instruction, self-directed learning, collaborative learning, experiential learning, AI-supported learning, authentic language use, and reflection within a single programme structure. Within Connect & Communicate and Collaborative Projects, students use AI as a learning support tool to search for information, brainstorm ideas, translate texts, build vocabulary, correct grammar and spelling, and help design posters for presentations. Students also develop their language skills through structured classroom instruction and independent practice using Build Language Skills (BLS) Online, before applying them through collaborative tasks, peer interaction, and real-life experiences. Video reflections and reflective writing further encourage students to evaluate their experiences and language development. This creates an integrated learning cycle of learning, practising, interacting, creating, applying, and reflecting, with technology and AI supporting students as active and independent users of English.

Applicability
The IEP ecosystem has strong potential for adaptation, replication, and scalability across universities with existing intensive or preparatory English programmes. Rather than developing an entirely new programme, institutions can adopt the IEP structure and ecosystem by integrating structured language instruction with authentic communication, collaborative projects, experiential learning, AI-supported activities, self-directed learning, and reflection. The model can be adapted to learner proficiency, institutional resources, and local cultural contexts, and individual components can also be introduced progressively into existing programmes. Its flexible integration of classroom, digital, social, and experiential learning environments makes the ecosystem a practical and sustainable model for enhancing intensive English language programmes across different higher education settings.

Innovation Description, Process and Implementation

The IEP is implemented as an integrated 10-week language learning ecosystem in which students move continuously across classroom, digital, social, and experiential learning environments. This ecosystem is structured around the FLAIR Learning Framework: Frame, Learn, Apply, Interact, and Reflect.

FRAME – Framing the Learning Journey
Students begin with an IEP Placement Test to identify their English proficiency levels and determine appropriate class placement. This frames the learning journey according to students' starting proficiency and language learning needs.

LEARN – Building and Practising Language Skills
Students develop their Listening, Speaking, Reading, and Writing skills through structured weekly language modules. Learning is reinforced through Build Language Skills (BLS) Online, where students independently complete assigned online exercises and homework, extending language practice beyond classroom hours and promoting self-directed learning.

APPLY – Putting Language into Meaningful Practice
Students apply the language knowledge and skills acquired through classroom and online learning in meaningful tasks through Connect & Communicate, Collaborative Projects, Cultural Showcase, Student Engagement Projects, and cultural experiences. AI further supports the learning process through information searching, brainstorming, translation, vocabulary building, grammar and spelling correction, and creating presentation materials.

INTERACT – Communicating in Authentic Contexts
Students use English for genuine communication and intercultural interaction beyond teacher-led classroom activities. Through the IEP Buddy System, each international IEP student is paired with a local UTM student, while collaborative projects and cultural experiences provide further opportunities to communicate with peers and local communities in authentic social and cultural contexts.

REFLECT – Evaluating Learning
Students evaluate their learning through video reflections and reflective writing, enabling them to revisit their experiences and recognise their language development.

Key Findings

1. Integrated Learning Beyond the Classroom
RO1: To develop an integrated English learning ecosystem that extends language learning beyond the classroom through collaborative projects, cultural activities, and self-directed learning activities.

IEP has demonstrated the English language learning ecosystem through an integrated combination of collaborative projects, cultural activities, the IEP Buddy System, Connect & Communicate, and self-directed learning through BLS Online. These interconnected learning experiences provided students with multiple opportunities to practise and use English across classroom, digital, social, and cultural settings, supporting a more immersive and continuous English learning ecosystem.

2. Human–AI Synergy in Meaningful Language Learning
RO2: To provide learners with meaningful opportunities to learn English by using AI as a mediator in collaborative projects, cultural activities, and self-directed learning activities.

Findings from a survey showed that all students used generative AI to support their learning, with no respondents reporting non-use. Students used AI primarily to translate texts (62.5%), followed by vocabulary building (50%), grammar and spelling correction (45.8%), and brainstorming ideas (37.5%). Students also used AI to draft essays or assignments (25%) and summarise academic texts (25%). These findings demonstrate AI's role as a learning mediator, particularly in helping students overcome language barriers, expand vocabulary, improve language accuracy, and generate ideas. Within the IEP ecosystem, this AI-supported preparation complements human-centred activities such as collaborative projects, cultural activities, and peer interaction, enabling students to subsequently apply their AI-supported learning through meaningful communication and collaboration with others.

3. English Language Development and Confidence

RO3: To enhance learners' English language development and confidence through collaborative projects, cultural activities, and self-directed learning activities.

Learners' English language development was measured by comparing students' pre-IEP Placement Test CEFR levels with their post-IEP English Proficiency Test CEFR levels. Of the 36 students analysed, 26 students (72.22%) progressed to a higher CEFR level, while 7 students (19.44%) maintained their initial proficiency level. Only 3 students (8.33%) recorded a lower CEFR level in the post-IEP assessment. Overall, 91.66% of students either improved or maintained their English proficiency level after completing the programme. These findings indicate an overall positive development in learners' English proficiency following their IEP learning experience.

Students' reflective writing further revealed increased confidence in using English, particularly in speaking, presenting, and interacting with others. Across reflections from students of different nationalities, a consistent progression emerged from initial hesitation, fear, and difficulty expressing ideas towards greater fluency, comfort, and confidence in communicating in English. This development was particularly evident through collaborative activities and group presentations. The students reflected:

> Student 1 (Saudi Arabia): "During a group presentation, I was able to convey my ideas fluently and respond to questions confidently, a clear testament to my progress."
>
> Student 2 (Somalia): "Initially, I felt unconfident in my pronunciation and often felt uncomfortable or embarrassed when speaking... Now, I can speak without discomfort or embarrassment."
>
> Student 3 (China): "At the beginning, I was afraid to speak in class because I thought my pronunciation and fluency were not good enough... I remember a group presentation where I spoke clearly and received positive feedback. This experience helped me overcome my fear of public speaking."

Student 4 (Egypt): "Initially, conversations felt hesitant, with long pauses for me to search for the right words. Now, discussions flow more naturally... I delivered the final presentation with greater confidence and clarity."

Collectively, these reflections demonstrate a clear shift from language anxiety and hesitation to greater fluency, willingness to communicate, and confidence in presenting and interacting in English. They further indicate that repeated opportunities to apply English through collaborative and authentic communicative activities played an important role in developing learners' communicative confidence.

Impact

The Intensive English Programme (IEP) generates significant value across multiple levels:

- Students: The IEP significantly enhances language proficiency, with a high success rate (97%) in achieving required academic benchmarks. Beyond test scores, students develop substantial communicative confidence, reduced language anxiety, and improved intercultural competence through the IEP Buddy System and experiential learning activities. Students transition from hesitant language learners to active, autonomous users of English.
- Educators: The programme empowers educators to shift towards a facilitator role, effectively leveraging AI as a supportive mediator. It provides a proven, structured yet flexible pedagogical model (FLAIR) that integrates face-to-face instruction with digital and experiential learning environments, allowing for more dynamic and impactful teaching.
- Institutions: The IEP ecosystem serves as a scalable, sustainable, and replicable model for higher education language programmes. It fosters meaningful community engagement through peer-assisted learning and enhances institutional reputation by producing graduates who are not only proficient in English but also culturally integrated and socially confident.

Recommendations for Classroom Practice

To effectively integrate, adapt, or replicate the IEP ecosystem, educators and institutions should consider the following strategies:

- integrate AI as a Learning Mediator: Encourage students to use AI tools for brainstorming, vocabulary enhancement, and grammar/spelling correction. The focus should remain on using AI to support the learning process, rather than as a shortcut, ensuring students remain active and independent users of English.
- implement Peer-Supported Learning (Buddy System): Pair international learners with local students to facilitate authentic communication, cultural exchange, and social integration. This interaction is critical for reducing communication anxiety and creating a sense of belonging.
- adopt the FLAIR Framework: Structure language programmes to encompass the full cycle of 'Frame, Learn, Apply, Interact, and Reflect.' This ensures that language acquisition is not confined to the classroom but extends into continuous, real-world application.
- incorporate Experiential Learning: Move language practice outside the classroom through cultural trips, showcases, and collaborative projects. This allows students to apply newly acquired vocabulary and grammar in authentic, meaningful contexts.
- prioritise Reflective Practice: Regularly incorporate video reflections and reflective writing tasks. These allow students to evaluate their own progress, revisit their experiences, and recognise their growth in confidence and fluency over time.

Other relevant information

As part of the programme's sustainability and intellectual property initiatives, the IEP team has developed dedicated Connect & Communicate and Collaborative Project modules to support the implementation of its immersive learning ecosystem. Copyright applications for both modules are currently in progress, reflecting efforts to formally protect the instructional materials developed by the team. The modules also have potential for further adaptation, replication, and use in other English language learning contexts, supporting the long-term scalability and sustainability of the IEP ecosystem.

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ID 90: Evaluating Library-Assisted Information Literacy Workshops Through AI-Assisted Triangulated Assessment Analytics

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Highlights: This innovation addresses the challenge of evaluating the effectiveness of library-assisted information literacy workshops beyond participant satisfaction surveys. Three workshops incorporating Generative AI support were designed to develop topic analysis, search strategy, source evaluation, evidence integration, and APA referencing skills. A novel Triangulated Information Literacy Impact Model (TILIM) was developed to analyse both student essays and lecturer feedback using AI-assisted coding. Findings from 30 research essays and 30 Turnitin assessment reports demonstrated strong evidence of information literacy development, with substantial convergence between student-demonstrated competencies and lecturer-recognised competencies.

Keywords: Information literacy; Generative AI; Library instruction; Assessment analytics; Triangulation

Introduction

The increasing use of Generative Artificial Intelligence (GenAI) in higher education has transformed the way students locate, evaluate, and use information. While AI tools offer powerful opportunities for supporting research processes, concerns remain regarding students' ability to identify credible information sources, validate AI-generated content, and apply information ethically. Most learners tend to use information provided by AI tools uncritically, and some even blindly trust all the information without factchecking or referring to the actual sources given. They are unable to distinguish between using GenAI as a tool, and positioning GenAI as a source. To address these challenges, three library-assisted workshops were implemented within MUF0012 English Unit 2 of the Monash University Foundation Year (MUFY) Programme at Sunway College Johor Bahru. The workshops focused on:

- topic analysis and background research
- search strategies and source evaluation
- APA referencing and ethical information use

Rather than evaluating workshop effectiveness through perception surveys alone, this innovation examined authentic evidence of learning through students completed research essays and lecturer assessment feedback. A novel AI-assisted triangulated framework was developed to evaluate the impact of library instruction on students' information literacy competencies, drawing on the established Framework for Information Literacy for Higher Education (Association of College and Research Libraries [ACRL], 2016) as the underlying competency structure against which student and lecturer evidence were coded.

Objectives

- Develop students' information literacy competencies through structured library-assisted workshops.
- Support responsible use of Generative AI for research and information seeking.
- Measure students' demonstration of information literacy competencies in authentic assessment tasks.
- Validate AI-assisted essay analysis through lecturer assessment feedback.
- Establish a scalable framework for evaluating library instruction using learning analytics.

NALI Approach

Novelty

This project introduces a new evaluation framework known as the Triangulated Information Literacy Impact Model (TILIM). The model triangulates three independent sources of evidence:

- workshop learning outcomes
- student research essays

- lecturer assessment feedback

Most library instruction evaluations rely on surveys or self-reported perceptions. TILIM instead analyses authentic student work which in this context refers to essays produced as students engaged with GenAI-assisted research and lecturer assessment evidence to measure actual learning transfer. In grounding competency measurement in authentic practice rather than self-report, TILIM aligns with sociocultural and practice-based understandings of information literacy, which emphasise that literate behaviour is best observed within the tools and contexts through which it is enacted rather than inferred from stated perceptions alone (Limberg et al., 2012).

Three original instruments support TILIM: the Information Literacy Competency Index–Essay (ILCI-E), Information Literacy Competency Index–Feedback (ILCI-F), and Competency Convergence Index (CCI).

Creativity
The innovation combines library instruction and the use of Generative AI with authentic assessment, learning analytics and qualitative content analysis. AI was positioned not as a teaching replacement or grading tool, but as an analytic assistant that systematically coded evidence of information literacy competencies from student essays and lecturer feedback. This positioning is consistent with emerging frameworks for structuring generative AI use around explicit, reviewable principles rather than open-ended delegation, an approach reflected in recent prompt-engineering scholarship for information literacy contexts (Lo, 2023).

Innovativeness
The innovation introduces several new practices including AI-Assisted Competency Coding, Feedback Analytics and Convergence Analysis. Student essays were analysed against six workshop-aligned information literacy competencies: Topic Analysis, Keyword Development, Search Strategy, Source Evaluation, Evidence Integration and Referencing Competency. Lecturer feedback from Turnitin reports was independently coded using the same competency framework and finally, agreement between student performance and lecturer judgment was measured through the Competency Convergence Index (CCI).

Applicability
The innovation can be applied to foundation and undergraduate programmes, as well as academic literacy or research methods modules. The framework is discipline-independent because it focuses on transferable information literacy competencies rather than subject-specific content. The methodology can also be replicated across institutions that provide library instruction and research skills support.

Innovation Description, Process and Implementation

A series of three information literacy workshops were conducted by the facilitator from the Library and Learning Commons. Workshop 1: Background Research focused on assisting students to identify task words, content words and limiting words besides teaching them how to generate keywords and expand topic concepts. Workshop 2: Search Strategies and Source Evaluation instructed students on how to use Boolean operators, conduct database searches, evaluate source credibility and verify AI-generated information. Meanwhile, Workshop 3: APA Referencing provided guidance on applying APA 7 conventions, creating citations and constructing reference lists aside from showing students how to acknowledge AI use appropriately. This final workshop's emphasis on ethical acknowledgment of AI use reflects current global guidance on media and information literacy, which explicitly situates transparent, critical engagement with AI-generated content as a core citizenship competency (UNESCO, 2021).

Next, the Evaluation Framework is divided into three stages:

Stage 1: Essay Analysis
Thirty student essays were analysed using the Information Literacy Competency Index-Essay (ILCI-E).

Stage 2: Feedback Analysis
Thirty Turnitin reports were analysed using the Information Literacy Competency Index-Feedback (ILCI-F).

Stage 3: Triangulation
The Competency Convergence Index (CCI) was calculated using:

$$CCI = | ILCI\text{-}E - ILCI\text{-}F |$$

Lower CCI values indicate stronger agreement between essay analysis and lecturer judgement.

Key Findings

Table 1: Summary statistics for ILCI-E, ILCI-F, and CCI (N = 30).

MEASURE	MEAN	RANGE	N
ILCI-E (essays)	27.43	17–30	30
ILCI-F (lecturer feedback)	25.4	14–30	30
CCI (convergence)	2.43 (mean)/2.00 (median)	0–7	30

Among the six coded competencies, students demonstrated the strongest performance in topic analysis (M = 4.97), source evaluation (M = 4.67), and referencing (M = 4.63), while evidence integration emerged as the weakest area (M = 4.17). Lecturer feedback showed a similar pattern, with source evaluation most consistently recognised (M = 4.50) and keyword development least consistently recognised (M = 4.00).

Table 2: Distribution of competency Convergence Index (CCI) agreement levels

PERFECT	VERY STRONG	STRONG	MODERATE	WEAK
8	9	8	4	2

Findings indicate substantial convergence between AI-assisted essay analysis and lecturer judgement, with perfect-to-strong agreement in 25 of 30 cases (83%).

Impact

The workshops produced measurable gains across three stakeholder levels. Students demonstrated stronger topic analysis, source evaluation, search strategies, and referencing practice, with 76.7% reaching Advanced Information Literacy on ILCI-E. Educators gained competency-level assessment analytics that support more targeted intervention planning, moving feedback beyond holistic grading toward specific, actionable diagnostic detail. At the institutional level, the innovation offers a scalable, evidence-based model for measuring library instruction impact. However, library instruction must be an on-going initiative if students are to acquire strong information literacy skills that serve to guide their behaviour when engaging with research and other scholarly tasks.

Recommendations for Classroom Practice

- Based on the earlier findings, it is recommended that library instruction be integrated into assessment design rather than offering stand-alone workshops. Authentic assessment artefacts could then be used to evaluate learning transfer.
- Generative AI tools should serve as analytic assistants, not a grading substitute. For future workshops, synthesis of evidence and integration of sources should be further emphasized. The continued use of GenAI is encouraged, but with explicit instruction on verification and ethical use.

Acknowledgement

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ID 91: AI-Generated Pre-and Post-Quizzes Using Edcafe for Flipped Learning

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Highlights: Learning First-Order Differential Equations can be challenging as students need to distinguish between multiple solution methods and apply appropriate procedures. This innovation integrates flipped learning with Edcafe, an AI tool used to generate pre- and post-quizzes across six subtopics. Students watched instructional videos before class, completed a pre-quiz, received lecturer-led instruction and repeated the quiz afterwards. The findings indicate an increase in average performance from 76.0% to 84.5% (+8.5 percentage points), accompanied by an estimated 26% reduction in median completion time.

Keywords: Artificial intelligence; Flipped learning; AI-Generated assessment; Formative assessment; First-order differential equations

Introduction

Artificial intelligence (AI), particularly generative AI, is increasingly being used in higher education to support formative assessment and feedback. Its value, however, depends on pedagogically sound implementation, human oversight, assessment criteria, and validation of AI outputs. AI-enabled formative-feedback systems may help lecturers provide timely, scalable feedback and redirect effort toward higher-value teaching and learning support (Lee & Moore, 2024).

In engineering education, flipped learning typically shifts initial content engagement to pre-class activities and uses face-to-face sessions for active learning, explanation, application, and problem solving. Reviews and meta-analytic evidence indicate generally positive learning effects, although implementation design and in-class pedagogy remain important (Güler et al., 2023; Strelan et al., 2020). Students learning differential equations often encounter conceptual and procedural difficulties, including insufficient algebraic and calculus foundations, reliance on memorised procedures, incorrect formula selection and errors in rewriting or solving equations (Fuhrmann et al., 2022).

Edcafe is an AI-supported teacher toolkit that can generate quizzes from a topic, text, webpage, or uploaded document, with materials editable by the lecturer before sharing with students (Edcafe AI, n.d.). This innovation therefore integrates Edcafe, an AI-based educational tool, to generate 10-item pre- and post-quizzes. Students watch the video, complete the pre-quiz, participate in lecturer-led learning, and complete the post-quiz to demonstrate their learning progress.

The innovation was implemented with 23 Semester 2 Chemical Process Engineering students at MJIIT, Universiti Teknologi Malaysia, during Semester 2, 2025/2026, across six First-Order Differential Equations subtopics. Preliminary findings indicate an increase in average quiz performance from 76.0% to 84.5% (+8.5 percentage points), accompanied by an estimated 26% reduction in median completion time. The innovation therefore provides a practical and measurable Watch–Diagnose–Teach–Reassess–Measure (WDTRM) approach that integrates AI-generated assessment with flipped learning to enhance mathematics learning in engineering education.

Objectives

- To increase students' average achievement in First-Order Differential Equations by comparing pre- and post-quiz scores across six subtopics.
- To improve students' assessment efficiency by reducing median completion time between pre- and post-quizzes across six subtopics.
- To evaluate the effectiveness of Edcafe AI-generated pre- and post-quizzes in supporting flipped learning through measurable improvements in students' achievement and assessment efficiency.

NALI Approach

Novelty

The novelty of this innovation lies in the integration of AI-generated assessment with flipped learning to create a continuous learning diagnosis and intervention cycle for First-Order Differential Equations. Unlike

conventional flipped classroom practice, where students watch instructional videos before attending class and classroom activities subsequently focus on content reinforcement or problem solving, this innovation introduces an AI-generated pre-quiz as an immediate diagnostic checkpoint before classroom instruction. Using Edcafe, a 10-item AI-generated quiz is administered before teaching to identify students' initial understanding of each subtopic. The lecturer then uses the assessment evidence to inform classroom instruction, focusing attention on concepts that require further explanation or reinforcement. Following the teaching intervention, students complete a corresponding AI-generated post-quiz to measure changes in achievement and assessment efficiency. The distinctive feature for performance improvement process is therefore the integration of pre-class learning, AI-generated diagnosis, lecturer-led intervention and AI-generated reassessment into a single structured WDTRM cycle as in Figure 1:

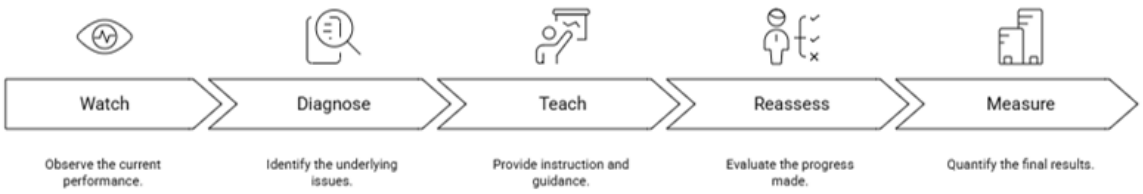


Figure 1: WDTRM cycle.

This approach transforms the role of a digital quiz from a conventional assessment activity into a real-time pedagogical feedback mechanism. The innovation also extends conventional pre- and post-assessment by examining both learning achievement through quiz scores and learning efficiency through median completion time. Thus, the novelty is not the adoption of Edcafe as a standalone technology, but the pedagogical design that connects AI-generated assessment evidence directly to classroom teaching and measurable learning improvement. This creates a practical approach in which assessment becomes an integral part of the teaching process rather than an activity conducted only after learning has taken place.

Creativity

The creative element of this innovation lies in transforming the conventional flipped classroom into a structured WDTRM learning cycle. As illustrated in Figure 2, students first watch a pre-class video, complete an AI-generated pre-quiz using

Edcafe, participate in lecturer-led learning, and then complete an AI-generated post-quiz to demonstrate their learning progress. The cycle is implemented across six First-Order Differential Equations subtopics, with both quiz performance and completion time used to measure learning improvement and efficiency. This transforms assessment from a final evaluation into an active component of the learning process.

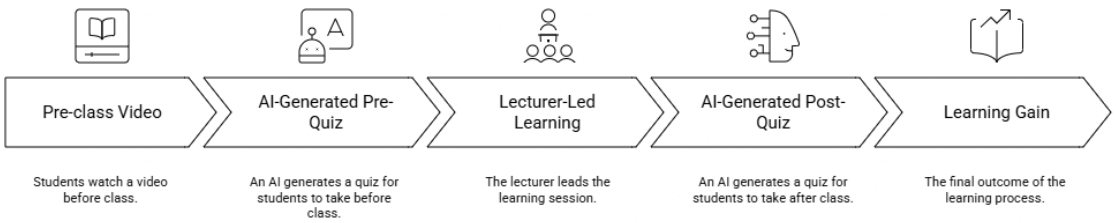


Figure 2: Creative design process.

Innovativeness

The innovation improves conventional flipped learning by integrating AI-generated pre- and post-quizzes through Edcafe into the teaching process. The pre-quiz provides immediate evidence of students' initial understanding, allowing the lecturer to focus classroom instruction on areas requiring reinforcement, while the post-quiz measures learning improvement after instruction. This transforms assessment from simply measuring learning into a tool for informing teaching, creating a continuous performance improvement process as in Figure 1 that enhances both teaching responsiveness and students' learning efficiency.

Applicability

The innovation is readily adaptable and scalable across different courses and educational settings because it uses a performance improvement process cycle as in Figure 1. Lecturers can adapt the pre-class videos and AI-generated quizzes to their respective subjects and learning outcomes, while the same approach can be replicated using Edcafe or other suitable AI-enabled assessment platforms. Although initially implemented for First-Order Differential Equations, the model can be extended to other mathematics, engineering and STEM subjects without major changes to the curriculum or classroom structure. Its simplicity, flexibility and low implementation complexity also support long-term sustainability and wider adoption.

Innovation Description, Process and Implementation

The innovation was implemented as a topic-based classroom intervention across six subtopics of First-Order Differential Equations: Terminology, Separable Equations, Linear Equations, Homogeneous Equations, Exact Equations and Bernoulli Equations. For each subtopic, students followed the same instructional sequence. The lecturer first provided the relevant pre-class learning video. At the beginning of the scheduled class, students completed the pre-quiz individually using Edcafe. The lecturer subsequently delivered the lesson and guided students through relevant mathematical concepts, solution procedures and examples. At the end of the lesson, students completed the post-quiz using Edcafe. The pre- and post-quiz results, including average score and median completion time, were recorded for each subtopic and subsequently compared to determine changes in students' learning achievement and assessment efficiency.

Key Findings

The implementation demonstrated a positive trend in students' learning achievement and assessment efficiency across the six First-Order Differential Equations subtopics. Based on the performance dataset, the overall average score increased from 76.0% in the pre-quiz to 84.5% in the post-quiz, representing an 8.5-percentage-point improvement. The overall median completion time also decreased from approximately 6.5 to 4.8 minutes, indicating an estimated 26% reduction in completion time. The largest learning gains were observed in Exact Equations (+14 percentage points), Linear Equations (+12 percentage points) and Separable Equations (+11 percentage points), while Homogeneous Equations showed a smaller gain (+4 percentage points) due to its already high pre-quiz performance of 92%. The simultaneous improvement in quiz scores and reduction in completion time suggests enhanced learning achievement and assessment efficiency. These findings demonstrate the potential of integrating AI-generated assessment with flipped learning to provide immediate learning evidence and support a more responsive teaching process.

Table 1: Pre- and post-quiz results.

SUBTOPIC	AVERAGE PRE-QUIZ SCORE	AVERAGE POST-QUIZ SCORE	LEARNING GAIN	MEDIAN TIME TAKEN	MEDIAN TIME TAKEN
Terminology	75%	81%	+6pp	7 min	5 min
Separable Equations	67%	78%	+11pp	6 min	5 min
Linear Equations	72%	84%	+12pp	7 min	5 min
Homogeneous Equations	92%	96%	+4pp	6 min	4 min
Exact Equations	63%	77%	+14pp	8 min	6 min
Bernoulli Equations	85%	91%	+6pp	5 min	4 min
Overall	76%	84.5%	+8.5pp	6.5 min	4.8 min

Impact

The innovation provides benefits at student, educator and institutional levels. For students, the approach provides a more active and structured learning experience by combining pre-class preparation, immediate assessment and opportunities to demonstrate learning progress, with preliminary results showing an increase in average performance from 76.0% to 84.5% and an estimated 26% reduction in median completion time. For educators, Edcafe-generated quizzes provide timely evidence of students' understanding, enabling more focused and responsive classroom instruction while reducing reliance on end-of-topic assessment alone. At the institutional level, the approach offers a simple, low-cost and

scalable model for AI-supported pedagogy that can be adapted to other mathematics, engineering and STEM courses. In the longer term, the innovation can contribute to the development of a more data-informed, student-centred and technology-enabled teaching culture, while demonstrating a practical pathway for integrating AI into teaching without replacing the role of the educator.

Recommendations for Classroom Practice

Educators can implement this approach by providing short pre-class videos, followed by AI-generated pre and post-quizzes to monitor students' understanding. Pre-quiz results should be used to identify learning gaps and guide classroom instruction, while post-quiz results can be used to measure learning improvement. The approach can be adapted to different subjects by adjusting the video content and quiz questions according to students' needs and learning outcomes. Educators should also review and validate AI-generated questions to ensure their accuracy and relevance.

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ID 92: An Institutional Framework for AI Readiness in Sustainable Education

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Highlights: Generative Artificial Intelligence (AI) created two linked challenges for Sunway College Johor Bahru: protecting academic integrity while preparing staff and students to use AI responsibly. RAISE (Readiness for AI in Sustainable Education) connects four institutional dimensions - Policy, People, Practice and Curriculum - and treats sustainable education as covering both VBE and ESD. A shared three-tier AI-use vocabulary is supported by staff and student AI literacy, classroom application and three AI curriculum agents. Implementation reached seven academic departments and 14 in-house programmes; the curriculum agents produced 1,251 generations across 186 threads between April and August 2026.

Keywords: Human-AI collaboration; AI readiness; Academic integrity; Sustainable education; Whole-institution approach

Introduction

Generative AI presents higher education with a dual challenge. Students may use it in ways that do not represent their own learning, while overly restrictive rules may limit opportunities to develop AI capability. Lecturers must therefore protect academic standards while designing learning and assessment in which AI use is purposeful, transparent and academically appropriate. A prohibition-only approach addresses misuse, but not readiness.

UNESCO calls for whole-institution action across governance, educator capacity and learner agency in Education for Sustainable Development (UNESCO, 2020), while its AI competency frameworks address capability development for teachers and students (UNESCO, 2024a, 2024b). Assessment frameworks are also making acceptable levels of AI involvement more explicit (Perkins et al., 2025). In Malaysia, MQF 2.0 strengthens Values-Based Education (VBE) and the Global Sustainability Agenda, requiring institutions to translate these expectations into programme and course design (Malaysian Qualifications Agency, 2024).

Sunway College Johor Bahru developed RAISE - Readiness for AI in Sustainable Education - as an institutional framework linking four dimensions: Policy, People, Practice and Curriculum. Sustainable education in RAISE covers both VBE and Education for Sustainable Development (ESD). Policy defines responsible AI use; People builds staff and student capability; Practice addresses meaningful use in teaching, learning and assessment; and Curriculum uses AI to support VBE/ESD integration. The dimensions emerged progressively from March 2025 but are not fixed steps. They operate together and can be strengthened in parallel.

Objectives

- Establish clear institutional governance and a common vocabulary for responsible AI use in assessment.
- Build staff and student capability to use AI critically and responsibly.
- Support meaningful AI use in teaching, learning and assessment while retaining human judgement and academic standards.
- Use AI to support the integration of VBE and ESD competencies into course design and documentation.

NALI Approach

Novelty

RAISE connects institutional responses that were previously separate. Lecturers classify assessment AI use as Permitted, Restricted or Prohibited, while students learn the same three-tier vocabulary through the AI Literacy e-Workshop. The Academic Integrity Policy also explains how misuse may be identified. This shared protocol links Policy, People and Practice, then extends into Curriculum through AI agents that support VBE/ESD integration while lecturers retain final academic judgement.

Creativity
RAISE makes responsible AI use visible through practical design. The policy discloses methods used to identify misuse, including similarity reports, random review and comparison with previous work. In the AI Literacy e-Workshop, students ask an AI tool about themselves and examine the fabricated biography it returns, experiencing hallucination directly. At the AI Forum, staff teams submitted their prompts as judging evidence alongside the prototype, making the human contribution visible and assessable.

Innovativeness
Before RAISE, AI expectations were set at course level on an ad hoc basis and students had no common institutional AI training. RAISE introduced a shared three-tier vocabulary, institution-wide AI literacy and structured AI support for VBE/ESD curriculum work. The improvement is organisational as well as technological: policy, capability development, classroom use and curriculum design are connected within one framework.

Applicability
RAISE is not tied to one cohort or discipline. Its common AI-use vocabulary, AI Literacy e-Workshop and curriculum-agent approach have reached 14 in-house programmes. The framework also fits the NALI Model's student-centred and blended-learning approach by linking expectations, capability, classroom use and curriculum design. Institutions can adapt these components to their own policies, technology and programme structures.

Innovation Description, Process and Implementation

RAISE developed through institutional implementation rather than as a stand-alone technology project. The Academic Integrity Policy, effective 25 March 2025, established the three-tier AI-use vocabulary. Lecturers specify the category for their assessments; where AI use is restricted, students must disclose AI assistance. The policy is communicated through staff briefings, the Student Handbook, course briefings, Library support and the AI Literacy e-Workshop.

The People dimension addressed both staff and students. The student AI Literacy e-Workshop, deployed in April 2025, contains nine self-paced sections and ten embedded formative questions. Staff development culminated in the AI Forum on 22 November 2025, covering prompting, custom chatbots, gamified activities, LMS question generation and verification of AI output. Lecturers then introduced AI-supported activities in teaching, learning and/or assessment, with student feedback collected during implementation.

In 2026, three AI curriculum agents extended RAISE into Curriculum. The principal Constructive Alignment for VBE/ESD agent supports the integration of values and sustainability competencies into course learning outcomes, synopses and teaching activities; two supporting agents assist with alignment and synopsis development. The agents propose options, but lecturers select, refine and approve the final wording. Figure 1 summarises how the four dimensions reinforce one another.

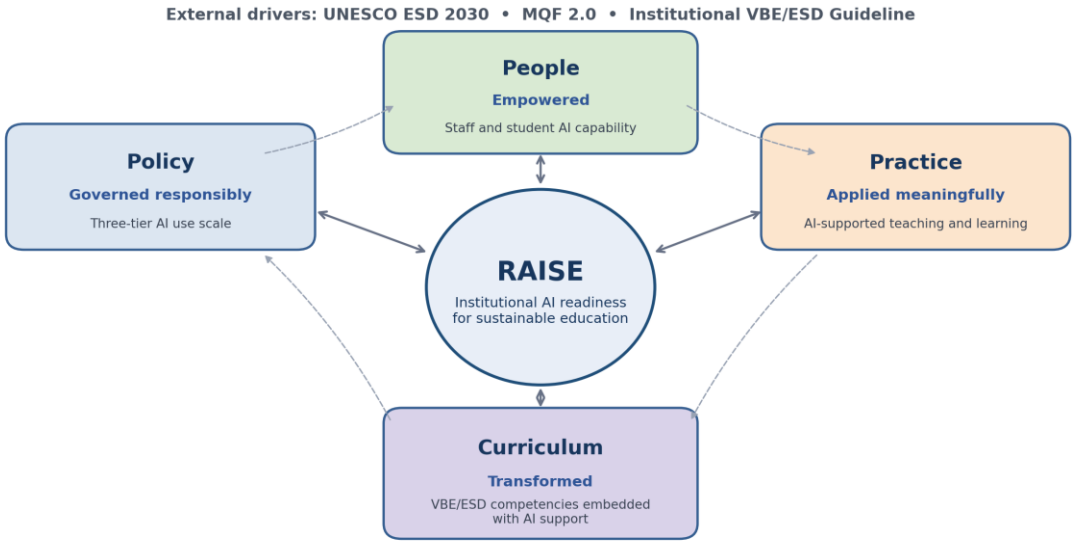


Figure 1: RAISE as four interconnected and mutually reinforcing dimensions of institutional AI readiness.

Evaluation used an institutional case-study approach. Participants were academic staff from seven departments (n = 77 post-Forum survey respondents; approximately 77% response rate) and students across 14 programmes (n = 280 e-Workshop enrolments; n = 233 Practice feedback responses). Evidence came from the post-Forum survey, LMS completion records, Practice feedback and curriculum-agent logs. Descriptive statistics were used. Agent activity is reported as access instances because the platform did not use authenticated user accounts. Guskey's (2000) levels were used to distinguish reaction and intended use from organisational support and behavioural evidence.

Key Findings

The College now uses one common three-tier vocabulary for AI use in assessment. Among 77 post-Forum respondents, 89.6% rated the overall experience four or five out of five (mean = 4.34), 90.9% were likely to integrate AI into teaching and 74.0% intended to do so within six months. Almost half (46.8%) had 11-20 years of teaching experience. Data privacy and academic integrity remained a barrier for 49.4%, compared with 33.8% citing technical difficulty, showing that capability development needs clear governance.

For students, 273 of 280 enrolled across 14 programmes completed the e-Workshop; because questions could be reattempted, this is evidence of coverage rather than attainment. Among 233 students providing feedback on AI-supported lessons, 97.9% found the experience helpful and 86.3% reported greater confidence. Only 61.4% considered AI-generated content accurate, suggesting that students did not accept AI output without question.

Between 28 April and 13 August 2026, the three AI curriculum agents recorded 154 access instances and produced 1,251 generations across 186 threads. The principal VBE/ESD agent accounted for 985 generations across 122 threads from 97 access instances; the Constructive Alignment Assistant produced 200 generations, and the Synopsis Assistant 66. These logs show substantial use, but do not represent unique staff counts or establish the quality of the resulting curriculum changes.

Using Guskey's (2000) levels, People provides evidence of reaction and intended application, while Curriculum provides direct evidence of tool use. Longer-term classroom adoption under Practice is still being assessed through the six-month follow-up. Current evidence therefore supports reach, user experience, intended adoption and tool use, rather than measured learning gain or sustained behavioural change.

Impact

RAISE has established a common institutional basis for responsible AI use. Staff and students now work with the same assessment vocabulary, while AI literacy is positioned within academic integrity. Staff development reached seven departments, and the student e-Workshop provided a common baseline across 14 in-house programmes. Feedback from AI-supported lessons shows high perceived helpfulness and greater confidence, alongside continued caution about AI accuracy.

At curriculum level, the three agents provide structured support for VBE/ESD integration while preserving lecturer judgement. RAISE's institutional contribution is the connection between governance, capability development, teaching practice and curriculum work; longer-term classroom adoption and curriculum outcomes remain under evaluation.

Recommendations for Classroom Practice

- State the AI-use category clearly in each assessment brief before students begin the task.
- Teach students how to interpret the category and disclose AI assistance where required.
- Use activities that require students to verify AI output and identify its limitations.
- Where appropriate, require prompts or other process evidence to make the student's contribution visible.
- Use AI curriculum tools as decision support; lecturers should refine and approve outputs and confirm VBE, ESD and disciplinary alignment.

Other relevant information

RAISE has not been submitted for commercialisation and has not received external awards. The College will use the post-Forum six-month follow-up to assess sustained classroom adoption and plans to extend the curriculum-agent approach to additional departments. Replication should retain a common AI-use vocabulary, transparent verification expectations and lecturer control over final academic decisions.

Acknowledgement

The authors thank the Sunway College Johor Bahru's Management, Department of Academic Quality, Library and Learning Commons, AI Forum 2025 organising committee, lecturers and students for their support and participation.

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ID 93: Understanding Cognitive Engagement and AI Adoption in Learning Platforms: Evidence from Filipino and Indonesian Higher Education

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Highlights: This project develops an evidence-informed approach for AI-enhanced learning platforms that combines technology acceptance factors with Bloom's cognitive engagement levels. Using comparative survey evidence from Indonesian and Filipino higher education, the approach links UTAUT constructs with lower-, middle-, and higher-order thinking and translates the findings into a hi-fidelity LMS prototype. Results show that facilitating conditions strongly support adoption, while higher-order thinking has the strongest relationship with behavioral intention, providing practical guidance for human-AI learning design.

Keywords: AI-enhanced learning; Learning management system; UTAUT; Bloom's taxonomy; Cognitive engagement

Introduction

Artificial Intelligence (AI) is increasingly integrated into higher education through adaptive learning, automated feedback, recommendation mechanisms, and AI-enhanced Learning Management Systems (LMS). However, successful adoption depends not only on AI functionality but also on perceived usefulness, ease of use, social influence, institutional support, and meaningful cognitive engagement (Nordhoff et al., 2020; Shahzad et al., 2024; Xavier et al., 2025). This project therefore combines UTAUT constructs—Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC)—with Bloom-based Lower-, Middle-, and Higher-Order Thinking (LOT, MOT, HOT). Comparative evidence from Indonesian and Filipino students and faculty is then translated into a hi-fidelity LMS prototype, positioning the contribution as an evidence-informed human-AI design and evaluation framework rather than a technology-only intervention.

Objectives

- Determine how PE, EE, SI, and FC influence Behavioral Intention to Use (BIU) AI-enhanced learning platforms.
- Evaluate relationships between LOT, MOT, HOT cognitive engagement and BIU, including cross-country and student–faculty patterns.
- Translate the empirical findings into practical design guidance for a Bloom-aware, human-AI LMS prototype.

NALI Approach

Novelty

The project integrates technology acceptance and cognitive learning depth within one AI-LMS design logic, connecting the conditions that encourage adoption with engagement across Bloom's levels and examining this relationship in two Southeast Asian higher-education contexts.

Creativity

Survey constructs are translated into visible dashboard functions, including Bloom-oriented assessment cues, target distributions, and AI-feedback summaries, bridging behavioral evidence, instructional design, and interface design.

Innovativeness

An evidence-to-design cycle links acceptance measurement, cognitive-engagement analysis, significant relationships, and AI-LMS feature requirements. AI is therefore treated as a pedagogically guided component rather than an isolated add-on.

Applicability

The UTAUT–Bloom measures and dashboard concept can be adapted across disciplines and existing LMS environments through assessment analytics, AI feedback, and teacher-facing monitoring, with initial evidence from two countries supporting further institutional replication.

Innovation Description, Process and Implementation

The innovation is an evidence-informed AI-enhanced LMS design framework supported by a hi-fidelity faculty dashboard. First, PE, EE, SI, FC and LOT, MOT, HOT define adoption and cognitive requirements. Second, structured survey responses from Indonesian and Filipino students and faculty are cleaned and converted into construct-level composite scores. Third, regression evaluates UTAUT effects on BIU, while Pearson and Spearman correlations evaluate cognitive engagement–BIU relationships. Fourth, significant findings are interpreted as design requirements, particularly reliable access, institutional support, technical infrastructure, and cognitively meaningful AI activities. Finally, these requirements are represented in the dashboard through Bloom-oriented monitoring and AI-supported feedback.

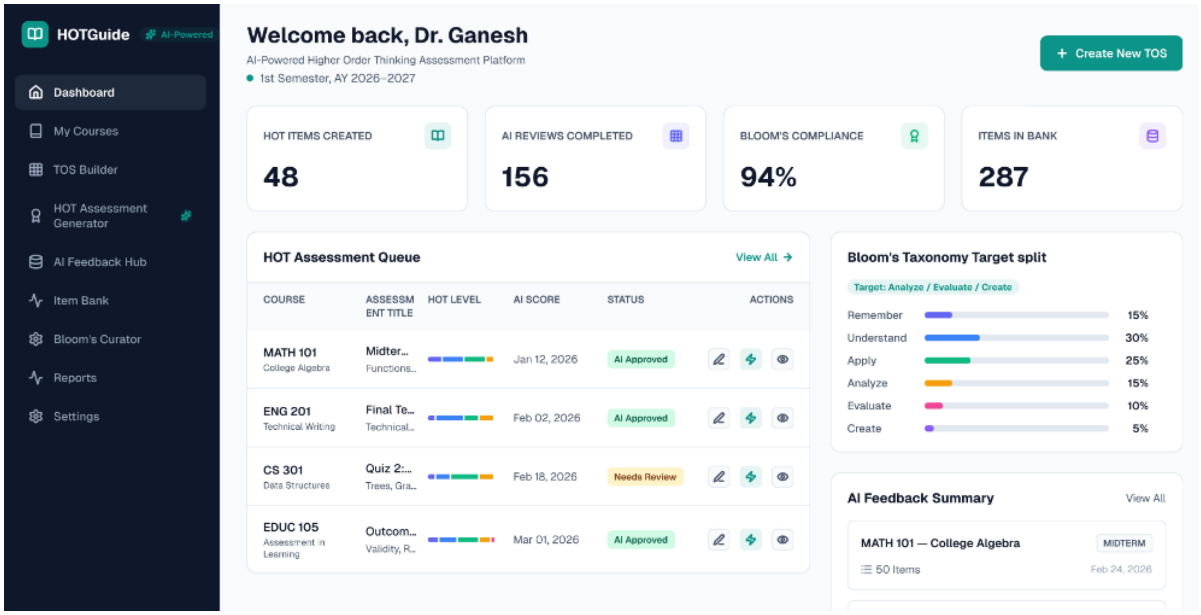


Figure 1: Hi-fidelity faculty dashboard prototype showing Bloom-oriented assessment monitoring and AI feedback functions.

Key Findings

Regression Analysis: Effect of UTAUT on Behavioral Intention

The regression model was significant ($F = 117.5$, $p < .001$) and explained 63.0% of BIU variance ($R^2 = .630$; adjusted $R^2 = .625$). All four UTAUT constructs had significant positive effects. FC was the strongest predictor ($\beta = .2817$, $p < .001$), followed by SI ($\beta = .2234$, $p = .001$), PE ($\beta = .1897$, $p < .001$), and EE ($\beta = .1828$, $p = .010$).

Table 1: Regression coefficients for UTAUT constructs predicting BIU.

VARIABLE	BETA (B)	STD. ERROR	T-VALUE	P-VALUE	INTERPRETATION
Constant	0.510	0.146	3.484	0.001	—
PE	0.1897	0.053	3.577	<0.001	Significant
EE	0.1828	0.070	2.593	0.010	Significant
SI	0.2234	0.064	3.489	0.001	Significant
FC	0.2817	0.078	3.627	<0.001	Significant

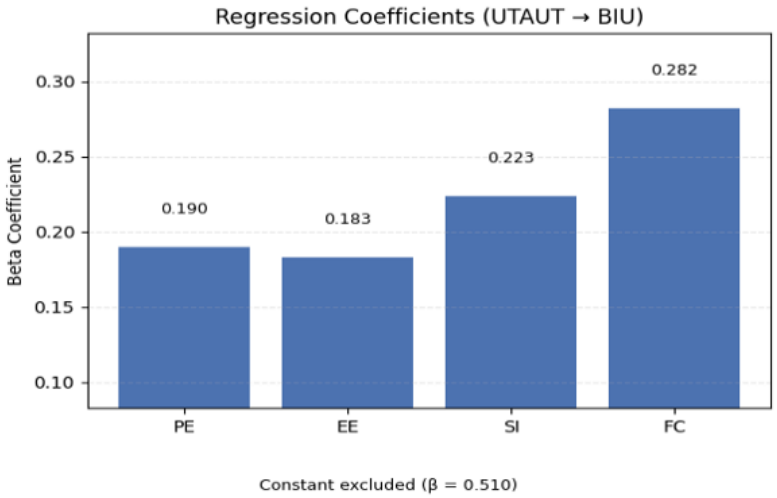


Figure 2: Regression coefficients for the UTAUT constructs predicting Behavioral Intention to Use (BIU).

Correlation Analysis: Cognitive Engagement and Behavioral Intention

All cognitive-engagement dimensions were strongly and positively related to BIU. HOT showed the strongest relationship (Pearson r = .816; Spearman ρ = .754), followed by MOT (r = .770; ρ = .704) and LOT (r = .762; ρ = .697); all p < .001. The agreement between Pearson and Spearman results supports the robustness of the observed relationships.

Table 2: Correlation between cognitive engagement and behavioral intention.

VARIABLE	PEARSON R	SPEARMAN P	P-VALUE	INTERPRETATION
LOT – BIU	0.762	0.697	<0.001	Strong, positive
MOT – BIU	0.770	0.704	<0.001	Strong, positive
HOT – BIU	0.816	0.754	<0.001	Strong, positive

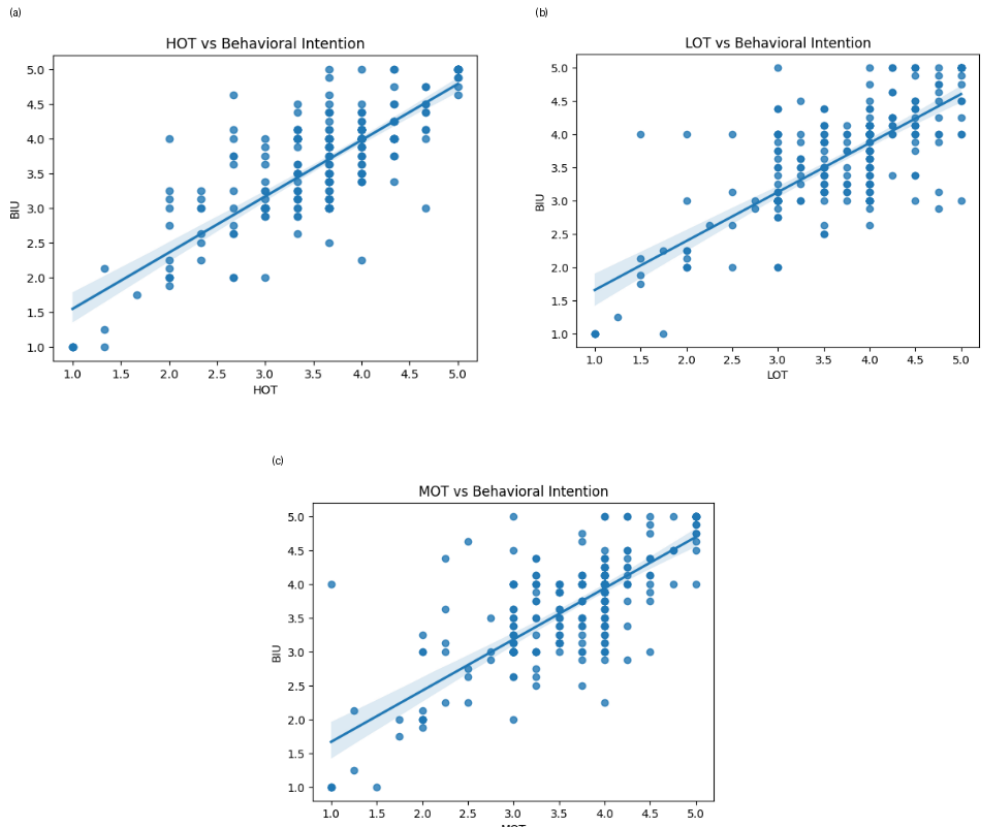


Figure 3: Relationships between cognitive engagement and BIU: (a) HOT vs. BIU, (b) LOT vs. BIU, and (c) MOT vs. BIU.

Bloom-based descriptive findings indicated high cognitive engagement across LOT, MOT, and HOT, with slightly stronger lower- and middle-order engagement while HOT remained substantial. The original discussion associates this pattern with interactive AI-learning features such as personalized support and immediate feedback, suggesting that AI-enhanced platforms can support both foundational and advanced cognitive processes. Acceptance results show that usefulness, ease of use, social influence, and especially facilitating conditions matter for continued use; reliable internet access, technical support, and institutional readiness therefore remain central implementation requirements.

Compared with the UTAUT2 application of Nordhoff et al. (2020), the present study similarly emphasizes social and support-related determinants, while extending the analysis to cognitive engagement. Reported comparisons also found no meaningful nationality differences between Indonesian and Filipino participants and broadly consistent views across students and faculty, indicating potential cross-context applicability while still requiring implementation-based validation.

Impact

The framework links AI use to cognitive depth rather than convenience alone. Students benefit from progressively structured learning activities; educators gain Bloom-oriented assessment and feedback visibility; and institutions receive evidence that infrastructure, access, technical support, and readiness are critical to sustained adoption. The combined UTAUT–Bloom framework therefore offers a practical way to evaluate whether an AI-enhanced LMS is usable, accepted, and pedagogically engaging.

Recommendations for Classroom Practice

Align AI-assisted activities with explicit Bloom levels; retain educator oversight of AI feedback and assessment; provide onboarding, reliable access, and technical support before expanding AI-dependent activities; and periodically review learner and educator feedback using acceptance and cognitive-engagement indicators to refine both platform functions and learning design.

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ID 94: The ACE Model: Empowering Students to Learn With AI, Not Just From AI

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Highlights: Generative AI is increasingly embedded in education, yet students need more than technical proficiency to use it effectively and critically. This project explored how 15 Master of Science in Education students learned to engage with AI as both a learning partner and an object of critical inquiry. Using observations and in-situ interviews, we identified three essential competencies: understanding AI capabilities and limitations, critically evaluating AI-generated outputs against credible evidence, and engaging with AI purposefully as a co-creator. These findings informed the development of the ACE Model Awareness, Critique, and Engagement a scalable framework for guiding responsible and meaningful AI-supported learning.

Keywords: Generative AI; AI-supported learning; ACE Model; Human-AI co-creation

Introduction

We initiated this project because we recognised that the rapid diffusion of generative artificial intelligence (GenAI) has destabilised conventional assumptions about what an assessment product can reveal about student learning. Text-based tasks that privilege recall, generic explanations, or polished final products can increasingly be completed with substantial machine assistance, creating a validity problem: a high-quality submission may not necessarily represent the learner's independent cognitive achievement. The research proposal therefore reframes assessment as a learning process in which students must interpret prompts, interrogate AI-generated responses, justify decisions, and reflect on the quality of their own reasoning. This orientation is consistent with assessment literacy, self-regulation, and evidence-based reasoning, which are central to PQC7007 Cognition in Science Learning.

The innovation is grounded in three complementary strands of evidence. First, evaluative judgement emphasises students' capacity to make informed decisions about the quality of their own and others' work (Tai et al., 2018), a capability that becomes more consequential when AI outputs can be fluent yet epistemically unreliable (Bearman et al., 2024). Second, contemporary assessment reform argues that institutions should redesign assessment to assure learning while enabling responsible engagement with GenAI, rather than relying primarily on detection or prohibition (Lodge et al., 2023). Third, sustainable assessment and feedback literacy shift attention from one-off performance towards learners' capacity to use criteria, feedback, and self-monitoring in future learning (Boud & Soler, 2016; Carless & Boud, 2018). Together, these strands support a move from assessing only the final answer to assessing the human judgement, verification, and reflection that produce it.

Objectives

- To examine how structured AI-assisted assessment tasks support students' ability to interpret, respond to, and evaluate assessment prompts in higher education science learning.
- To develop an evidence-based ACE framework that promotes deeper learning, metacognitive reflection, and responsible GenAI use.

NALI Approach

Novelty

The ACE Model changes the unit of assessment from a static student product to an auditable cognitive process. Students are expected to demonstrate Awareness of AI capabilities and limitations, Critique of AI-generated content against disciplinary criteria and evidence, and responsible Engagement, in which AI contributions are strategically integrated and transparently documented. The framework therefore makes evaluative judgement and epistemic responsibility visible within assessment, rather than treating AI use as an external academic-integrity issue.

Creativity

The learning design uses AI-generated responses as deliberately contestable artefacts. Students compare human and AI responses, identify inaccuracies or unsupported claims, revise drafts, document prompts and changes, and explain why specific AI suggestions were accepted, modified, or rejected.

This human-AI co-creation pedagogical design creates multiple opportunities for students to articulate their reasoning.

Innovativeness

The framework combines assessment literacy, evaluative judgement, metacognition, and process transparency into a single operational model. Instead of rewarding fluent AI-assisted output, the ACE Model privileges verification, evidence use, quality calibration, reflection, and traceable decision-making. This directly addresses the proposal's aim of using AI as a tool for thinking rather than merely for producing outputs.

Applicability

The ACE Model is designed as a transferable assessment architecture rather than a single task. Its components, such as AI-output critique, prompt/process logs, justification, reflection, and, in the future, rubric criteria, can be adapted to written

assignments, project work, formative feedback, and discipline-specific problem-solving. The intended outputs include staff training, reusable rubrics and guidelines, support for replication beyond PQC7007, and longer-term institutional use.

Innovation Description, Process and Implementation

The ACE Model (Awareness, Critique, Engagement) is a pedagogical innovation designed to transform higher education assessment from vulnerable, product-based tasks (e.g., surface summarisation and standard essays) into process-oriented, AI-resilient learning experiences. Grounded in an exploratory qualitative research design, the ACE Model addresses the widespread availability of generative AI (GenAI), such as ChatGPT, by embedding AI interaction directly into student learning workflows and assessment criteria. Rather than treating AI as a plagiarism threat or a tool for automatic task completion, the ACE Model positions GenAI as a cognitive partner. It systematically shifts the focus of assessment towards prompting mechanics, fact verification, curriculum adaptation, and metacognitive decision-making.

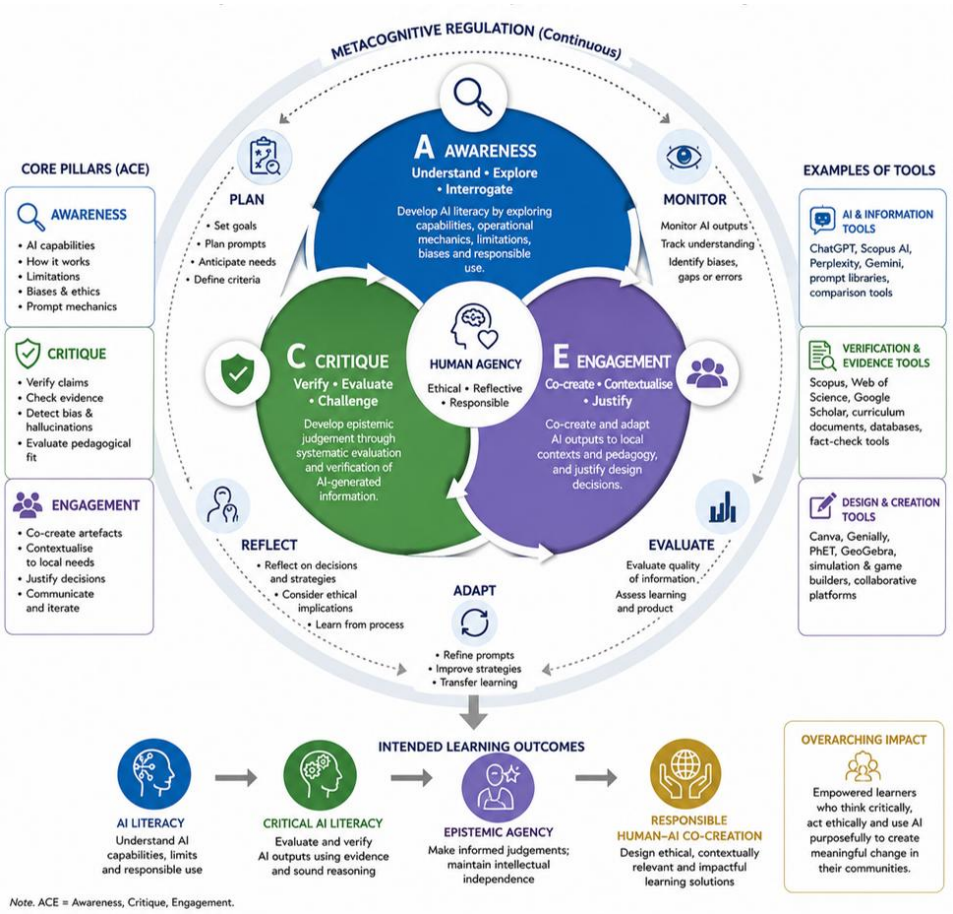


Figure 1: The ACE model

The ACE Model (Awareness–Critique–Engagement) is a cyclical pedagogical framework for developing critical, reflective, and responsible engagement with generative AI. Awareness develops students' understanding of AI capabilities, mechanisms, limitations, and responsible use; Critique develops epistemic judgement through systematic verification and evaluation of AI-generated knowledge; and Engagement develops human–AI co-creation by requiring learners to contextualise, transform, and justify the use of AI contributions. Continuous metacognitive reflection connects the three pillars, enabling learners to monitor and regulate their reliance on AI while maintaining human intellectual and pedagogical agency.

Table 1: The ACE model and its explanation.

CORE PILLAR	REFINED PURPOSE	KEY STUDENT PROCESSES	IMPLEMENTATIO N & TOOLS	SAMPLE LEARNING ACTIVITY	EVIDENCE / LEARNING OUTPUT
A — Awareness: Understand & Interrogate AI	Develop AI literacy by understanding what generative AI can do, how prompting shapes outputs, and where its epistemic and technical limitations lie.	Explore AI capabilities; identify limitations and biases; examine prompt–response relationships; distinguish fluent output from reliable knowledge; practise responsible AI use.	ChatGPT, Scopus AI, prompt comparison, persona prompting, constraint-based prompting, multi-turn prompting.	Prompt Mechanics Log: Students begin with a generic prompt and progressively add disciplinary, pedagogical, contextual, and cognitive constraints. They compare how each modification changes the response.	Annotated prompt history; AI capability/limitat ion map; prompt-refinement log; initial reflection on responsible use.
C — Critique: Verify, Evaluate & Challenge	Develop critical AI literacy and epistemic judgement by systematically evaluating AI-generated information rather than accepting it at face value.	Fact-check claims; identify hallucinations; evaluate evidence; compare AI outputs with scholarly literature; detect bias, oversimplificatio n, and contextual inaccuracies; assess pedagogical suitability.	Scopus/Web of Science literature, peer-reviewed sources, curriculum documents, verification matrices, source triangulation.	AI Hallucination Audit: Students annotate an AI response claim by claim and classify each statement as verified, partially supported, unsupported, misleading, or incorrect, supported by credible evidence.	AI verification matrix; annotated AI response; evidence table; critique report.
E — Engagement: Co-create, Contextualise & Justify	Move from consuming AI-generated content toward human–AI co-creation, where students retain intellectual and pedagogical agency.	Adapt ideas; synthesize human and AI contributions; contextualise materials; create pedagogical artefacts; make design decisions; justify acceptance, modification, or rejection of AI suggestions.	Generative AI plus disciplinary/desi gn tools; local curriculum standards; collaborative design; peer feedback; iterative prototyping.	AI-Supported Pedagogical Design Challenge: Students use AI selectively to develop an educational artefact such as a game, simulation, inquiry activity, or teaching resource aligned with Malaysian curriculum requirements.	Educational artefact/prototy pe; design rationale; AI contribution statement; Metacognitive Rationale Appendix.

Key Findings

We began the research by asking students to use AI without any scaffolding. We found that many of them had limited prompt-engineering skills and did not validate AI-generated outputs. At one point, a student shared that she constantly felt 'stupid' because AI gave her all the perfect answers. We conducted a short activity in which all groups entered a similar prompt and then discussed the AI-generated outputs. The outputs differed considerably, and students discovered that the AI generated suggestions based on their previous interactions with it. This activity exposed students to AI hallucinations and biases, increasing their awareness of these limitations. Participants' reflections included the following observations: '…its limitations in providing critical thinking and deep analysis made some of its reasoning unreliable and questionable… GenAI does not really help since the answers sometimes are confusing and misleading'.

Next, students were asked to critique AI-generated outputs alongside scholarly articles. Where misalignments occurred, they were asked to discuss them and make evidence-based decisions. The findings showed that students became more critical of information generated by AI, as reflected in their comments. One student wrote, "GenAI was used to identify key scholars… From these suggestions, the original journal articles were searched, reviewed and evaluated to ensure their relevance and credibility", while another student commented, "As what you said, nothing against AI, but don't copy without thinking critically on the information".

In terms of engagement, students strategically integrated AI as a co-creator to refine their writing, test theoretical frameworks, conduct comparative analyses, and design learning artefacts. Their reflections demonstrated how they co-created with AI. For example, one student stated that AI "was primarily used as a cognitive aid to summarise literature, clarify conceptual distinctions and refine the phrasing of our research gaps".

Above all, we found that the task itself must be designed to enable students to apply the ACE Model. An example of such a task is provided in Figure 2.

Assignment 2 (20 % - Group Work)

You are given two learning theories. Your task is to explain how these theories can be compared, contrasted, and integrated into a new or hybrid science learning model.

1. Present your integrated model in a form of your choice (e.g., infographic, podcast, concept map, interactive activity, mini lecture).
2. Your explanation should:
   (a) highlight the core concepts and key scholars of both theories,
   (b) analyse their similarities, differences, and gaps,
   (c) propose a synthesised or hybrid explanation/model, and
   (d) engage your peers with a short task or discussion to evaluate the usefulness of your integrated model.

Note: You are encouraged to use any generative AI. Please keep your discussion log with the AI and give justifications for the synthesised or hybrid model. Please show evidence of how you reject/accept the given suggestions. Please verify your model by discussing it with your peers and with primary data.

Figure 2: Example of a task designed to encourage students to apply the ACE Model.

The findings of our study are consistent with much of the literature. In particular, we argue that the assessment construct must extend beyond the correctness of the final product to include students' capacity to evaluate quality, verify AI claims, and exercise human judgement. This aligns closely with scholarship on evaluative judgement (Tai et al., 2018; Bearman et al., 2024). Asking students to provide their reasoning alongside their AI outputs makes the process transparent and establishes a core evidentiary requirement. Prompt histories, revision decisions, and explicit justifications create a traceable record of human-AI co-creation and make student cognition more visible for assessment. Moreover, because students are consistently encouraged to engage in metacognitive activities, metacognitive oversight becomes central to the validity of assessment in the AI era. Requiring students to explain why AI output was accepted, rejected, or modified shifts the emphasis from polished production to reasoning, self-monitoring, and feedback use (Boud & Soler, 2016; Carless & Boud, 2018).

Impact

For students, the intended impact is a shift from passive acceptance of AI-generated text towards active epistemic agency: learners must interrogate the quality of information, substantiate claims, and remain

accountable for their decisions. For educators, the ACE Model provides a practical language for redesigning assessment around visible learning processes. At the institutional level, the innovation supports academic integrity without reducing institutional responses to surveillance or AI detection; instead, it strengthens learning assurance by generating evidence of judgement, verification, and reflection. The project also has capacity-building value because its planned professional-development module translates the research into lecturer-facing guidance on AI capabilities and limitations, critical evaluation, AI-resilient prompt design, and responsible formative and summative assessment.

Recommendations for Classroom Practice

- Define permitted and expected AI use at the task level, and require students to state how AI contributed to their work.
- Assess the reasoning trail as well as the final product: include verification, source checking, revision rationale, and reflective commentary in the rubric.
- Use contrasting human and AI examples to calibrate students' evaluative judgement before high-stakes assessment.
- Require concise prompt/process documentation where AI materially influences the submission, while avoiding documentation that becomes burdensome or disconnected from learning outcomes.
- Build formative cycles in which students critique AI output, receive peer or expert feedback, revise their work, and explain the basis for their revisions.
- Adapt ACE criteria to disciplinary epistemology: what counts as valid evidence, acceptable uncertainty, and responsible AI use should be made explicit within each subject area.

Other relevant information

The project is positioned to support the scalability of the ACE framework: the same three dimensions can be applied across different tasks and rubrics while preserving the core requirement that students demonstrate awareness, critique, and responsible engagement.

Acknowledgement

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ID 95: A Human–AI Synergy Model for Authentic Industry-Based Assessment in Property Taxation Education

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Highlights: Property Taxation competency is central to this innovation, developed through an authentic MBJB industry problem in which AI serves as a learning and reasoning scaffold while lecturers and MBJB practitioners retain validation and assessment authority. The five-stage cycle, Learn, Apply, Createor/Solve, Industry-Based Assessment and Reflect/Revise, culminates in an Authentic Industry-Based Assessment (AIBA) where MBJB officers judge students' property tax solutions for professional fitness rather than media quality. Among 30 respondents, 96.7% perceived the task as effective or very effective and 100% were satisfied with industry involvement, supporting a subsequent MBJB data-review consultancy.

Keywords: Human–AI synergy; Property assessment taxation; Authentic industry-based assessment (AIBA); Adaptive feedback; Knowledge transfer

Introduction

Property taxation is a statutory valuation domain where legal interpretation, data accuracy, numerical reasoning and public communication converge. In the Property Taxation and Valuation subject (2024/2025 and 2025/2026), students learn the legal basis of rates under the Local Government Act 1976, valuation lists, classification, rate determination and tax computation. A conventional lecture and examination format cannot build the professional judgement needed to reconcile records or explain tax obligations to diverse communities, so an academic visit with MBJB became the anchor problem for course redesign.

The central claim: students learn and demonstrate Property Taxation competency through an authentic industry problem, with AI as a learning and reasoning scaffold, while lecturers and industry practitioners retain validation, judgement and assessment authority. Students used institutionally approved generative AI tools to generate alternative explanations, interrogate preliminary data patterns and refine communication drafts; every AI-assisted output was logged in an AI verification log recording the query, output, source consulted, correction and justification. MBJB officers contribute judgement through AIBA, defined below.

Objectives

- Strengthen students' application of statutory property taxation and valuation principles through an authentic municipal problem.
- Use Human–AI synergy to provide adaptive learning, reasoning support, formative feedback and communication refinement while retaining human validation and judgement.
- Implement Authentic Industry-Based Assessment (AIBA), in which students' property tax solutions are evaluated against academic and professional criteria by lecturers and MBJB practitioners.
- Develop transferable professional competencies that support industry engagement, public communication and knowledge transfer.

NALI Approach

Novelty

The novelty lies in converging two pillars around one outcome: Property Taxation professional competency. AI-assisted learning and reasoning support (Human–AI Synergy) builds the technical foundation, with every AI-assisted step recorded in an AI verification log; AIBA tests whether that foundation is fit for real municipal practice, using authentic professional tasks, criteria and feedback from industry practitioners under lecturer oversight. Both pillars meet in one student performance: a property tax communication product that is statutorily accurate (lecturer validated) and professionally fit for practice (MBJB validated), rather than three parallel activities.

Creativity
The design transforms the same statutory content for different audiences, languages and media. Seven groups produced platform specific briefs (TikTok, Facebook, Instagram, YouTube), and selected students created multilingual RTM radio advertisements in Malay, English, Chinese and Tamil across four stations (Johor FM, TraXX FM, Ai FM, Minnal FM). AI-assisted ideation supplies alternative explanations matched to audience profiles; students and lecturers remain responsible for accuracy, tone and sensitivity before release.

Innovativeness
The pedagogical model progresses through five stages: Learn, Apply, Create/Solve, Industry-Based Assessment, and Reflect/Revise. This differs from the project's impact pathway, moving from course learning to professional capability, industry engagement, and consultancy or knowledge transfer, since consultancy is a downstream outcome rather than a teaching stage. The MBJB consultancy that followed is evidence of professional relevance and institutional impact, not proof that AI improved learning (consultancy value reported once, under Impact).

The Human–AI Synergy Model below (Figure 1) shows how AI adaptive support and human validation converge into a single authentic property tax solution.

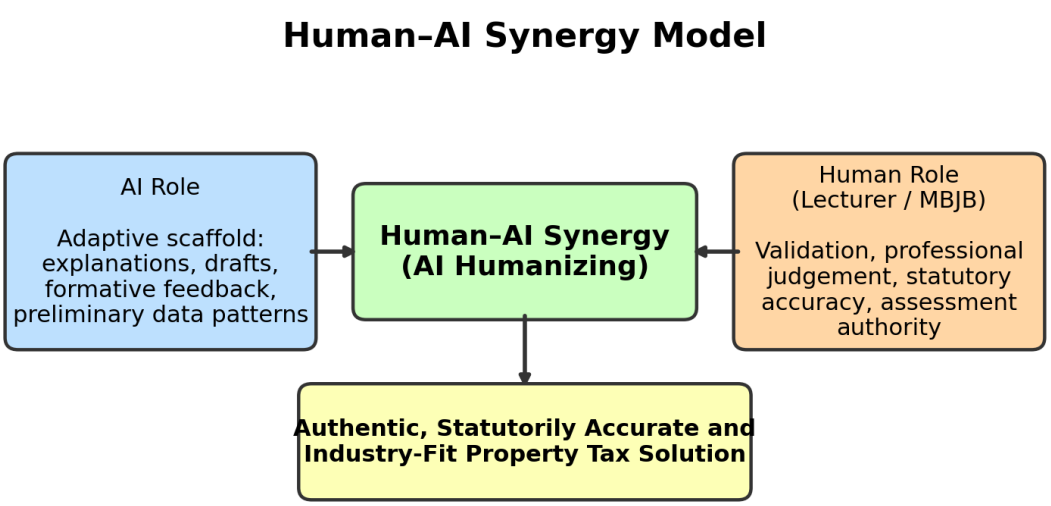


Figure 1: Human–AI synergy model.

The table below operationalises Human–AI synergy stage by stage, so that the division of labour between AI and humans is demonstrated rather than only described.

Table 1: Human AI synergy operationalization.

STAGE	AI ROLE	HUMAN ROLE (LECTURER / MBJB)
Learn	Adapts explanations to learner readiness; generates differentiated practice questions; gives immediate formative feedback.	Diagnoses misconceptions; validates statutory accuracy; contextualises legal provisions.
Apply	Assists preliminary interrogation of valuation taxation data; flags candidate patterns/anomalies.	Students verify every flagged item against authoritative records; lecturer validates conclusions.
Create/Solve	Generates alternative explanations and drafts; adapts tone/register to audience and language; critiques clarity.	Students confirm legal accuracy of every claim; lecturer approves final wording before dissemination.
Industry Based Assessment (AIBA)	None: AI does not participate in assessment or grading.	MBJB officers assess professional fitness against statutory/valuation criteria; lecturer assesses academic criteria.
Reflect/Revise	Highlights gaps between the student's draft and feedback received, on request.	Students question and justify revisions; lecturer and MBJB confirm the final output is fit for practice.

The fifth stage, Reflect/Revise, makes synergy visible as a sequence: AI suggests, the student questions, the lecturer validates, industry challenges, the student revises, and finally justifies the outcome. Academic integrity is reinforced through an AI verification log recording the query, output, source consulted, correction and justification.

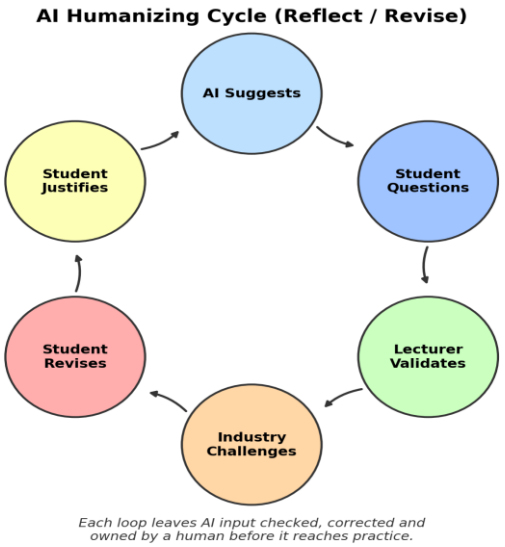


Figure 2: AI humanizing cycle within reflect/revise.

Applicability

The model is replicable in courses involving regulated professional judgement, such as land acquisition, planning, property management and local government finance, given an authentic partner problem. It needs governed data, an approved AI environment, an AIBA rubric weighted toward professional criteria, and human accountability at each stage. Platform independence supports scalability; sustainability depends on educator AI literacy, data governance and continuing agency partnerships.

Innovation Description, Process and Implementation

Implementation follows five connected stages, anchored throughout by the MBJB property tax problem introduced through the academic visit.

1) Learn. Lecturer explanation, worked examples and AI-assisted practice build statutory foundations; AI reframes concepts and gives feedback while the lecturer diagnoses misconceptions and validates accuracy.
2) Apply. Students examine MBJB property valuation and taxation data (rates, categories, calculations); the later consultancy compared P2 2023, P1 2024, PSNB and ePBT in Access and Excel. AI flags preliminary patterns; students verify against authoritative data and the lecturer validates conclusions.
3) Create/Solve. Students turn verified knowledge into communication products, videos for TikTok, Facebook, Instagram, YouTube, and multilingual radio, explaining a property tax issue to an affected owner or community. AI supports drafting and audience adaptation; students and lecturers verify legal content before release.
4) Industry-Based Assessment (AIBA). MBJB officers assess whether the property tax solution is fit for practice, not just media quality. The rubric weights statutory accuracy, tax and valuation reasoning, evidence traceability, practical relevance, audience suitability and AI transparency; production values are secondary. Students received MBJB certificates of appreciation.
5) Reflect/Revise. Students receive combined AI, lecturer and MBJB feedback, then revise and justify their output, demonstrating the human–AI division of labour in practice.

Separately, the course generated a knowledge transfer outcome: UTM was appointed to review PS2020 property tax data between PSNB and ePBT over two months (consultancy value reported under Impact). This consultancy reflects professional application of the same disciplinary and data verification skills taught in Apply and Create/Solve, not a fourth teaching stage or proof that AI improved learning.

Key Findings

The student survey (n = 30, a single cohort, voluntary response) shows strong engagement: satisfaction with the group task, achievement of objectives, overall effectiveness and industry involvement were all rated highly (Figure 3), with 96.7% perceiving the task as effective or very effective and 100% satisfied with industry involvement. These are self-reported perception measures rather than independent competency

evidence; AIBA rubric scores are not yet analysed and are prioritised for future reporting. MBJB's rubric-based AIBA, certificates and multilingual RTM dissemination add further evidence of authentic participation.

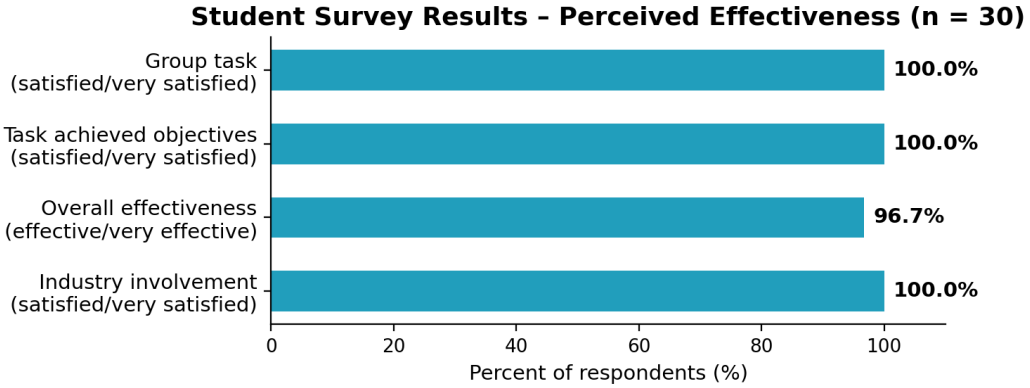


Figure 3: Student survey results – perceived effectiveness (n = 30).

The PS2020 review (Table 2) evidences the professional relevance of competencies developed in Apply and Create/Solve, not that students personally executed the paid RM19,959.64 consultancy. The survey is descriptive (n = 30) and lacks a comparison group, learning gain measure, or AI-specific condition; results support acceptability and engagement rather than a causal AI-learning claim.

Table 2: PS2020 data reconciliation summary

METRIC	VALUE
P1-2024 records supplied	351,255
Unique holdings after cleaning	351,247
Duplicate holdings identified	4
Holdings matched between P1-2024 and PSNB	342,099
Unmatched P1-2024 records	9,148
Unmatched PSNB records	1,011
Total unmatched holdings	10,159

Impact

For students, the innovation combines statutory knowledge, data verification, multilingual communication and direct feedback via AIBA. For MBJB and the community, student outputs extend property tax awareness through social media and RTM. For UTM, the RM19,959.64 consultancy illustrates the knowledge transfer pathway to professional capability and industry engagement, strengthening university–industry–government collaboration, without proving a specific AI-learning effect.

Recommendations for Classroom Practice

Educators should secure an authentic partner problem and map every AI function to an explicit human role via an AI verification log. AIBA rubrics should weight statutory accuracy over production quality, with rubric scores reported alongside satisfaction data to evidence competency gain. The Reflect/Revise stage needs dedicated feedback time, and confidential data must stay off unapproved systems.

Other relevant information

Documentary evidence includes the MBJB cooperation letter, academic visit materials, the AIBA rubric and assessment records, student certificates, UTM NewsHub coverage and the PS2020 report, scaling as a toolkit of the AIBA rubric, AI verification log and Reflect or Revise guide.

Acknowledgement

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ID 96: Adaptive Science Curriculum for E-Waste Management through Nature of Science and Project-Based Learning

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Highlights: Electronic waste (E-waste) is a growing environmental issue associated with discarded electrical and electronic devices and their embedded components. Unmanaged and informal E-waste processing may cause environmental pollution and health consequences. This innovation develops and evaluates an adaptive science curriculum integrating E-waste management, Nature of Science (NOS), and Project-Based Learning (PjBL). The intervention involved 35 secondary school students using a five-stage PjBL module. Findings showed a 92.9% overall improvement, with a statistically significant difference between pre-test and post-test scores, $t(34) = 22.17$, $p < .001$. The innovation supports knowledge, awareness, attitude, behaviour, environmental awareness, project skills, personal development, and collaboration.

Keywords: E-waste Management; Project-Based Learning; Nature of Science; Adaptive Science Curriculum; Environmental Education

Introduction

Electronic waste (E-waste) refers to discarded electrical and electronic devices that are broken, outdated and forsaken by previous users. The rapid increase in electronic technologies has contributed to the growing generation of E-waste. In the Asia Pacific region, approximately 24.9 million tons of E-waste were produced in 2019 (Andeobu et al., 2021). E-waste is also the fastest-growing waste stream, with only 17.4% of global E-waste formally collected (Quinto et al., 2025). Improper and informal E-waste processing may cause environmental pollution and health consequences (Srivastava et al., 2025; Mashende et al., 2026).

The issue requires greater attention in school education as secondary school students have demonstrated limited knowledge of E-waste management (Ercan & Bilen, 2014). The Malaysian science curriculum also provides limited attention to contemporary E-waste issues, with only 5.2% of science curriculum content related to waste recycling under Sustainable Development Goal 12 (Said et al., 2024). Therefore, students need knowledge and awareness to address future E-waste challenges (Andeobu et al., 2021; Quinto et al., 2025).

Nature of Science (NOS) provides opportunities for learners to connect scientific knowledge and practices with real-world situations and societal values (Abd-El-khalick & Lederman, 2000; Okan & Kaya, 2023). Project-Based Learning (PjBL) provides opportunities for learners to construct knowledge and experiences through meaningful problems, inquiry, collaboration and tangible project outcomes (Awamleh, 2024; Markula & Aksela, 2022). Therefore, this research aims to develop and evaluate an adaptive science curriculum specifically in E-waste management through enforcing the view of NOS.

Objectives

- Examine students' current E-waste interpretation profiles before engaging with the PjBL E-waste learning module;
- Evaluate students' actions in obtaining knowledge of E-waste through PjBL learning activities;
- Identify the significant difference in students' interpretation of E-waste from their perspective; and
- Identify possible structural components from the view of NOS through the Reconceptualised Family Resemblance Approach (RFN) as indicators that trigger learners' ideas about E-waste knowledge.

NALI Approach

Novelty

The innovation integrates E-waste management, Nature of Science (NOS), Project-Based Learning (PjBL) and Ai into an adaptive science curriculum. E-waste is addressed as a socio-scientific issue involving scientific knowledge, environmental concerns, social values and societal considerations. The Reconceptualised Family Resemblance Approach (RFN) is used to connect science through cognitive-epistemic and social-institutional systems (Kaya & Erduran, 2016).

Creativity

The innovation applies to NOS through a five-stage PjBL process: project presentation and problem identification, individual or team research, design and development, building/testing and evaluation, and project delivery. These stages were adapted from Felipe et al. (2016).

Innovativeness

PjBL provides opportunities for learners to construct knowledge and experiences with peers through educational projects (Awamleh, 2024). It also involves meaningful problems, inquiry, collaboration and tangible project outcomes (Markula & Aksela, 2022). The integration of PjBL with NOS allows students to investigate E-waste through authentic project activities while developing knowledge, awareness, attitude, behaviour, project skills and collaborative skills.

Applicability

The adaptive curriculum can be implemented within science education to address E-waste as a real-world socio-scientific issue. Its five-stage PjBL structure provides a systematic learning process that can be adapted to learning activities involving E-waste management, environmental sustainability and scientific practices. The integration of RFN also provides a framework for examining scientific knowledge and practices within the learning activities. This supports the potential adaptation of the approach across learning contexts where environmental and socio-scientific issues are addressed.

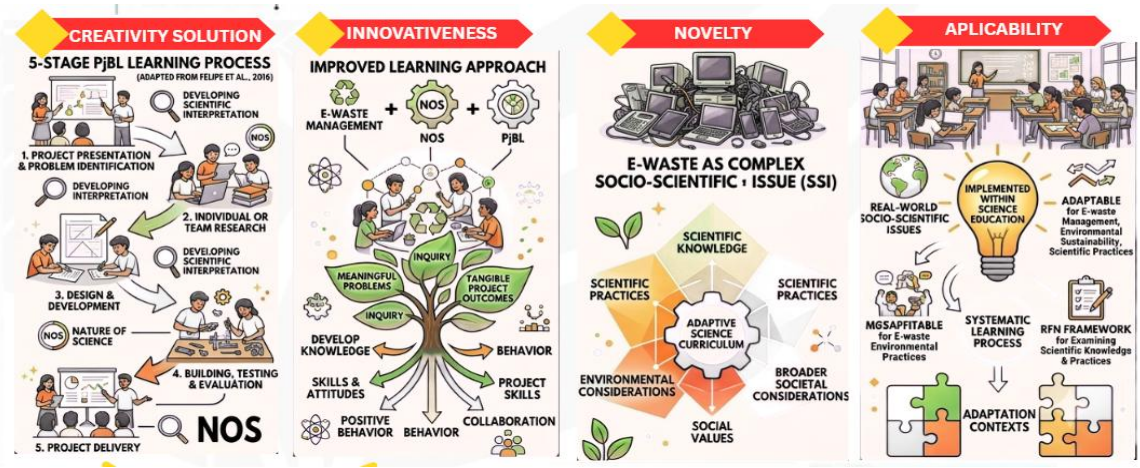


Figure 1: NALI approach throughout this project

Innovation Description, Process and Implementation

The innovation was implemented through a five-stage Project-Based Learning module integrating E-waste management, NOS perspectives and Ai. The learning process begins with project presentation and problem identification, followed by individual or team research, design and development, building/testing and evaluation, and project delivery. The module was evaluated among 35 secondary school students using a one-group pre-test and post-test design. A 25-item questionnaire examined knowledge, awareness, attitude and behaviour, while students' open-ended responses were analysed using inductive thematic analysis (Jowsey et al., 2021). The module was also analysed using Epistemic Network Analysis (ENA) based on the RFN framework to examine connections among scientific knowledge and practice (Mulvey et al., 2021; Peters-Burton et al., 2023).

Key Findings

The findings showed an overall improvement of 92.9% in students' E-waste knowledge, awareness, attitude and behaviour, with the mean score increasing from 3.01 (pre-test) to 4.86 (post-test). The paired-samples t-test showed a statistically significant difference between the pre-test and post-test scores, t(34)

= 22.17, p < .001. Thematic analysis further identified four major outcomes: increased knowledge and understanding of E-waste, environmental awareness and sustainability, PjBL and innovation skills, and personal development and collaborative skills. ENA analysis also showed that the module incorporated multiple dimensions of scientific knowledge, practice and the social context of science based on the RFN framework (Mulvey et al., 2021; Peters-Burton et al., 2023).

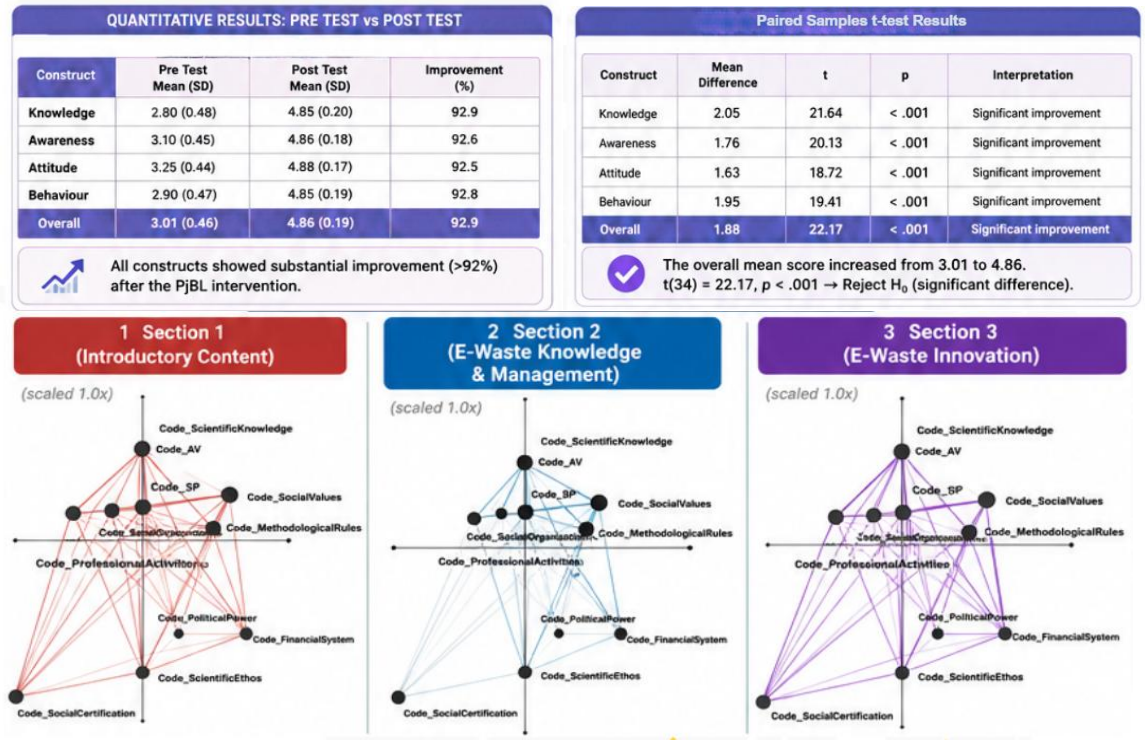


Figure 2: Results obtained in this project

Impact

The integration of PjBL provided students with opportunities to investigate E-waste as a real-world environmental issue, work collaboratively, develop solutions and apply their knowledge through authentic project experiences. The incorporation of NOS and RFN further connected scientific knowledge with scientific practices and social and environmental considerations.

Recommendations for Classroom Practice

The E-waste learning module can be implemented through a five-stage PjBL process beginning with project presentation and problem identification and progressing through research, design and development, building/testing and evaluation, and project delivery. Teachers can use E-waste as a real-world socio-scientific issue to connect scientific knowledge with environmental and societal concerns. The use of authentic project activities can provide opportunities for students to construct knowledge, collaborate with peers and develop project and innovation skills.

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ID 97: BizDay: Transforming Business Assessment through Authentic Experiential Learning and Industry Engagement

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Highlights: BizDay transforms conventional business assessment from a submission-and-grading exercise into an authentic, experiential, and industry-connected learning journey. Through the Learn–Apply–Showcase–Connect–Reflect model, students apply disciplinary knowledge and use AI tools to support ideation, research, and project development, while retaining responsibility for critical judgement and decision-making. Students demonstrate and defend their work before academic and industry audiences, receive professional feedback, and reflect for improvement. BizDay ultimately repositions assessment from an endpoint of learning into a platform for continuous learning and professional growth.

Keywords: Authentic Assessment; Experiential Learning; Human-AI Synergy; Industry-Connected Learning

Introduction

The rapid adoption of Generative Artificial Intelligence (GenAI) is reshaping higher education, prompting educators to reconsider conventional approaches to assessment. As GenAI can increasingly support the production of academic and professional outputs, assessment design must move beyond from evaluating the final product and focusing on the processes that demonstrate students' knowledge application, critical judgement, communication, decision-making and ability to defend their work. Recent research highlights the importance of authentic and experiential assessment in the GenAI era, particularly through real-world, process-oriented and interpersonal learning experiences that preserve meaningful human participation while enabling responsible use of AI (Kofinas et al., 2025).

BizDay was developed in response to this need by transforming curriculum-based business assessment into an authentic, experiential and industry-connected learning journey. Through the Learn–Apply–Showcase–Connect–Reflect model, students' progress from disciplinary learning to practical application, with AI supporting ideation, research and project development where appropriate. Students remain accountable for their decisions and subsequently showcase, communicate and defend their work before subject experts and industry practitioners, receive professional feedback, and reflect on opportunities for improvement. This design aligns with contemporary evidence that authentic assessment can strengthen critical thinking, problem-solving and collaboration while supporting the development of competencies relevant to future professional practice (Zhan et al., 2025).

Objectives

- To strengthen students' application of disciplinary knowledge by transforming curriculum-based business assessments into authentic, real-world projects that connect academic learning with professional practice.
- To enhance students' future-ready competencies in critical thinking, decision-making, teamwork, communication, presentation, and professional confidence through collaborative and experiential learning.
- To provide an authentic alternative assessment environment where students demonstrate and defend their work to both academics and industry practitioners, receive professional feedback, and reflect on opportunities for continuous improvement.
- To foster responsible Human–AI synergy by enabling students to leverage AI for ideation, research, and project development while retaining human accountability for critical judgement, decision-making, communication, and defence of their work.

NALI Approach

Novelty

BizDay provides a different approach to assessment by moving beyond the conventional Learn–Complete–Submit–Grade process towards a Learn–Apply–Showcase–Connect–Reflect learning cycle. Instead of focusing mainly on students submitting their work for assessment, BizDay gives students the opportunity to apply what they have learned and present their work to a wider audience. Students also interact with academic staff and industry practitioners, explain and defend their ideas, receive feedback, and reflect on how they can improve their work. This responds to emerging calls for assessment in the

GenAI era to shift attention from final outputs towards process, workplace relevance, and synchronous interpersonal demonstration of learning (Kofinas et al., 2025). In an AI-enabled environment, AI supports selected stages of project development while students remain accountable for their judgement, decisions, communication, and defence of their work. The novelty lies in integrating Human–AI-supported learning, authentic assessment, experiential learning, industry engagement, and reflection within one structured assessment journey.

Creativity
BizDay creatively redesigns assessment as an interactive business learning ecosystem rather than a one-way transaction between student and lecturer. Curriculum-based projects are brought into a shared showcase where students become creators, presenters, problem-solvers, and defenders of their learning. The design combines AI-supported project development, collaborative learning, authentic business challenges, live demonstrations, cross-programme peer learning, industry questioning, professional feedback, and reflection. The integration of GenAI within experiential learning and authentic assessment is consistent with emerging approaches that position AI as a learning support within authentic learning activities (Salinas-Navarro et al., 2024). It creates multiple learning interactions within a single experience, allowing students to learn not only from lecturers but also from AI tools, peers, authentic audiences, and industry practitioners.

Innovativeness
BizDay improves conventional assessment by shifting the emphasis from evaluating only the final output towards evaluating students' ability to apply, communicate, justify, and defend their learning. Recent research suggests that authentic assessment in the GenAI era should extend beyond output-based assessment towards social, experiential, and performative approaches that make student capability more visible (Kofinas et al., 2025). AI is positioned as a learning support rather than a substitute for student capability: students may leverage AI during project development but remain responsible for the decisions and knowledge demonstrated during the showcase. Academic assessment is further enriched through authentic questioning and professional feedback from industry practitioners. This transforms assessment from a predominantly lecturer-centred evaluation activity into a student-centred, competency-oriented, Human–AI-supported and industry-connected learning process.

Applicability
BizDay is designed to be adaptable and scalable as it builds on existing curriculum-based projects rather than introducing an additional assessment. It can be implemented within a single subject and gradually extended to other programmes, faculties, institutions, or disciplines that use project-based assessments. The Learn–Apply–Showcase–Connect–Reflect cycle can also be adapted according to different learning outcomes, cohort sizes, assessment formats, levels of AI integration, and industry needs.

Innovation Description, Process and Implementation

BizDay is a Human–AI-supported, authentic experiential assessment model that transforms curriculum-based business projects into a structured journey from knowledge acquisition to application, authentic demonstration, professional engagement, and reflective improvement. Rather than ending with assignment submission, BizDay extends assessment into an active learning process through the Learn–Apply–Showcase–Connect–Reflect (LASCR) Model.

Learn – Build Knowledge. Students develop disciplinary knowledge and competencies through curriculum-based learning activities and assessment preparation.

Apply – Create with Human–AI Synergy. Students collaboratively translate disciplinary knowledge into authentic business projects. AI tools support appropriate activities such as ideation, research, exploration and project development, while students retain responsibility for critical evaluation, ethical use, decision-making and final outputs.

Showcase – Make Learning Visible. Students move beyond submitting an assignment by presenting, demonstrating and defending their work in real time. This makes students' understanding, communication, reasoning and ownership of their work observable to authentic audiences.

Connect – Engage with Authentic Audiences. Academic and industry practitioners question students, exchange professional perspectives and provide feedback. This introduces human judgement, workplace expectations and industry relevance into the assessment experience.

Reflect – Turn Feedback into Further Learning. Students evaluate their performance and feedback, identify strengths and areas for improvement, and transfer these insights into subsequent learning and

professional development. Reflection reconnects to LEARN, making assessment a continuous learning cycle rather than an endpoint.

BizDay 2026 operationalised this model across multiple business programmes, engaging 558 students through 111 curriculum-based projects, supported by 28 external industry judges and 14 internal judges. Effectiveness was evaluated through implementation evidence and post-event surveys involving 145 students and 21 stakeholders, examining knowledge application, competency development, feedback, authentic learning and perceptions of the assessment experience.

Key Findings

Evaluation of BizDay 2026 demonstrated positive outcomes in knowledge application, competency development, authentic learning, and professional feedback. The post-event student survey (n = 145) showed that teamwork and collaboration was the highest-rated learning outcome (M = 4.26/5), followed by feedback helping students identify areas for improvement (M = 4.21/5). Students also reported positive outcomes in communication and presentation skills (M = 4.18/5), understanding of subject content (M = 4.18/5), and confidence in presenting ideas professionally (M = 4.17/5). Furthermore, 75.2% agreed or strongly agreed that BizDay encouraged them to apply theoretical knowledge in practical situations.

Stakeholder evaluation (n = 21) further reinforced these findings. All stakeholders (100%) agreed or strongly agreed that BizDay provided students with an authentic learning experience (M = 4.43/5), while 95.2% regarded it as a meaningful learning experience. Importantly, 90.5% perceived BizDay as an effective alternative to conventional written or presentation-based assessment, and 85.7% agreed that it effectively integrated academic learning with real-world business practice.

Collectively, the findings demonstrate that BizDay extends assessment beyond evaluating final outputs by creating opportunities for students to apply knowledge, collaborate, communicate, demonstrate and defend their learning, engage with authentic audiences, and learn from professional feedback. The evidence supports BizDay as an effective student-centred, authentic, experiential, and industry-connected assessment model that strengthens the connection between academic learning and professional practice.

Impact

BizDay creates impact by transforming assessment into an active, authentic, and industry-connected learning experience that benefits students, educators, industry stakeholders, and the institution. For students, the model strengthens the application of disciplinary knowledge while developing teamwork, communication, presentation, confidence, and professional interaction. Authentic questioning and professional feedback empower students to take greater ownership of their learning by requiring them to demonstrate, justify, and defend their decisions, while reflection enables feedback to be translated into continuous improvement.

For educators, BizDay extends assessment beyond evaluating final submissions by providing opportunities to observe how students apply their knowledge, explain their reasoning, communication skills and demonstrates their competencies. In an AI-enabled learning environment, the model also helps educators preserve meaningful human accountability: AI can support project development, while students remain responsible for the judgement, decisions, and understanding demonstrated during authentic interaction.

For industry stakeholders, BizDay provides opportunities to share professional insights, workplace expectations, and constructive feedback with students. At the institutional level, BizDay strengthens engagement between academia and industry while supporting authentic assessment and student-centred learning. As the model can be adapted to different programmes and disciplines, it also provides opportunities for wider implementation across the institution.

In the longer term, BizDay contributes to a shift from assessment as an endpoint for measuring learning to assessment as a platform for generating further learning, human–AI capability, professional growth, and industry connection. This encourages students to become active and responsible learners who can confidently demonstrate their knowledge, skills and understanding in an increasingly AI-enabled workplace.

Recommendations for Classroom Practice

Educators can adopt BizDay by transforming existing curriculum-based projects into authentic experiential assessments using the Learn–Apply–Showcase–Connect–Reflect (LASCR) Model, rather than introducing an additional assessment. Implementation should begin by aligning learning outcomes, assessment tasks, authentic business or professional contexts, and assessment criteria. Students should receive clear guidance on project expectations, responsible AI use, teamwork, and preparation for real-time presentation, questioning, and defence of their work.

During Apply, educators may allow appropriate AI tools to support ideation, research, exploration, and project development while establishing clear expectations for ethical use, verification, critical judgement, and student ownership of final decisions. The Showcase and Connect stages should involve authentic audiences such as industry practitioners, educators, peers, or community partners who can question students and provide actionable feedback. A structured Reflect activity should subsequently require students to evaluate feedback, identify strengths and learning gaps, and determine necessary improvements for future academic or professional practice.

For effective adoption, educators may begin with a single subject or small-scale showcase before expanding across programmes or disciplines. The LASCR Model can be customised according to discipline, learner needs, cohort size, available resources, assessment format, and level of AI integration. Sustainability can be strengthened by embedding the model within existing assessments, developing reusable rubrics and implementation guidelines, maintaining partnerships with external stakeholders, and systematically evaluating student learning outcomes after each implementation.

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ID 99: NutriBite Chocolate Energy Bar: An Inclusive Functional Food Innovation for Sustainable Healthy Living

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Highlights: Nutri Bite Chocolate Energy Bar is an inclusive functional food innovation developed through a TVET-based Project-Based Learning approach involving Students with Special Educational Needs (SEN). The innovation addresses students' preference for sweet snacks and low vegetable acceptance by incorporating bitter melon into a chocolate-based energy bar. Through product development, testing, packaging, marketing, and commercialisation, students gained authentic vocational and entrepreneurial experiences. The innovation promotes healthier snacking while enhancing students' practical skills, communication, teamwork, self-confidence, and entrepreneurial competencies.

Keywords: Special Educational Needs; Functional Food; NutriBite Bar; TVET; Entrepreneurship; Project-Based Learning

Introduction

Entrepreneurial skills are widely recognised as an effective approach to addressing the employment challenges faced by Students with Special Educational Needs (SEN), particularly those with learning disabilities who often experience difficulties in securing sustainable employment after graduation. Developing entrepreneurial competencies through vocational education enables these students to become more independent, self-reliant, and economically empowered. Implementing creative thinking, food innovation, and entrepreneurship education encourages SEN students to transform their ideas into marketable products while enhancing their practical, communication, and problem-solving skills. NutriBite Chocolate Energy Bar is a nutritious functional snack developed by students of SMPK Vokasional Indahpura through an inclusive vocational education programme. The product combines the rich taste of dark chocolate with eight carefully selected natural ingredients—oats, almonds, dates, pumpkin seeds, honey, cranberries, bitter melon (Momordica charantia), and dark chocolate—to provide a natural source of energy, dietary fibre, antioxidants, and essential nutrients. Unlike conventional chocolate snacks, Nutri Bite incorporates the nutritional benefits of bitter melon, a functional ingredient known for its health-promoting properties, without compromising taste and consumer acceptance. (Jia et al., 2017; Paudel et al., 2021; Temple, 2022). This innovative formulation offers a healthier, convenient, and satisfying snack suitable for people of all ages. More than just a food product, Nutri Bite Chocolate Energy Bar was developed through a TVET-based learning approach that integrates food innovation, entrepreneurship, and vocational skills. It provides Students with Special Educational Needs (SEN) with authentic hands-on experience in product development, food processing, branding, packaging, marketing, and commercialisation, while promoting healthy eating habits and sustainable entrepreneurship.

Objectives

- To produce healthy energy bars suitable for special education students and hostel students.
- To increase vegetable intake through snacks.
- To provide a low-sugar snack alternative that supplies energy and balanced nutrition.
- To develop entrepreneurial skills through product production and marketing.

NALI Approach

Novelty

NutriBite Chocolate Energy Bar is an innovative functional snack that uniquely incorporates bitter melon into a chocolate-based energy bar, transforming a traditionally preferred vegetable into a delicious and nutritious product. Unlike conventional energy bars that mainly focus on energy enhancement, Nutri Bite combines functional nutrition, natural ingredients, vocational learning, and inclusive education. The product was designed, produced, and commercialised by Special Educational Needs (SEN) students, providing both health benefits and authentic entrepreneurial experiences.

- Innovation Highlights
- Innovative use of bitter melon in a chocolate energy bar.
- Functional food with natural ingredients and high nutritional value.
- Developed through an inclusive TVET learning approach.

- Integrates health, entrepreneurship, and vocational education into one product.

Creativity
Eight-Ingredient Functional Blend

Nutri Bite Chocolate Energy Bar is creatively formulated using eight selected natural ingredients, each contributing unique nutritional benefits to produce a healthy, delicious, and functional snack.

Dark Chocolate	Rich in flavonoids, improve blood flow to the brain. Helps reduce stress and improve mood. (Scholey & Owen, 2013)
Oats	High in Fiber, keeps you full longer. Helps control blood sugar levels. Good for heart and digestion.
Almonds	Rich in protein and healthy fats. Contains vitamin E. Improves focus and memory.
Dates	Natural sweetener with high fiber content. Provide instant energy without sugar spikes. Good for digestion and stamina.
Pumpkin Seeds	Contain magnesium, zinc, and iron. Boost energy, improve focus and support the immune system. Contain tryptophan – helps improve sleep and emotional stability.
Honey (Original)	Natural source of sugar. Boosts energy and immunity. Natural antioxidants help fight fatigue.
Cranberries	Source of vitamin C and fiber, good for digestion. Rich in polyphenols that fight free radicals. Support urinary tract health.
Bitter Melon Flakes	Rich in bioactive compounds with antioxidant properties. Contains naturally occurring phytochemicals. Has potential functional food applications. (Jia et al., 2017)

Innovativeness
Nutri Bite Chocolate Energy Bar is an innovative functional snack developed through an inclusive TVET-based learning approach that integrates food innovation, nutrition, and entrepreneurship into authentic learning experiences for Students with Special Educational Needs (SEN). Rather than producing a food product alone, students actively participate in every stage of the innovation process, including recipe formulation, ingredient selection, food preparation, quality control, packaging design, branding, costing, marketing, and product presentation.

- This hands-on pedagogical approach enhances students' vocational competencies, creativity, communication, critical thinking, teamwork, and entrepreneurial skills while providing meaningful real-world learning experiences. The incorporation of bitter melon (*Momordica charantia*) into a chocolate energy bar demonstrates an innovative food formulation that promotes healthier eating habits without compromising taste and consumer acceptance.
- Innovation Highlights
- Integrates TVET, entrepreneurship, and functional food innovation.
- Provides authentic project-based learning for SEN students. (Bong et al., 2025)
- Develops employability and entrepreneurial competencies.
- Promotes healthy food innovation using natural ingredients.

Applicability
Nutri Bite Chocolate Energy Bar has strong potential for adaptation, replication, and scalability across vocational schools, special education institutions, colleges, and community-based entrepreneurship programmes. The production process uses affordable and easily accessible ingredients, making it practical for implementation in various educational settings.

- The innovation can be incorporated into Food Preparation and Production, Entrepreneurship, Life Skills, and TVET programmes to provide students with authentic learning experiences in food production and business development. Beyond the classroom, the product has commercial potential through school cooperatives, entrepreneurship projects, exhibitions, online platforms, and local retail markets.

- Its combination of healthy nutrition, vocational education, and entrepreneurship supports long-term sustainability by promoting healthier lifestyles while equipping students with practical skills for future employment and self-employment.
- Potential for Expansion
- Vocational schools and Special Education schools.
- Community entrepreneurship programmes.
- School cooperative (School Enterprise) initiatives.
- TVET institutions and colleges.
- Small-scale commercial production.
- Community health and nutrition campaigns.

Innovation Description, Process and Implementation

Nutri Bite Chocolate Energy Bar is an inclusive functional food innovation developed through a TVET-based Project-Based Learning (PBL) approach involving Students with Special Educational Needs (SEN). The innovation combines food production, healthy eating, vocational skills, and entrepreneurship within an authentic learning environment.

The development process began with a needs analysis conducted among hostel students to identify their snack and vegetable preferences. Based on the findings, teachers and students collaboratively developed a chocolate-based energy bar incorporating bitter melon as a functional ingredient. Students participated in ingredient preparation, weighing, food production, quality control, packaging, and product presentation under structured teacher guidance.

The innovation was implemented through several cycles of product testing, feedback, and refinement. Feedback from teachers, customers, and exhibition visitors was used to improve the taste, texture, packaging, and product size. Students were subsequently involved in costing, marketing, sales, and product promotion, allowing them to experience the complete process from product development to commercialisation.

Throughout the implementation, teachers used demonstrations, visual instructions, repetition, task division, and hands-on guidance to accommodate students' individual learning abilities. Product quality, customer feedback, practical performance, and students' participation were used to evaluate the effectiveness and continuous improvement of the innovation.

Key Findings

PROGRESS	DATE	DETAILS
Progress 1 Needs Analysis	June 2025	A preliminary study was conducted to identify snack preferences among hostel students. 58% preferred sweet and chocolate-based snacks, while 89% disliked eating vegetables. These findings indicated a need for a healthy and affordable snack that matched students' taste preferences. Teachers and students collaboratively explored the development of a nutritious snack incorporating vegetables in a more acceptable form for learners.
First Practical & Product Testing	August 2025	The first practical session was conducted with students receiving hands-on training from teachers in producing NutriBite Bar. Initial product testing was conducted collaboratively by teachers and students, while samples were distributed to school teachers for feedback. The feedback was used to improve the product's taste and overall quality.
Product Refinement	September 2025	The production process was repeated based on previous feedback. Ingredients and formulation were adjusted where necessary, with improvements focusing mainly on taste and texture, while maintaining the nutritional value and suitability of the product for students.
External Testing & Feedback	October 2025	NutriBite Bar was showcased at a state-level exhibition. External customers provided feedback through Google Forms. Overall responses indicated that the product was very tasty and highly nutritious, while packaging enhancement was identified as the main area for improvement.
External Testing & Feedback	June 2026	NutriBite Bar was showcased at a national-level education sector event in Putrajaya. Feedback was collected from external customers through Google Forms. The product received positive responses, particularly regarding its taste and nutritional value. Customers also suggested that the product could be offered without the smaller size to simplify packaging and handling.

PROGRESS	DATE	DETAILS
Product Testing & Exhibition Preparation	22 June 2026	Students produced 12 regular-size bars and 45 mini bars for a TVET exhibition in Putrajaya. Special packaging was prepared for the exhibition. The product received positive feedback from visitors and customers, providing further evidence of market acceptance.
Market Testing & Product Standardisation	26 June 2026	Following a request from the school for the 20th School Convocation, the team decided to focus on the regular-size NutriBite Bar. This decision was based on the smaller packaging being more time-consuming to prepare and more difficult to store. All products sold received positive reviews. 88% of customers agreed that NutriBite was unique, with a distinctive slightly bitter yet pleasant taste, high perceived nutritional value, and low sweetness.
Stock Production & Intellectual Property	July 2026	16 regular-size bars were produced for school sales and stock purposes. The team also initiated the process of obtaining copyright protection for the NutriBite product.

Impact

Impact on Students

- Improved vocational competencies in food preparation and production.
- Enhanced creativity, communication, teamwork, and problem-solving skills.
- Increased self-confidence through hands-on learning and public product promotion.
- Strengthened entrepreneurial and employability skills through real business experiences.

Impact on Educators

- Provides an innovative Project-Based Learning (PBL) model for integrating food innovation with entrepreneurship.
- Enhances teaching effectiveness through authentic, student-centred learning.
- Serves as a practical teaching resource for vocational and special education programmes.

Impact on the Institution

- Strengthens the school's culture of innovation and entrepreneurship.
- Promotes inclusive TVET education aligned with national educational aspirations.
- Enhances the institution's visibility through innovation competitions, exhibitions, and community engagement.

Impact on the Community

- Encourages healthier snacking habits through a nutritious functional food.
- Raises awareness of healthy food choices using natural ingredients.
- Demonstrates the capabilities and potential of Students with Special Educational Needs (SEN) in developing commercially viable products.
- Supports sustainable community entrepreneurship through innovative food products.

Long-Term Impact

- Promotes sustainable healthy lifestyles.
- Encourages lifelong entrepreneurial thinking.
- Improves employability and self-employment opportunities for SEN students.
- Provides a scalable innovation model that can be adopted by other vocational and special education institutions.

Recommendations for Classroom Practice

The Nutri Bite Chocolate Energy Bar project can be integrated into vocational and special education classrooms through Project-Based Learning (PBL), where Students with Special Educational Needs (SEN) participate in the complete process of product development, from ingredient preparation and food production to packaging, costing, marketing, and sales. Teachers are encouraged to divide the production process into structured, manageable tasks supported by visual instructions, demonstrations, repetition, and hands-on practice according to students' individual abilities.

The project can also be adapted across different learning areas, including Food Preparation and Production, Entrepreneurship, Mathematics, Communication, and Digital Skills. Students may practise weighing ingredients, calculating production costs, designing product labels, communicating with customers, collecting feedback, and promoting products through digital platforms.

For effective implementation, teachers should assign roles based on students' strengths and provide opportunities for role rotation to develop independence, teamwork, communication, and leadership

skills. Continuous assessment through teacher observation, practical performance, peer assessment, customer feedback, and student reflection is recommended to monitor students' progress.

This approach can be replicated using other locally available ingredients and modified according to students' abilities, school facilities, and community needs. Through authentic product-based learning, students can connect classroom knowledge with real-world vocational and entrepreneurial experiences.

Other relevant information

Nutri Bite Chocolate Energy Bar demonstrates promising potential for educational entrepreneurship and small-scale commercialisation. The product has undergone several stages of development, testing, refinement, exhibition, and customer feedback since June 2025.

The product was introduced to external audiences through state- and national-level exhibitions, where feedback was collected to improve its taste, texture, packaging, and product presentation. Customer responses also contributed to the decision to focus on the standard bar size, as it was more practical for production, packaging, and storage.

In addition, demand for Nutri Bite during the school's 20th Convocation demonstrated its potential as a school-based enterprise product. The innovation may be further developed through school cooperatives, entrepreneurship programmes, TVET exhibitions, community events, and small-scale commercial production.

Beyond its commercial potential, Nutri Bite provides an inclusive platform for demonstrating the capabilities of Students with Special Educational Needs (SEN) in developing, producing, promoting, and commercialising a marketable food product. Future development may include improved packaging, nutritional analysis, product standardisation, branding enhancement, and appropriate intellectual property protection.

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ID 100: Visual and Verbal Stimulation (SVSL) as Scaffolding in Newman's Procedure to Enhance Coordinate Geometry Problem-Solving Ability

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Highlights: SVSL as scaffolding in Newman's Procedure is a curriculum-aligned multimodal scaffolding innovation for Form Four Additional Mathematics. Developed from students documented Coordinate Geometry errors, it integrates the Newman Worksheet (LKN), Formula and Terminology List (SIR), GeoGebra, teacher think-alouds and structured questioning across five Newman stages. In a quasi-experiment involving 163 Form Four students across four learning conditions (Control: Newman's Procedure only; visual stimulation; verbal stimulation and integrated SVSL) found that the SVSL group demonstrated the strongest overall learning profile: highest adjusted achievement, lowest mental effort and highest Newman mastery. The innovation turns error diagnosis into a practical, progressively faded routine for collaborative and self-regulated problem solving.

Keywords: integrated visual and verbal scaffolding; Newman's Procedure; Coordinate Geometry; Additional Mathematics; problem solving

Introduction

Coordinate Geometry (CG) problem solving in Additional Mathematics requires students to coordinate verbal conditions, visual–spatial representations, algebraic transformations and multi-step reasoning. Need analysis of 73 students' written solutions, supported by interviews with three teachers and six students, identified cascading difficulties in reading mathematical terms and symbols, interpreting task demands, visualising coordinate relationships, selecting formulas and sustaining accurate algebraic procedures. Transformation errors were particularly prominent, indicating that conventional formula practice alone does not adequately support students in converting information into a coherent solution plan. SVSL–Newman was therefore developed as a curriculum-aligned response for Content Standards 7.1–7.4 of Form Four Additional Mathematics (Bahagian Pembangunan Kurikulum [BPK], 2018). The strategy draws on social constructivism, cognitive load theory and the cognitive theory of multimedia learning to make mathematical reasoning visible, discussable and progressively self-regulated (Mayer, 2024; Vygotsky, 1978).

Objectives

- To develop and validate a Visual and Verbal Stimulation (SVSL) strategy that scaffolds the five stages of Newman's Procedure for Form Four CG problem solving.
- To evaluate the effects of SVSL on post-test achievement, mental effort and Newman mastery relative to visual-only, verbal-only and Newman-only learning conditions.
- To establish a practical, curriculum-aligned implementation model that teachers can adapt for routine, complex routine and non-routine CG tasks.

NALI Approach

SVSL as scaffolding in Newman's Procedure operationalises student-centred and collaborative learning through structured peer discussion, teacher-facilitated questioning, digital visualisation and formative self-checking. Students first observe explicit modelling, then co-construct solutions in groups, and finally apply the routine independently. The design treats assessment as learning: the Lembaran Kerja Newman (LKN) captures students' decisions, misconceptions and solution pathways at each stage, enabling immediate feedback rather than judgement based only on final answer

Novelty

The innovation does not merely add digital tools to a Newman lesson. It converts Newman's Procedure from an error-diagnosis framework into a diagnostic-to-instructional system. Five categories of CG error-reading, comprehension, transformation, process skills and encoding-are explicitly mapped to targeted visual and verbal scaffolds. For example, formula-selection and representation errors at the transformation stage are addressed through LKN prompts L7-L10, the Senarai Istilah dan Rumus (SIR), dynamic GeoGebra representations and verbal prompts T1-T4. This purposeful mapping is distinctive because the support is determined by the cognitive barrier being addressed, rather than by the technology available (Kania et al., 2024).

Creativity
SVSL as scaffolding in Newman's Procedure translates abstract problem-solving processes into an accessible learner toolkit. LKN contains 13 visible actions (L1-L13), including keyword marking, Cartesian sketching, formula selection, solution planning and final-answer checking. SIR provides on-demand definitions, symbols, formulas and annotated examples, while GeoGebra and OneNote make changing coordinates, lines, ratios and loci observable in real time. Structured verbal prompts (M1-K2) : "What?", "Why?", "How?" and "Is it logical?" elicit justification and verification. Optional prompts are deliberately reserved for complex and non-routine tasks, balancing productive support with cognitive-load management.

Innovativeness
The strategy integrates static visual resources, dynamic digital representations and verbalised reasoning through three progressively faded phases: instructional demonstration, structured facilitation and self-empowerment. In Phase 1, teachers model the routine through think-aloud protocol (TAP) and annotated visualisation. In Phase 2, students use the same tools collaboratively while teachers diagnose and question rather than provide answers. In Phase 3, students use the prompts and resources independently. This gradual transfer of responsibility transforms CG learning from answer imitation to regulated problem solving (Anghileri, 2006).

Applicability
The resource kit comprises a student manual, LKN, SIR, structured-question guide, GeoGebra guidance and lesson plans. It can be implemented using printed materials and freely available digital tools, making it feasible in classrooms with varying levels of technology access. The full design contains six 80-minute learning sessions: four content-focused sessions on segment division, parallel/perpendicular lines, polygon area and locus, followed by two integrative problem-solving sessions. Content experts evaluated the visual and verbal components, learning tasks and lesson plans; the key content-validity indices reached S-CVI/Ave = 1.000. The feedback questionnaire demonstrated strong internal consistency (Cronbach's a = .923).

Innovation Description, Process and Implementation

SVSL as scaffolding in Newman's Procedure was developed through ADDIE, beginning with document analysis, diagnostic scripts and interviews, then refined through expert review and pilot implementation. The pedagogical mechanism is summarised in Table 1. In the quasi-experiment, 163 Form Four students learned under four conditions: Newman-only control (n = 35), verbal stimulation (SL, n = 39), visual stimulation (SV, n = 44) and integrated SVSL (n = 45). Pre- and post-tests comprised 13 items spanning routine, complex routine and non-routine CG problems. Mental effort ratings, Newman-mastery scores, student scripts and open-ended feedback provided convergent evidence of impact.

Table 1: Diagnostic-to-instructional mapping in SVSL as scaffolding in Newman's Procedure

NEWMAN STAGE	TYPICAL CG BARRIER	TARGETED SVSL SCAFFOLD
Reading	Terms, symbols and key information	L1-L3; SIR; M1-M3; highlighting
Comprehension	Task demands and coordinate representation	L4-L6; Cartesian sketches; F1-F4; GeoGebra
Transformation	Formula selection and mathematical modelling	L7-L10; SIR; T1-T4; dynamic visualisation
Process skills	Algebraic manipulation and calculation accuracy	L11-L12; OneNote/Smartboard annotation; P1-P6; self-checking
Encoding	Answer format, justification and verification	L13; K1-K2; reasonableness checks

Key Findings

After controlling for corresponding pre-test scores, learning strategy had a significant multivariate effect on the combined outcomes of achievement, mental effort and Newman mastery, Pillai's Trace = 0.323, $F(9, 468) = 6.27$, $p < 0.001$, partial $\eta^2 = 0.108$. Follow-up ANCOVA showed significant group effects for post-test performance, $F(3, 158) = 14.24$, $p < 0.001$, partial $\eta^2 = 0.213$; mental effort, $F(3, 158) = 9.40$, $p < 0.001$, partial $\eta^2 = .152$; and Newman mastery, $F(3, 158) = 7.39$, $p < 0.001$, partial $\eta^2 = 0.123$. SVSL recorded the highest adjusted post-test mean (9.00), compared with SV (6.25), SL (3.79) and control (1.32), alongside the lowest adjusted mental-effort score (7.37) and highest Newman mastery (1.84). The SVSL group was significantly higher than SL and control on achievement, although its difference from SV was not significant after Bonferroni adjustment ($p = 0.114$).

The integrated condition was especially advantageous for demanding tasks. For non-routine problems, SVSL achieved a gain of 4.40 versus 0.40 for control and the highest performance–mental-effort efficiency index (0.67 versus −0.93). For complex routine tasks, 40.7% of SVSL students reached the "able to answer" Newman level, compared with 1.3% in control. Pre–post scripts showed movement from fragmented or absent responses to organised representations, justified formula selection and complete solution sequences. Among the 45 SVSL students who completed the feedback questionnaire, 93.3%–97.8% agreed or strongly agreed that the strategy supported the five Newman stages and their overall CG problem-solving ability.

Impact

SVSL as scaffolding in Newman's Procedure improves more than final marks. It makes students' mathematical thinking observable, enabling them to identify what is known, represent relationships, select a strategy, monitor calculations and verify an answer. The evidence indicates that the integrated design supports high achievement with lower perceived mental effort, particularly when students confront unfamiliar multi-step problems. For teachers, the kit offers a common language for diagnosing errors and responding with targeted prompts instead of repeating explanations or supplying procedures. For schools, it provides a reusable, DSKP-aligned approach for strengthening reasoning, confidence and learner agency in Additional Mathematics.

Recommendations for Classroom Practice

Teachers should begin by identifying the dominant Newman barriers in their own students' work, then use the matched SVSL prompts rather than applying every scaffold mechanically. For direct questions, the optional prompts may be reduced; for complex or non-routine problems, LKN, SIR, dynamic visualisation and justification prompts should be used together. Implementation should preserve the three-phase progression from modelling to collaboration and independent practice. The same diagnostic-to-instructional logic can be adapted to other Additional Mathematics topics requiring translation between words, diagrams, symbols and procedures.

Other relevant information

The SVSL resource kit includes a student manual, printable and digital scaffolds, structured verbal prompts, lesson plans and GeoGebra guidance. It is designed for adaptation through teacher professional learning communities and can be implemented with low-cost printed resources where devices or connectivity are limited.

Acknowledgement

The author gratefully acknowledges Associate Professor Dr Abdul Halim Bin Abdullah for academic supervision and guidance in the development and evaluation of this innovation. Sincere appreciation is also extended to the participating schools, the Ministry of Education Malaysia (KPM) and the Melaka State Education Department (JPN Melaka) for their permission, cooperation and support throughout the implementation of the study.

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ID 101: ThesiScan 2.0: Enhanced Thesis Formatting Checker using AI

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Highlights: Thesis format verification at UTM is still largely manual, and a preliminary review found typography errors in 90% and line-spacing violations in 75% of sampled theses. ThesiScan 2.0 is a web-based Human-AI Synergy tool that combines native PDF metadata analysis with computer-vision layout extraction to automatically check five formatting aspects: programme name, font consistency, citation and reference consistency, margins, and line spacing. Evaluated on 50 real theses, it achieved 99.90% accuracy and a 96.41% F1-score at 0.28 seconds per page, giving students instant, actionable feedback and reducing supervisors' manual formatting-review workload before submission.

Keywords: Automated Thesis Verification; Computer Vision; Document Formatting Compliance; Hybrid Document Analysis

Introduction

Submitting a thesis in the correct institutional format is a mandatory graduation requirement, yet formatting compliance is often treated as a purely administrative hurdle rather than a learning opportunity. At Universiti Teknologi Malaysia (UTM), standardised Microsoft Word and LaTeX templates are provided (School of Graduate Studies, 2023), but repeated revisions frequently introduce inconsistencies in margins, typography, line spacing, and citation ordering that students struggle to self-detect. A preliminary review of a collection of theses from the UTM Institutional Repository found typography errors in 90% and line-spacing violations in 75% of the sample. Meanwhile, verification still relies on manual inspection by supervisors, examiners, and administrative staff, a process that is time-consuming, inconsistent, and contributes to repeated revision cycles that delay graduation (Kamaruzaman et al., 2024).

Existing academic-writing tools address only fragments of this problem: Grammarly and QuillBot improve grammar, Turnitin checks plagiarism, and IEEE PDF eXpress validates PDF compatibility, but none verify institution-specific thesis formatting (Dizon & Gayed, 2021). An earlier version UTM thesis checker in 2025 automated programme name, citation, and margin verification using OCR and regular expressions, but could not reliably verify fine-grained attributes such as font consistency and line spacing (Lim, 2025). ThesiScan 2.0 addresses this gap as a Human-AI Synergy innovation: it augments, rather than replaces, human judgement by giving students and lecturers an instant, explainable, and comprehensive formatting check across five formatting dimensions, turning a stressful administrative bottleneck into an opportunity for independent self-correction.

Objectives

- To develop a font compliance checker using hybrid metadata analysis to automatically validate font consistency and size requirements in UTM theses.
- To implement a spacing analyzer using geometric layout extraction to measure vertical spacing in the body text of UTM theses.
- To evaluate the performance of the thesis format compliance checker by comparing accuracy, processing speed, and error rate against the existing thesis formatting checker.

NALI Approach

Novelty

Unlike existing writing-support tools that address only a single dimension of academic writing quality, such as grammar, plagiarism, or PDF accessibility, ThesiScan 2.0 unifies five distinct formatting dimensions, programme name, font consistency, citation/reference consistency, margin, and line spacing, within one verification pipeline. Its core novelty is replacing OCR-dependent text recognition with a dual-stream architecture that reads formatting attributes directly from native PDF metadata and uses computer vision only for structural regions that metadata cannot describe, avoiding the recognition errors that limited the prior UTM checker (Lim, 2025).

Creativity

The system creatively combines two complementary data sources rather than relying on one: a metadata stream (PyMuPDF) for text-level attributes and a geometric stream (OpenCV) for spatial layout,

unified through a shared coordinate-mapping pipeline so every detected violation can be annotated directly onto the original PDF. A self-learning dominant-style module statistically infers each thesis's own intended font and size from its most frequent usage rather than a hard-coded rule, while semantic-aware filtering automatically excludes equations, captions, and tables from spacing and font checks to reduce false positives.

Innovativeness

ThesiScan 2.0 improves on existing manual and OCR-based practice in concrete ways: it expands verification coverage from three modules to five, extends citation-style support from IEEE-only to both IEEE and APA, and replaces a single-user desktop application with a cloud-hosted, role-based web platform for students, lecturers, and administrators. Processing speed improved roughly five-fold, from 1.54 seconds per page in the predecessor to 0.28 seconds per page, while overall verification accuracy reached 99.90%.

Applicability

The system is deployed as a Docker-containerised, cloud-hosted web application (Fly.io) that students and lecturers' access directly through a browser using their institutional Google account, with roles (student, lecturer, administrator) automatically assigned by email domain and compliance reports shared through each user's own Google Drive. Because the verification rules sit in a configurable, rule-based validation layer rather than being hard-coded, the same architecture could in future be adapted to other institutions' formatting guidelines, supporting realistic scalability beyond UTM.

Innovation Description, Process and Implementation

ThesiScan 2.0 processes each uploaded PDF thesis through two parallel pipelines, illustrated in Figure 1. A metadata stream, built on PyMuPDF, extracts text, font attributes, and coordinates directly from the PDF's native structure to verify programme name declarations, font consistency, and citation/reference consistency. A geometric stream, built on OpenCV, rasterises each page and applies adaptive thresholding and connected-component analysis to detect margin boundaries and structural regions (tables, figures, equations) that are not explicitly represented in the metadata. Both streams feed a unified verification pipeline, where rule-based semantic validation compares extracted attributes against the UTM Thesis Writing Guidelines, and detected violations are spatially annotated directly onto the original PDF to generate a compliance report.

The web application follows a Model-View-Controller architecture built on Flask, with an SQLite database managing user accounts, submission records, and analysis history, and Google Drive integration for generating and sharing annotated compliance reports. Students upload their thesis and receive an itemised report identifying each violation; lecturers can monitor their students' submissions and review compliance status; administrators manage accounts and system configuration. The complete system was containerised with Docker and deployed on the Fly.io cloud platform so it is usable without local installation.

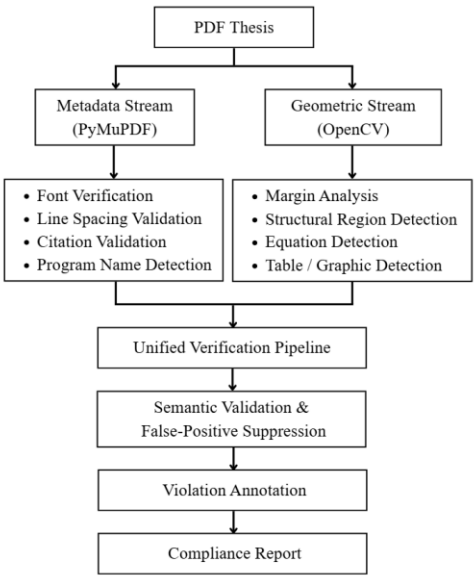


Figure 1: Hybrid metadata-geometric verification architecture of ThesiScan 2.0 (adapted from Ooi & Omar, 2026).

Key Findings

The enhanced system was evaluated on an independent dataset of 50 UTM theses (28 bachelor's, 21 master's, 1 doctoral; 4,560 pages total), distinct from the 20-thesis sample used to motivate the study. Table 1 summarises the measured module-level performance.

Table 1: Module-level verification performance of ThesiScan 2.0 (Ooi & Omar, 2026).

MODULE	PRECISION	RECALL	F1-SCORE
Programme Name	97.50%	100.00%	98.33%
Font Consistency	83.23%	94.51%	90.05%
Citation & Reference	84.33%	100.00%	93.09%
Margin Detection	100.00%	100.00%	100.00%
Line Spacing	91.54%	93.90%	94.93%

Overall, ThesiScan 2.0 achieved an accuracy of 99.90% ± 0.12%, precision of 95.28% ± 5.99%, recall of 97.97% ± 5.10%, and F1-score of 96.41% ± 3.99%, processing a thesis in an average of 25.87 seconds (0.28 seconds per page) (Ooi & Omar, 2026). Compared with the predecessor OCR-based checker, coverage expanded from three modules to five; citation-style support extended to IEEE and APA formats, and processing speed achieved 0.28 seconds per page. These are demonstrated technical results measured directly on the evaluation dataset.

Impact

ThesiScan 2.0 gives students an itemised and spatially annotated report they can act on independently. It essentially turns formatting compliance from a source of anxiety into a self-directed learning task, rather than a bottleneck resolved only through supervisor intervention. For universities, the system helps safeguard the professional credibility of their graduate output and institutional repository at scale. Since its test deployment in the Faculty of Electrical Engineering's FYP programme in 2025-2026, the tool has been used by 28 students to check 28 thesis submissions, all first-time users identifying and correcting at least one formatting violation independently before supervisor review. By elaborating why, a formatting rule was violated rather than only flagging that it was, the tool builds formatting literacy as a transferable skill, one that students can carry into future academic and professional writing.

Compared with its predecessor ThesiScan 1.0 (Lim, 2025), which attained a Bronze Medal at NALI 2025, more students were able to self-correct without supervisor intervention. A cursory thesis review among non-users of ThesiScan 2.0 still contained at least one formatting violation at the point of submission. By contrast, none of the 28 ThesiScan 2.0 users' final submissions retained a violation after using the tool, indicating that access to instant, itemised feedback measurably reduces the formatting errors reaching supervisors and examiners at submission time. Furthermore,

ThesiScan has been presented in NALI 2025, where it attained a Bronze Medal, as well as in IPIARTI 2025 and ICSIPA 2026. The work has been approved with a Copyright from MyIPO. Currently, ThesiScan 2.0 is being piloted at the Faculty of Electrical Engineering's FYP program, and because the underlying validation layer is configurable, successful implementation may see it being expanded to other faculties and universities in Malaysia and beyond.

Recommendations for Classroom Practice

- Introduce ThesiScan 2.0 to postgraduate research and Final Year Project students as a self-check step before drafting thesis submission to supervisors, so formatting feedback arrives before content review rather than alongside it.
- Encourage lecturers to use the compliance report as a shared reference during supervision meetings, focusing discussion on content rather than re-explaining formatting rules.
- Embed the tool in research writing workshops so students learn to interpret annotated violations as a formatting-literacy skill, not just a submission gate.
- Pilot the system across a small number of faculties before wider rollout, to gather usage feedback and confirm role-based access works across different email domains.

Acknowledgement

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ID 102: HAIL-B: A Human-Centred AI Learning Behaviour Framework for Responsible AI-Assisted Engineering Education

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Highlights: The increasing use of generative AI in higher education has raised concerns about students becoming overly dependent on AI, potentially affecting critical thinking and independent learning. To address this issue, this project developed the Human-Centred AI Learning Behaviour Framework (HAIL-B) to guide responsible and effective AI use in engineering education. The framework integrates AI learning behaviours, self-regulated learning, and learning analytics to support timely teaching interventions. Validation with engineering undergraduates demonstrated that HAIL-B provides meaningful insights into students' learning behaviours and offers a practical, scalable approach for promoting learner autonomy and responsible AI-assisted learning.

Keywords: Generative AI; Self-Regulated Learning; Human-Centered AI Learning Behaviour Framework; Engineering Education

Introduction

The rapid advancement of generative artificial intelligence (AI) has brought significant changes to higher education, creating new opportunities to improve teaching, learning, and student engagement (Kasneci *et al*., 2023; Zawacki-Richter *et al*., 2019). While AI tools can help students access information quickly and support their learning process, there is growing concern that students may become overly dependent on these technologies. Such overreliance can lead to surface-level learning, reduced critical thinking, and weaker self-regulated learning skills, which are essential for academic and professional success (Akgun & Greenhow, 2022; Holmes *et al*., 2022). In engineering education, where problem-solving, analytical thinking, and independent learning are highly valued, this issue has become increasingly important.

With the increasing use of artificial intelligence (AI) in education, recent guidelines by the European Commission (2026) have highlighted the importance of developing AI literacy and encouraging students to use AI responsibly and ethically. In response to this growing need, this project introduces the Human-Centred AI Learning Behaviour Framework (HAIL-B), an educational innovation grounded in empirical evidence. The framework combines AI learning behaviour profiling with established self-regulated learning (SRL) principles to provide a better understanding of how students interact with generative AI during the learning process. More importantly, HAIL-B serves as a practical tool for educators to identify different patterns of AI use and design targeted interventions that encourage critical thinking, independent learning, and responsible engagement with AI technologies.

HAIL-B aims to promote a balanced approach to AI use by encouraging students to remain actively engaged in the learning process rather than relying on AI as a substitute for thinking and problem-solving. Through the integration of critical thinking practices, learner autonomy, and structured AI guidance, the framework helps students make informed decisions about when and how AI should be used in their learning activities. At the same time, HAIL-B provides educators with actionable learning analytics that can support early intervention, personalised feedback, and targeted learning support (Zimmerman, 2002; Winne & Hadwin, 1998). Ultimately, the framework positions AI as a learning partner that enhances, rather than replaces, students' cognitive development and independent learning capabilities.

Objectives

- To develop and implement the Human-Centred AI Learning Behaviour Framework (HAIL-B) as an educational innovation that promotes responsible and effective use of generative AI in engineering education.
- To evaluate students' AI learning behaviours and self-regulated learning using a validated measurement framework, enabling educators to identify learning patterns and provide targeted instructional support.
- To enhance learner autonomy, critical thinking, and academic performance by fostering responsible AI-assisted learning through evidence-based pedagogical strategies and learning analytics.

The innovation package consists of the HAIL-B framework, a validated AI learning behaviour instrument, learning analytics dashboard, and educator intervention guidelines for responsible AI-assisted learning.

NALI Approach

Novelty
HAIL-B is among the first educational frameworks to integrate AI learning behaviour assessment, self-regulated learning, and learning analytics into a single pedagogical model. Rather than promoting AI use alone, the framework enables educators to understand how students learn with AI and use these insights to provide timely, evidence-based interventions that foster responsible AI engagement and independent learning.

Creativity
HAIL-B combines AI learning behaviour profiling, self-regulated learning, learning analytics, and structured AI-guided activities into a unified educational framework. It positions AI as a learning partner that enhances critical thinking, reflection, and learner autonomy rather than replacing students' cognitive efforts.

Innovativeness
HAIL-B introduces an evidence-based pedagogical framework that enables educators to identify students' AI learning behaviours and provide timely, data-informed interventions. The integration of behavioural diagnostics with AI-assisted learning promotes responsible AI use while strengthening independent learning and academic success.

Applicability
HAIL-B is scalable and adaptable across engineering and other higher education programmes. It can be integrated with existing AI platforms and learning management systems with minimal resources, providing a sustainable framework that supports responsible AI literacy and continuous improvement in teaching and learning.

Innovation Description, Process and Implementation

The Human-Centred AI Learning Behaviour Framework (HAIL-B) is an evidence-based educational innovation that promotes responsible and effective use of generative AI while strengthening students' self-regulated learning. The framework guides students to use AI critically through verification, effective prompting, critical evaluation, and reflective learning, rather than relying on AI to complete learning tasks.

HAIL-B integrates five AI learning behaviour dimensions—AI Usage, Verification, Prompt Competency, Critical Evaluation, and AI Dependency—with three self-regulated learning dimensions: Planning, Monitoring, and Help Seeking. The implementation follows a four-stage cycle: guided AI-assisted learning, behaviour assessment, learning analytics, and targeted pedagogical intervention. Figure 1 illustrates the overall implementation process.

The framework was implemented in a first-year engineering course, where students engaged with structured AI-assisted learning activities. Learning behaviours and academic performance were analysed using validated instruments and statistical methods to evaluate the effectiveness of the framework. The findings support HAIL-B as a scalable approach for fostering responsible AI use, learner autonomy, and evidence-based teaching practices.

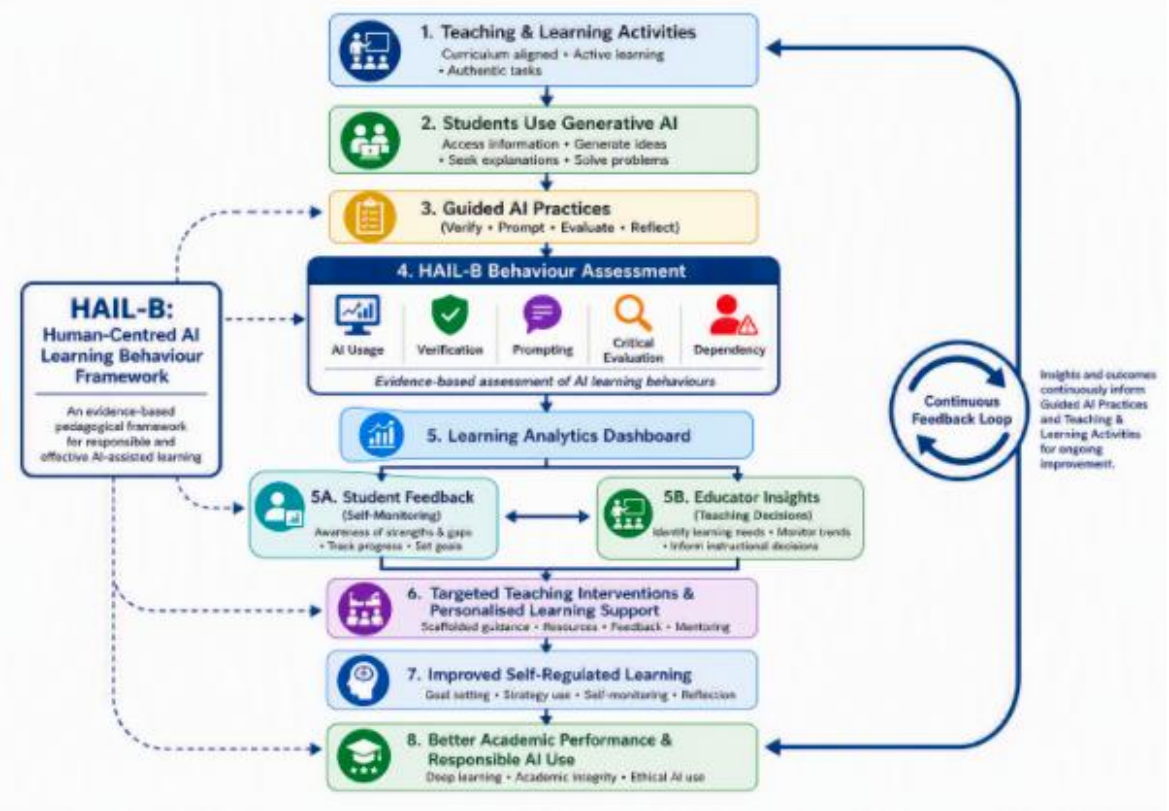


Figure 1: Human-Centred AI Learning Behaviour Framework (HAIL-B): A Pedagogical Framework for Responsible AI-Assisted Learning

Key Findings

The implementation of HAIL-B revealed that responsible AI learning behaviours contribute to better learning outcomes. Students who critically evaluated AI-generated content were more likely to engage in adaptive help-seeking, which was the only self-regulated learning behaviour significantly associated with higher academic performance. Conversely, AI dependency negatively affected learning monitoring and directly reduced academic performance.

Beyond traditional academic indicators such as CGPA, HAIL-B successfully identified actionable AI learning behaviour patterns, enabling educators to detect at-risk learners and provide targeted interventions. These findings highlight the framework's potential to promote critical AI use, learner autonomy, and responsible AI-assisted learning at scale.

Impact

HAIL-B promotes responsible AI use by enhancing students' critical thinking, learner autonomy, and self-regulated learning. It supports educators with learning analytics for personalised instruction and offers institutions a scalable framework for integrating responsible AI practices into higher education.

Recommendations for Classroom Practice

Educators are encouraged to embed HAIL-B into AI-supported learning by incorporating structured AI activities, behavioural assessment, and timely instructional interventions. The framework can be readily adapted across disciplines and learning environments, supporting sustainable and responsible AI-enabled education.

Other relevant information

HAIL-B is designed as a flexible educational framework that complements, rather than replaces, existing teaching practices. Its modular design allows institutions to customise learning activities, behavioural assessments, and intervention strategies according to programme requirements. The framework is

suitable for face-to-face, blended, and online learning environments and has the potential to support future developments in learning analytics and AI-enhanced education.

STEP	STATISTICAL ANALYSIS	PURPOSE	KEY RESULTS	MAIN FINDINGS
1	**Cronbach's Alpha Reliability Analysis**	To assess the internal consistency of the questionnaire items measuring each AI Learning Behaviour and Self-Regulated Learning (SRL) construct.	• Most constructs achieved acceptable reliability (α = 0.639–0.765). • AI Dependency improved from α = 0.205 to α = 0.565 after removing one item.	The questionnaire demonstrated acceptable reliability and was suitable for subsequent statistical analyses.
2	**Descriptive Statistics**	To summarise students' AI learning behaviours, SRL dimensions, CGPA, and CLO1 attainment, and to understand the characteristics of the sample.	• Students generally reported moderate to high levels of AI learning behaviours and SRL with sufficient variability for further analysis.	Students actively used generative AI but differed in how they regulated their learning with AI.
3	**Pearson Correlation Analysis**	To examine the strength and direction of relationships among AI learning behaviours, SRL dimensions, CGPA, and academic performance.	• Prompting Competency and Critical Evaluation: strongest positive correlation (r = 0.704). • Critical Evaluation correlated positively with Help Seeking (r = 0.472). • AI Dependency correlated negatively with Monitoring (r = −0.309). • CGPA showed weak correlations with AI learning behaviours.	Responsible AI learning behaviours were associated with adaptive SRL behaviours, while AI Dependency was associated with poorer monitoring.
4	**Simple Linear Regression** (Baseline Regression)	To establish whether students' prior academic ability (CGPA) predicts academic performance (CLO1).	• Model significant, $F(1,77) = 34.86$, $p < .001$. • Explained 31.2% of the variance ($R^2 = 0.312$). • CGPA significantly predicted CLO1 ($\beta = 20.16$, $p < .001$).	Prior academic ability was the strongest predictor of academic performance.
5	**Hierarchical Multiple Regression**	To determine whether AI learning behaviours and SRL explain additional variance in CLO1 beyond CGPA.	• Adding AI learning behaviours increased R^2 from 0.312 to 0.351 ($\Delta R^2 = 0.039$). • Adding overall SRL increased R^2 marginally to 0.352 ($\Delta R^2 = 0.001$). • Only CGPA remained significant across all models.	AI learning behaviours and overall SRL contributed little additional explanatory power beyond prior academic ability.
6	**Multiple Regression** (AI Learning Behaviours → SRL)	To identify which AI learning behaviours predict each dimension of SRL (Planning, Monitoring, and Help Seeking).	• **Planning:** No significant predictors ($R^2 = 0.011$). • **Monitoring:** AI Dependency negatively predicted Monitoring ($\beta = -0.138$, $p = .014$; $R^2 = 0.188$). • **Help Seeking:** Critical Evaluation positively predicted Help Seeking ($\beta = 0.178$, $p < .001$; $R^2 = 0.260$).	Critical Evaluation promoted adaptive Help Seeking, while AI Dependency reduced Monitoring. No AI behaviour predicted Planning.
7	**Multiple Regression** (SRL → Academic Performance)	To determine which SRL dimensions significantly predict academic performance.	• Model significant, $F(3,75) = 5.01$, $p < .003$. • Explained 16.7% of the variance ($R^2 = 0.167$). • Only **Help Seeking** significantly predicted CLO1 ($\beta = 8.94$, $p < .001$). • Planning and Monitoring were not significant.	Adaptive Help Seeking was the only SRL behaviour associated with higher academic performance.
8	**Mediation Analysis** (Model 1)	To examine whether Help Seeking mediates the relationship between Critical Evaluation and CLO1 after controlling for CGPA.	• Critical Evaluation significantly predicted Help Seeking, which significantly predicted CLO1. • Indirect effect significant (95% bootstrap CI did not include zero); direct effect not significant.	**Full (indirect-only) mediation** was supported. Critical Evaluation improved academic performance indirectly by encouraging students to seek help.
9	**Mediation Analysis** (Model 2)	To examine whether Monitoring mediates the relationship between AI Dependency and CLO1.	• Indirect effect not significant (bootstrap CI included zero). • AI Dependency retained a significant negative direct effect on CLO1.	Monitoring did not mediate the relationship. AI Dependency directly reduced academic performance.
10	**Regression Assumption Testing**	To verify that the assumptions of multiple regression were satisfied before interpreting the regression and mediation models.	• Normal probability plots indicated approximate normality. • Line fit plots supported linearity. • Tolerance = 0.740–0.833; VIF = 1.20–1.35 (no multicollinearity). • Standardised residuals within ±3 (no influential outliers).	The regression assumptions were satisfactorily met, supporting the validity of the regression and mediation analyses.

Overall Conclusion: Prior academic ability is the strongest determinant of academic performance. Among learning processes, adaptive Help Seeking is the key pathway that links responsible AI use (critical evaluation) to better academic outcomes, while over-reliance on AI (AI dependency) undermines performance.

Figure 2: Summary of Statistical Analyses and Key Findings

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ID 105: SeaClear: Transforming Bathymetric Data Processing into Authentic Hydrographic Learning

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Highlights: SeaClear transforms a real-world hydrographic data-quality challenge into an authentic, research-informed digital learning experience. This MATLAB-based learning system engages students with genuine Single Beam Echo Sounder bathymetric data, enabling them to investigate sea-spike anomalies, compare Mean Absolute Deviation (MAD), Median and Mixed filtering approaches, visualize raw and processed seabed profiles and evaluate the results against hydrographic quality criteria. Using field data collected at Pantai Tanjung Batu, Bintulu, SeaClear reduced the reported MAD from 1.0618 to 0.4314. Rather than presenting students with a predetermined solution, the learning process progressively moves from identifying a real data-quality problem to diagnosing anomalies, testing alternative solutions, analyzing evidence, validating results, and justifying professional decisions. This lecturer–student problem-solving approach connects authentic field data, statistical reasoning, digital technology, research evidence and professional judgement within a reusable learning workflow. The innovation demonstrates how a real professional problem can become a catalyst for collaborative knowledge creation, transforming students from passive users of analytical tools into active problem solvers who investigate, evaluate and justify solutions to authentic hydrographic challenges.

Keywords: Hydrography; Bathymetry; Authentic Learning; Digital Laboratory; Sea-Spike Filtering

Introduction

Hydrographic surveying is an applied discipline in which reliable seabed information depends not only on field data acquisition but also on the professional judgement used during data processing and quality control. Single Beam Echo Sounder (SBES) observations can contain abrupt sea-spike anomalies arising from environmental disturbances, vessel motion, signal reflection, instrument behavior or other acquisition effects. These observations cannot simply be removed without consideration because under-filtering leaves unreliable depths in the dataset, while excessive filtering can suppress genuine seabed morphology.

This challenge provides a strong opportunity for authentic learning. However, practical hydrographic instruction can easily become procedural when students are provided with already-cleaned datasets or are assessed mainly on whether they can follow a prescribed software workflow. Such an approach limits opportunities to practice the reasoning that professional surveyors need to recognize suspicious observations, choosing an appropriate processing strategy, evaluating the consequences of parameter changes and justifying whether a result is fit for its intended purpose.

SeaClear was developed to address this gap through progressive lecturer-student problem solving centered on a real hydrographic data-quality problem. It is a semi-automatic MATLAB-based bathymetric processing system that integrates Mean Absolute Deviation (MAD), Median Filtering (MF) and a Mixed filtering mode within one visual environment. Learners can load raw northing, easting and depth observations, select a filtering method and sensitivity level, compare original and filtered profiles, inspect filtering bounds and three-dimensional bathymetric behavior, evaluate data-quality indicators and export the processed result. The system therefore makes both the processing action and its consequences visible to the learner while allowing students to investigate and evaluate alternative solutions rather than simply follow a prescribed procedure.

The innovation is grounded in real field practice rather than synthetic classroom exercise. SeaClear was developed from postgraduate research and tested using genuine coastal SBES observations collected at Pantai Tanjung Batu, Bintulu, Sarawak. The published case study demonstrated substantial reduction of anomalous variation while retaining the broader seabed form, and the work was subsequently

published in Revue Internationale de Géomatique in 2025. The system is also documented through Copyright Application IP/CR/07369. This creates a complete research-to-learning pathway in which a real surveying problem is progressively investigated, leading to software development, field validation, publication and intellectual-property development as part of the research-led teaching and learning process.

Objectives

- Transform a real hydrographic data-quality problem into an authentic, experiential and project-based learning activity.
- Develop learner's ability to recognise sea-spike anomalies, compare filtering strategies and explain how processing choices influence bathymetric results.
- Strengthen statistical reasoning, spatial interpretation and standards literacy using MAD, RMSE, MAE and Total Vertical Uncertainty (TVU) information.
- Introduce competency-based assessment in which learners are evaluated on evidence, interpretation and professional justification rather than software operation alone.
- Provide a reusable hydrographic practical that connects field data, digital processing, research innovation and professional quality-control practice.

NALI Approach

Novelty

SeaClear offers novelty at two interconnected levels. Technically, it integrates MAD, Median and Mixed filtering, adjustable sensitivity, raw-versus-filtered comparison, filtering bounds, 3D seabed visualisation, statistical indicators and hydrographic quality evaluation within one semi-automatic environment. Pedagogically, the field-validated system is converted into an authentic learning and assessment environment through progressive lecturer–student problem solving, in which learners investigate a real data-quality problem, make, test and defend their own processing decisions. Instead of receiving a predetermined "correct" cleaned dataset, learners work with genuine noisy SBES observations and must decide what should be treated as an anomaly, how strongly it should be filtered and whether the resulting bathymetry remains credible for its intended hydrographic purpose. This process moves learning beyond following a prescribed software procedure towards investigating the problem, comparing alternatives, evaluating evidence and justifying a professional decision.

Creativity

SeaClear creatively combines project-based learning, experiential learning, authentic hydrographic problem solving, challenge-based data-quality analysis and competency-based assessment within a progressive lecturer–student learning process centred on one real dataset. The learning task is deliberately open enough to produce different processing outcomes, requiring students to investigate the data, compare evidence, test alternative approaches and justify their decisions rather than reproduce a single instructor-defined answer. The system therefore turns bathymetric filtering from a software demonstration into a structured professional problem-solving and decision=making exercise, where students learn through investigating and resolving an authentic data-quality issue. The integrated educational approaches and their progression from problem identification to solution justification are illustrated in Figure 1.

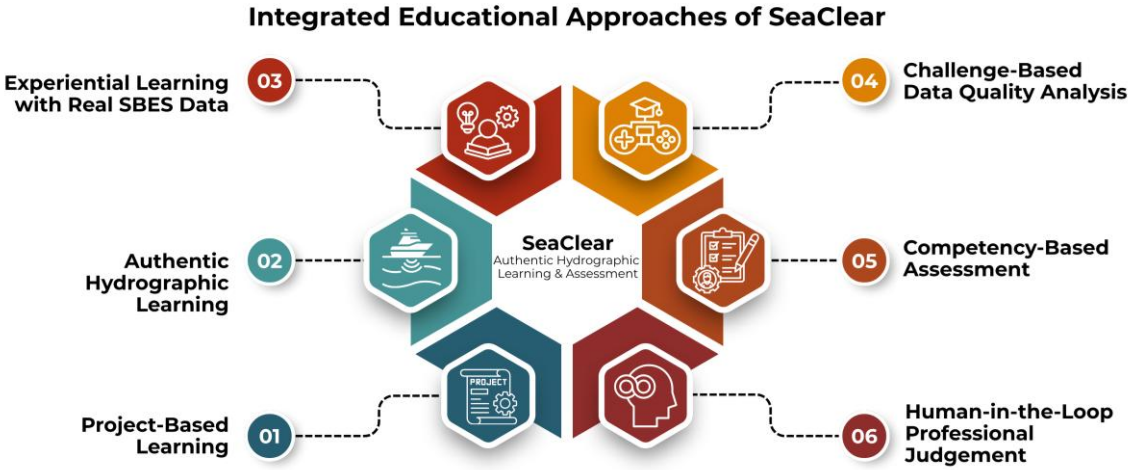


Figure 1: Integrated Educational Approaches of SeaClear for Category 1 Learning and Assessment.

Innovativeness

SeaClear changes the practical learning process from black-box data cleaning to a transparent and examinable process that harnesses human–AI synergy in professional decision-making. Learners first inspect the raw signal, diagnose likely sea-spikes, configure a filtering strategy, apply the algorithm, compare graphical and three-dimensional changes, and then validate the outcome before exporting the data. At each stage, learners are required to interpret the evidence and make a judgement, while the software provides rapid computational feedback that allows them to test the consequences of their decisions. This cycle supports iterative learning because learners can return to earlier stages, modify the filtering settings and observe how their decisions alter the bathymetric surface. Through this repeated process of investigation, testing, reflection and refinement, learners progressively develop the ability to assess data quality and justify whether a processed dataset is fit for its intended hydrographic purpose.

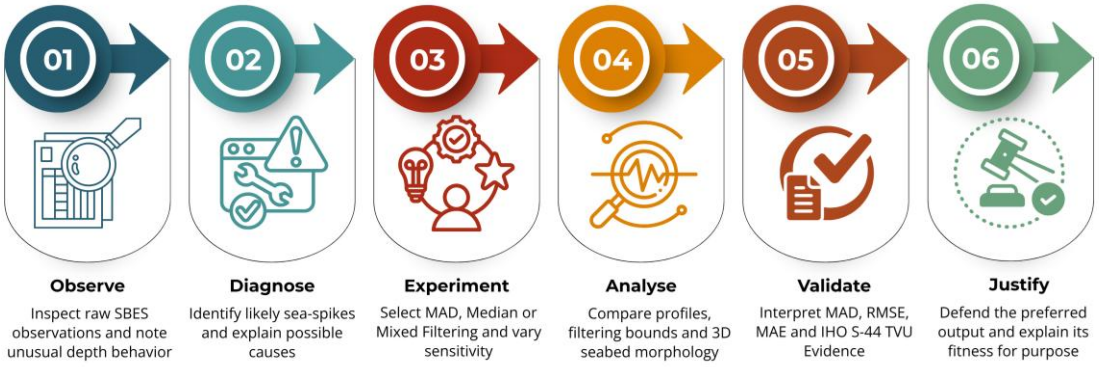


Figure 2: Six-Stage SeaClear Authentic Learning and Assessment Cycle.

Applicability

SeaClear can be applied in hydrography, geomatics, marine geospatial, coastal engineering and geospatial data-processing courses. It can support laboratory practicals, project-based assignments, final-year projects, postgraduate research training and professional short courses. Because the learning activity uses standard CSV or

TXT bathymetric files, students can repeatedly investigate data-quality problems and test different processing strategies without requiring a survey vessel and echo sounder for every class session. Educators may use the Bintulu dataset as a common benchmark or substitute locally acquired data to reflect different coastal environments, competency levels and intended learning outcomes. This flexibility allows the same learning approach to progress from basic bathymetric interpretation to advanced parameter experimentation and standards-based assessment, while maintaining a consistent focus on problem solving and professional judgement.

Innovation Description, Process and Implementation

SeaClear can be applied in hydrography, geomatics, marine geospatial, coastal engineering and geospatial data-processing courses. It can support laboratory practicals, project-based assignments, final-year projects, postgraduate research training and professional short courses. Because the activity can begin with standard CSV or TXT bathymetric files, learners can investigate and practise data-quality control without requiring a survey vessel and echo sounder for every class session. Educators may use the Bintulu dataset as a common benchmark or substitute locally acquired data to suit different environments, competency levels and learning outcomes. The same system can therefore support different stages of learning, from introductory bathymetric interpretation and anomaly identification to advanced parameter experimentation, AI/ML-supported analysis and standards-based professional assessment.

The real-world case provides the foundation for the authenticity of the learning design. Field data were collected at Pantai Tanjung Batu, Bintulu, across an approximately 500 m × 1,000 m coastal survey area using SBES and positioning equipment. Observations were collected at 2-second intervals with approximately 5 m point spacing, 25 m survey-line spacing and a vessel speed of about 5 knots. The original dataset contains pronounced sea-spike anomalies, allowing learners to work with the uncertainty and processing trade-offs encountered in an actual hydrographic survey rather than with artificially inserted textbook errors. This enables the lecturer to use the real dataset as a problem trigger, while students progressively investigate the anomalies, test alternative processing strategies and evaluate whether their decisions produce a credible bathymetric result.

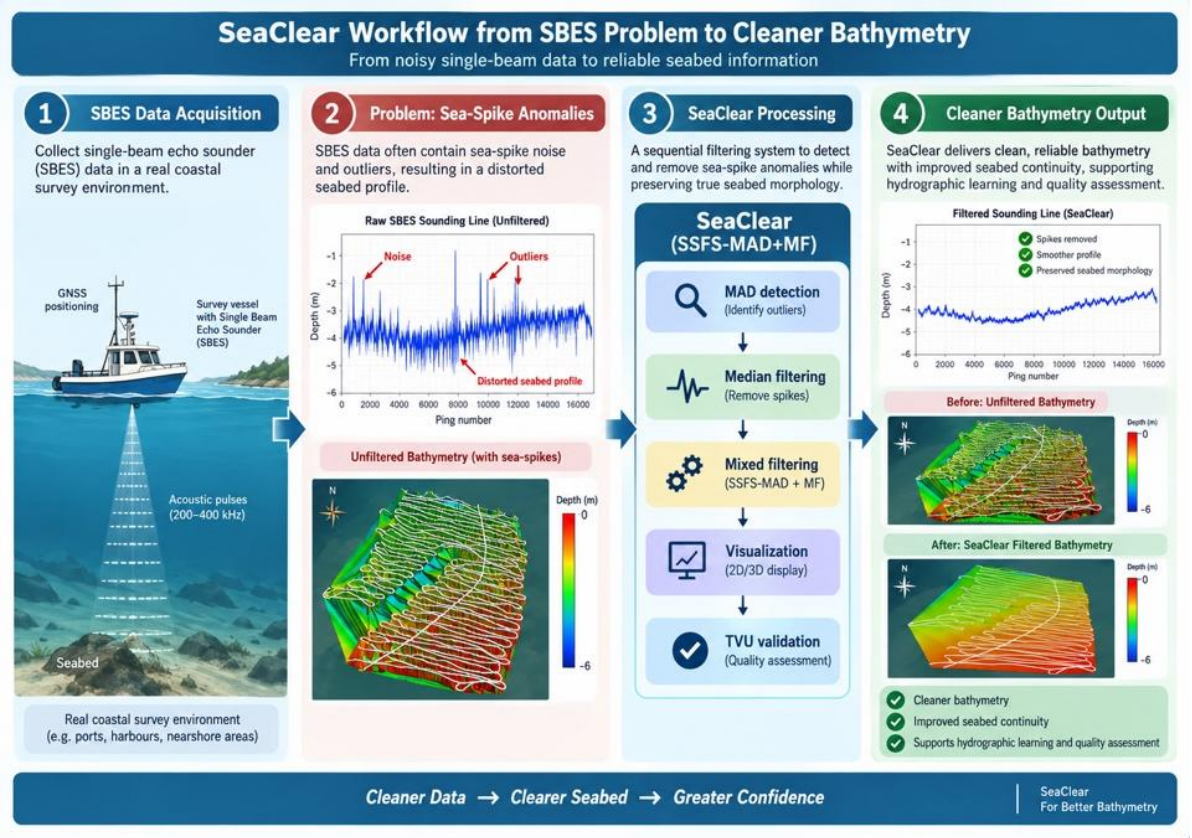


Figure 3: From Real Bintulu Survey Data to an Authentic SeaClear Learning Activity.

Key Findings

The technical evidence supporting SeaClear comes from the Bintulu field implementation. The published evaluation reported that Mixed/MAD processing reduced MAD from 1.0618 to 0.4314, demonstrating a substantial reduction in anomalous variation. The raw depth range of approximately −3.8 m to 1.5 m was refined to approximately −3.2 m to 1.0 m while the broader seabed morphology remained interpretable. The Mixed/MAD result was evaluated at Order 2, with 59.39% of observations within the assessed TVU criterion, while RMSE and MAE were reported as 1.4188 m and 0.9663 m respectively. These findings are pedagogically valuable because they show that successful filtering is not equivalent to making the

surface as smooth as possible. Learners must balance noise reduction with preservation of credible seabed features, recognize that different performance indicators describe different aspects of data quality, and understand that an improved dataset may still have limitations for more demanding hydrographic purposes. This creates an authentic assessment context in which students must investigate and interpret evidence, compare alternative processing outcomes, and justify their decisions rather than simply report the final output.

At the student-innovation level, SeaClear also demonstrates an extended learning outcome beyond conventional coursework. The development pathway progressed from identifying a real field problem, investigating the data and exploring possible solutions to algorithm implementation, software programming, real-world validation, peer-reviewed publication and intellectual-property documentation. Through progressive lecturer–student problem solving, the project connects field investigation with research, programming and professional hydrographic practice. This illustrates how postgraduate learning can empower students to become contributors and creators of discipline-specific educational technologies, rather than only users of existing commercial software. The resulting experience allows students to see how a professional problem can be progressively developed into a tested and reusable learning solution.

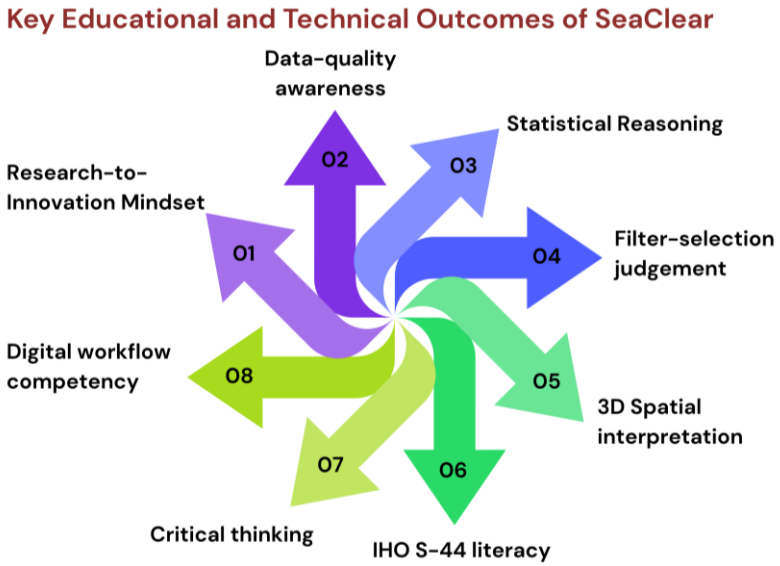


Figure 4: Key Educational and Technical Outcomes Supported by SeaClear Field Evidence.

Impact

For students, SeaClear develops authentic hydrographic problem-solving by requiring observation, anomaly recognition, statistical reasoning, filter-selection judgement, spatial interpretation, standards literacy and professional justification. The learner is not rewarded simply for obtaining a visually smooth surface; the assessment focuses on whether the processing choice is supported by evidence and whether the learner can explain the consequences of that choice. Where AI/ML-supported analysis is introduced, learners are also required to question, interpret and validate computational outputs rather than accept them as final answers. This strengthens learner agency and connects technical knowledge with the type of evidence-based professional judgement in professional hydrographic practice.

For educators, SeaClear provides a reusable digital practical and an assessment structure that can be delivered after fieldwork or independently using archived datasets. The system enables instructors to assess both process and product through observation notes, parameter records, comparative outputs, standards checks and final recommendations. It also allows lecturers to facilitate progressive problem solving, moving students from problem identification and investigation to solution testing, validation and justification. For institutions, it demonstrates a research-to-teaching pathway in which a postgraduate innovation can generate a software system, published research, intellectual-property output and a reusable educational resource. This supports student innovation, research-led teaching and the broader principles of Education 5.0 through the integration of technology, human judgement, authentic problem solving and knowledge creation.

The wider professional relevance extends to hydrographic surveying firms, port and coastal authorities, marine engineering practitioners, researchers and agencies that require reliable bathymetric quality control. SeaClear can serve as an introductory training environment for understanding outlier filtering and quality assurance before learner's progress to more complex commercial hydrographic processing platforms. The use of authentic datasets also allows professional learners to revisit data-quality problems in a controlled environment, test alternative approaches and reflect on the consequences of their processing decisions. Its potential therefore extends from university learning to professional upskilling and continuing education.



Figure 5: Multi-Stakeholder Impact of SeaClear.

Overall, SeaClear positions hydrographic education as a continuum from observation to interpretation, from data to decision, and from research to innovation. Its Category 1 contribution lies in transforming how bathymetric data processing is taught and assessed through an authentic progressive problem-solving approach: the software is the enabling technology, while the educational innovation is the lecturer–student learning process that uses real-world data, evidence-based investigation, professional judgement and competency-focused assessment to develop solutions to authentic hydrographic problems.

Recommendations for Classroom Practice

A SeaClear practical should begin with raw observations so that learners first identify and discuss possible sea-spikes and formulate an initial hypothesis about the data-quality problem before applying automated functions. Each learner or group should test at least two filtering approaches or parameter settings and submit a concise technical justification. Assessment may consider six competencies: anomaly recognition; appropriateness of filter selection; parameter reasoning; interpretation of 1D and 3D changes; understanding of MAD, RMSE, MAE and TVU; and professional justification of the final result. Where AI/ML functions are incorporated, an additional competency can assess learners' ability to interpret, verify and critically evaluate AI-supported outputs rather than accept them without question. For advanced cohorts, educators can require learners to compare SeaClear with another processing environment, modify filtering parameters, apply the workflow to a new locally collected dataset, or

propose improvements to the algorithm. Future classroom implementation can additionally use pre/post competency rubrics and learner feedback to quantify educational gains across larger cohorts.

As a future direction, SeaClear could be further developed for wider educational and professional use. Its modular structure may allow institutions and training providers to adapt the learning activities, datasets and competency requirements to their own contexts. Future development could also explore the incorporation of AI/ML-supported functions where appropriate. Potential applications may extend beyond university teaching to professional training and continuing education in hydrographic surveying and bathymetric data quality control. These possibilities remain at the proposal stage and are intended to provide directions for further development, collaboration and potential adoption of SeaClear in academic and professional learning environments.

Other relevant information

SeaClear originated from postgraduate research within the Geomatic Innovation Research Group (GnG), Universiti Teknologi Malaysia. The technical system and real-world Bintulu case study were published as "Optimizing Sea-Spike Detection and Removal in Bathymetric Data: A Case Study of Bintulu, Sarawak" in Revue Internationale de Géomatique in 2025. The system is documented through Copyright Application IP/CR/07369, with an invention date of 1 November 2024. The copyright documentation identifies Nurfazira Binti Mohamed Fadil as the programmer and Ts. Sr. Dr. Kelvin Tang Kang Wee as supervisor. These outputs demonstrate that SeaClear is a developed, field-tested and research-supported innovation with potential for continued educational adoption, professional training and future commercialization.

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ID 106: AI Math Detective Guiding Critical Reasoning in Mathematics Learning

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Highlights: Generative AI is already embedded in students' learning, but frequent use does not guarantee critical verification. AI Math Detective is a low disruption classroom practice that reverses the usual ask AI for the answer. Students first attempt Mathematics, inspect a deliberately flawed AI solution, diagnosed a difficulty, request targeted help, and resume independent reasoning. In a pilot with 36 students, pre- and post-survey results showed positive changes in hint seeking, mathematical explanation and AI learning confidence for mathematics which supports more purposeful and responsible AI use.

Keywords: generative artificial intelligence; AI literacy; human-AI synergy.

Introduction

Generative Artificial Intelligence (GenAI) has rapidly moved from an emerging technology to an everyday learning resource for university students. In mathematics, its value is particularly visible because conversational systems can provide explanations, hint and worked solutions on demand. However, mathematical fluency is not equivalent to accepting an AI generated answer. Recent evidence shows both promise and risk. A large experimental study found that ChatGPT generated hints can support mathematics learning, yet 32% of generated hints initially failed quality checks which demonstrate that human supervision remains necessary (Pardos & Bhanhadri, 2024). Yoon et al. (2024) demonstrated the students' conceptions of AI shape how they engage with AI generated mathematical arguments and that critical engagement should be explicitly supported. More recent work further suggests that the timing and sequence of student-AI interaction matter for mathematical reasoning (Yoon et al., 2026).

The problem addressed by AI Math Detective is not simply AI access or AI acceptance. It is the gap between using AI and using AI well. Students may know that AI can make mistakes while still accepting a plausible looking derivation or may request a complete solution before attempting the problem themselves. This distinction is important because feedback is most useful when it supports the learner's reasoning and self-regulation rather than replacing it (Soderstrom & Palm, 2026). The innovation positions the student as the final mathematical judge and AI as a fallible cognitive support.

The practice was developed for Intermediate Mathematics course and embedded within existing teaching. This practice uses past-year questions to connect AI literacy directly to disciplinary learning. The invention operationalizes Human-AI synergy through two complementary role which is AI Detective who interrogates and repairs AI generated mathematics, and AI Tutor who request assistance after making independent attempt.

Objectives

- To evaluate the correctness of AI-generated mathematical solution
- To develop responsible AI-use routine in which students attempt mathematical problems independently
- To examine changes in students' confidence and AI supported learning practices.

NALI Approach

Novelty

The novelty lies in giving AI a different role in mathematics learning. instead of simply asking AI for an answer, students first examine AI generated solution and decide whether it is correct. They look for a mistake, explain why a step may be wrong, and work out how to correct it. Only after this do they use AI for targeted help when they need it. The innovation integrates critical AI literacy into mathematics itself rather than treating AI literacy as a separate digital skills lesson.

Creativity

The detective converts mathematical error analysis into investigative task. Students are not told to distrust AI, instead, they are encouraged to look at the solution carefully and decide whether the answer can be trusted. In the second activity, student follow a simple process as shown in Figure 1. The students record where they get stuck, what they ask AI, what they learn from the response, and how they use that information to complete the question themselves.

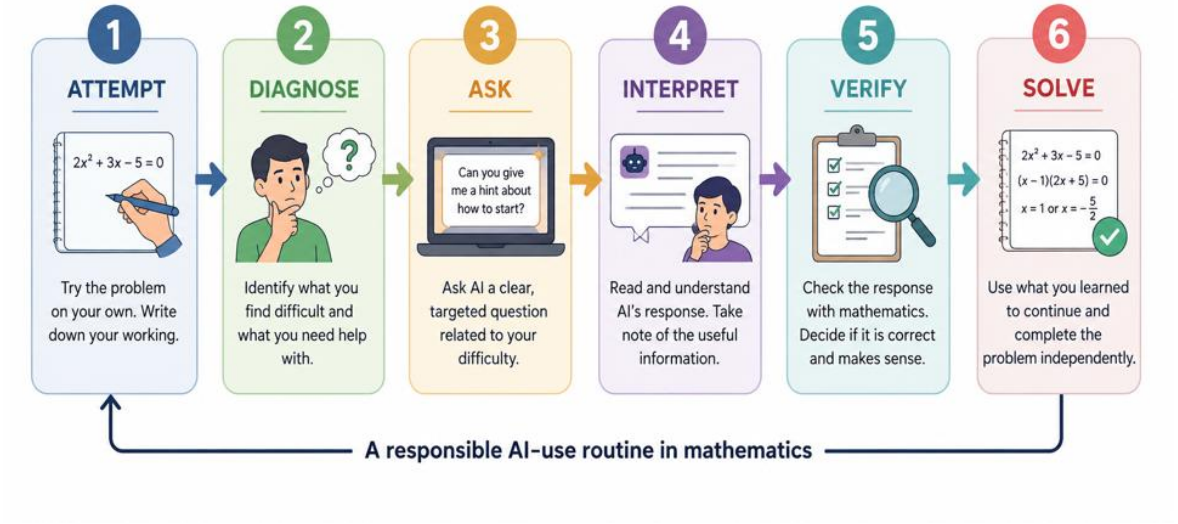


Figure 1: AI Math Detective Flow

Innovativeness

The innovation embeds simple rules to guide students in using AI effectively. Students first try the problem on their own and identify where they are having difficulty before turning to AI. They can then use AI for a specific purpose, such as understanding a concept, getting a hint, or checking one of their steps. This encourages students to think first, ask purposeful question, and check response rather than simply copying an answer. Importantly, students who can solve the problem independently are not required to use AI although they may still use them to check and verify their final answer.

Applicability

AI Math Detective is simple, affordable and easy to implement in a normal mathematics class. It only requires an existing course question, a prepared AI-generated solution or case, worksheet and access to AI tool during the tutor activity. The same approach can also be used with different mathematics topic by changing the question or the type of error students need to investigate. This makes the activity easy for lecturers to adapt and use without making major changes to the existing syllabus.

Innovation Description, Process and Implementation

AI Math Detective is a guided Human-AI learning practice designed for Intermediate Mathematics course. The innovation changes the usual pattern of using GenAI from "ask AI and obtain answer" to "think first, ask purposefully, and verify the response". It does not require a new application or major changes to the existing syllabus. Instead, it introduces structured rules for when and how students interact with AI during mathematics learning.

The innovation consists of two complementary activities: AI Detective and AI Tutor. In the AI detective activity, students are presented with AI generated mathematical solution containing a deliberate error. Students first examine the solution independently and give a verdict on whether it its correct, incorrect, or incomplete. Then they identify the first questionable step, explain why it is problematic, and produce the corrected solution. For example, in surd equation, AI incorrectly divides by $\sqrt{x}$, which result in the valid solution $x = 0$. Students need to recognise the mathematical step from AI rather than simply accept its final answer.

In AI Tutor activity, students work on past year question without AI first. They identify the point at which they experience difficulty before using AI. AI is used only for a specific purpose, such as explaining a concept, provide hint, or check working step. Then student continue solving the question independently. Students who can solve the problem without AI are not required to use it but may use AI for verification. The overall learning flow is Attempt → Diagnose → Ask → Interpret → Verify → Solve as shown in Figure 1.

The pilot involved 36 Intermediate Mathematics students. Evaluation was conducted using pre- and post-survey with 5-point Likert scale to examine the students' confidence, verification practices, error identification, mathematical reasoning and purposeful AI use.

Key Findings

The pre- and post-analysis shows students' self-reported on the mathematics learning with AI support are shown in Table 1.

Table 1: pre and post survey analysis.

KEY OUTCOME	PRE	POST	CHANGE	P
Confidence in using AI for solving mathematics problem	3.56	3.83	+0.28	0.023
Explaining why solution is correct/incorrect	3.28	3.64	+0.36	0.041
Asking AI for hints rather than complete solutions	3.72	4.19	+0.47	0.009

The pre-post analysis showed positive changes in the three key outcomes. The largest improvement was observed in students' ability to ask AI for hints rather than complete solutions (0.47, p = .009). Students also showed improvement in their ability to explain why a mathematical solution is correct or incorrect (+0.36, p = .041) and their confidence in using AI for solving mathematics problem (+0.28, p = .023).

The findings are closely aligned with the two activities. In Ai Detective students had to examiner the AI generated solution, identify mathematical step error and justify their judgement. In AI Tutor, students first attempted the problem independently before asking AI for targeted assistance. The results suggest that the structured process encouraged students to move beyond simply obtaining answers towards questioning, interpreting, and AI more purposefully.

Impact

AI Math Detective helps students use AI as a learning support rather than an answer provider. This activity encourages to question AI responses, check mathematical reasoning, and seek targeted assistance when needed. This supports more responsible and purposeful use of AI. Besides, this will keep students responsible for their own mathematical thinking. For lecturers or educators, the innovation provides a simple and low disruption way to integrate AI into existing mathematics lesson.it uses existing questions, worksheet and available AI tools without require new software or major curriculum changes. The approach can be adapted to different topics, learning contexts and outside classroom.

Recommendations for Classroom Practice

Educators should as students to attempt the problem first and identify their difficulty before using AI. AI can then be used for a specific purpose such as request for hint, explain concept, or checking particular working step. The activities can be implemented as short classroom activities using existing tutorial or past year questions. Educators can prepare AI solutions with suitable errors for students to investigate and adapt the level of difficulty according to student's needs. This makes the approach practical, repeatable and easy to integrate into regular mathematics or other subjects learning.

Acknowledgement

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ID 108: QaulanAI: Creative Da'wah, Ethical AI, and "Adab" in Communication

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Highlights: Islamic Studies students generally have a strong command of da'wah content, but face limitations in producing digital media content creatively and technically, while young people are increasingly consuming religious content in short-video formats. The use of generative AI has the potential to facilitate digital content production, but it also raises challenges related to source accuracy, the authenticity of Qur'anic and hadith quotations, and the suitability of visual content with Islamic ethical principles. QaulanAI is introduced as a project-based learning framework that guides students in producing creative da'wah videos using generative AI through a five-stage workflow. Qur'an-based qaulan principles are used as the basis for ethical review, while a human-in-the-loop verification protocol is implemented to ensure that content is reviewed before publication. Implementation with seven MHID 1143 (Communication and Application of Da'wah Media) students resulted in 42 da'wah videos published through the course TikTok account @dakwah.utm. The five highest-performing videos recorded more than 1,770 views, with a like rate of 6.7%. The distinctiveness of QaulanAI lies in operationalising Islamic communication ethics as a review mechanism for AI-generated content, thereby integrating AI literacy, media production skills, and da'wah values within a single project-based learning framework.

Keywords: generative AI; Da'wah; Islamic communication ethics; Project-based learning; Human-AI collaboration

Introduction

Short videos have now become a primary channel through which Malaysian youth receive religious content. TikTok has been accepted as a platform for da'wah and informal religious learning among Muslim youth (Abdul Wahid et al., 2023), and informal-style preachers have been shown to reach Millennials and Generation Z (Salsabila & Kholil, 2024), in line with the mediatization of religious practices within digital environments (Campbell, 2013). For Islamic Studies programmes, graduates must be able to communicate da'wah through media formats that are actually used by audiences.

Two major barriers have been identified in the production of digital da'wah content. First, students in Islamic Studies typically have a strong command of religious texts, but still have limitations in technical skills such as scriptwriting, visual production, voice-over recording, and digital content editing. Second, the emergence of generative artificial intelligence (AI) has the potential to reduce these technical barriers through automation in the production of text, visuals, and multimedia content.

However, the use of generative AI in producing religious content also introduces risks that require attention. For example, Large Language Models may generate inaccurate references, fabricated quotations, or unauthenticated source attributions (Kasneci et al., 2023). Such risks are particularly significant in the context of Qur'anic and hadith content because errors in quotation, translation, interpretation, or source attribution may affect the accuracy and authority of da'wah content. At the same time, AI-based image-generation technologies may produce visual representations that are inconsistent with Islamic principles, values, and norms.

Therefore, the use of generative AI in producing da'wah content requires a balance between harnessing technological capabilities and maintaining scholarly rigour, source verification, and compliance with sharia principles. Students have reported enthusiasm about AI alongside uncertainty regarding ethical boundaries (Chan & Hu, 2023), while UNESCO emphasises that generative AI in education must remain human-centred, with educators verifying its outputs (Miao & Holmes, 2023).

QaulanAI addresses this gap. Generative AI serves as a creative partner throughout the video production process, while the qaulan ethical layer and human verification protocol ensure that da'wah content is accurate, courteous, and transparent. This framework aligns with the NALI 2026 theme, Human-AI Synergy in Pedagogy, and Category 2 (AI-Enhanced Teaching and Learning): applications of generative AI, human-AI collaboration, AI literacy, and ethical and transparent use of AI.

Objectives

- To develop a structured and replicable framework for producing creative da'wah videos supported by generative AI.
- To apply Qur'anic qaulan principles as operational ethical checkpoints at every stage of AI-assisted content production.
- To develop responsible AI literacy, including verification of religious sources and transparent disclosure of AI use.
- To disseminate student-produced da'wah content to real audiences through TikTok and evaluate its reach.

NALI Approach

Novelty

In terms of novelty, most frameworks for the use of generative artificial intelligence (AI) in education emphasise ethical issues and academic integrity in general, without integrating communication principles grounded in specific religious sources as a mechanism for evaluating AI-generated content. QaulanAI offers a different approach by developing an ethical layer based on qaulan principles in the Qur'an, namely communication principles that are already studied by students within the context of Islamic Studies. These principles are then translated from normative concepts into an operational filtering and evaluation mechanism for assessing AI-generated content, particularly in terms of accuracy, appropriateness, adab, and Islamic communication values. This approach establishes a clearer connection between acquired religious knowledge and the practice of producing AI-based digital content. To the authors' knowledge, based on the literature review conducted, an approach that operationalises Qur'anic qaulan principles as an evaluation framework for generative AI outputs in the context of learning to produce da'wah content has not been specifically identified. Therefore, QaulanAI has the potential to make a novel contribution by integrating Qur'anic communication principles with generative AI pedagogy in Islamic Studies education.

Creativity

Creativity in the development of QaulanAI is reflected through three main elements. First, the development of a five-stage workflow that adapts professional media production processes while simplifying and tailoring them to the skill levels of students without a media background. This approach enables students to follow the content production process systematically without compromising creativity. Second, the use of a qaulan checklist as a guiding instrument for translating Qur'an-based communication principles into concrete questions and criteria for evaluating AI-generated content. Third, the open publication of content through TikTok makes the assignment more authentic because learning outcomes are assessed not only within the classroom context but also through actual audience responses and reception. This approach provides a more contextual learning experience and encourages students to produce relevant, creative, and responsible content.

Innovation

In terms of innovation, QaulanAI transforms the conventional video-production assignment, which typically focuses on recording and delivering lectures, into a learning experience that integrates human-AI collaboration. In this approach, each party has a clear and complementary role and does not replace the other. AI is used to accelerate and facilitate the creative production process, including idea generation and content development. Students remain responsible for human judgement, information verification, assessment of content suitability, and reflection on the learning process and outcomes. Lecturers serve as guides and ensure the accuracy of religious content and compliance with the established principles. This division of roles reflects the human-centred approach to AI use recommended by UNESCO (Miao & Holmes, 2023), while also integrating structured project-based learning principles that have the potential to enhance student engagement in the learning process (Kokotsaki et al., 2016).

Usability

In terms of usability, the workflow and checklist developed in QaulanAI have the potential to be applied flexibly across various courses involving media production and communication. The workflow structure can be adapted according to learning outcomes, students' proficiency levels, and the type of media product being produced, while the ethical and values layer can be modified based on the value framework or discipline appropriate to the course context. In addition, the framework does not depend on the use of specific paid software, thereby potentially reducing cost constraints and increasing students' access to digital content production processes. QaulanAI can also be implemented within one semester and adapted for both full-time and part-time programmes. From a pedagogical perspective, this approach is consistent with the principles of the NALI Model, which emphasise student-centred

learning and blended learning approaches, particularly through the integration of face-to-face learning, self-directed activities, digital technologies, and authentic experiences in content production.

Innovation Description, Process and Implementation

QaulanAI was implemented as a project-based learning assignment in the course MHID 1143 Communication and Application of Da'wah Media at the Academy of Islamic Civilisation, Universiti Teknologi Malaysia, during the 2025/2026 Session. Seven students individually produced creative da'wah videos in three formats: book review videos, infographic videos, and individual da'wah videos, based on selected themes for defined target audiences. The generative AI tools used were ChatGPT (script generation and refinement), Canva AI (image and video generation), CapCut (video editing and production), and Suno (original background music generation). The framework consists of three integrated components:

a) Five-stage production workflow. Students progressed through the stages of idea generation, scriptwriting, visualisation, voice and editing, and publication and reflection. Generative AI was used at each stage to accelerate and enrich production.
b) Qaulan ethical layer. The Qur'an outlines six forms of expression that shape Islamic communication ethics: qaulan sadida (truthful speech), qaulan baligha (effective speech), qaulan ma'rufa (good speech), qaulan karima (noble speech), qaulan layyina (gentle speech), and qaulan maysura (easy speech) (Hendra & Musliadi, 2019). QaulanAI operationalises these principles as a checklist applied by students to every AI output before acceptance, as well as criteria in the assessment rubric.
c) Human verification protocol. AI is never the final decision-maker for religious content. Every Qur'anic verse, hadith, and scholarly claim in the script must be verified against authoritative sources and properly referenced; lecturers review the script before production, peers review the video draft, and students submit an AI-use declaration listing the tools and prompts used. Only after this process is the video published on the course TikTok account @dakwah.utm. Assessment uses a rubric that considers message accuracy and source verification, compliance with qaulan principles, creativity and production quality, transparency of AI use, and audience engagement. Table 1 summarises the workflow.

Table 1: QaulanAI Workflow

STAGE	STUDENT ACTIVITY	ROLE OF GENERATIVE AI	QAULAN / ETHICAL CHECKPOINT
1. Idea	Select the da'wah theme and target audience	Brainstorm angles, hooks, and audience insights	Qaulan sadida: truthful and sourced message
2. Script	Write a 60–90 second script with evidence verified from authoritative sources	Refine language, tone, and structure	Qaulan layyina & ma'rufa: gentle, courteous, non-provocative
3. Visualisation	Create a storyboard; generate or select visuals	Image/video generation, scene suggestions	No depictions that violate sharia; modest and culturally appropriate imagery
4. Voice & editing	Record or synthesise narration; assemble the video	Text-to-speech, subtitles, editing assistance	Qaulan baligha: clear delivery; pronunciation checked by lecturer
5. Publication & reflection	Upload to the course TikTok account; write the AI declaration and reflection		Transparency: tools and prompts disclosed; peer and lecturer review before publication

Key Findings

Seven students produced 42 creative da'wah videos (an average of three per student), all of which were published on @dakwah.utm. As of September 2026, the account had 100 followers and 700 cumulative likes; this 7:1 ratio indicates that the content reached beyond the existing follower base through TikTok's recommendation algorithm. Table 2 presents the five videos with the highest reach.

Table 2: Top Five Videos on the @dakwah.utm Account (as of September 2026)

VIDEO	FORMAT	DATE	VIEWS	LIKES
Book Review "Chaiyok"	Book review	June 2026	372	29
Infographic "13 rukun solat"	Infographic	18 July 2026	359	20
Book Review "Pujuklah Hati"	Book review	June 2026	362	13

VIDEO	FORMAT	DATE	VIEWS	LIKES
"Ketenangan jiwa" Video	Individual video	3 July 2026	348	20
Book Review "Mr Right"	Book review	18 July 2026	331	36

The five top-performing videos accumulated 1,772 views and 118 likes, representing an engagement rate of 6.7%, which exceeds the estimated general TikTok average of 3–5%. The relatively consistent reach (331–372 views) across the three video formats indicates consistent quality that did not depend on only one or two students. Book reviews dominated three of the five top positions, while the video Mr Right recorded the highest number of likes (36) despite having the lowest number of views, indicating the content that generated the strongest resonance. From a process perspective, all students completed the AI-use declaration and underwent lecturer script review before publication; Suno also enabled original background music without copyright concerns. Within one semester, students without a media background were able to produce content that was competitive with existing da'wah content creators.

Impact

For students, QaulanAI develops three competencies simultaneously: media production, responsible AI literacy, and disciplined verification of religious texts. For educators, it provides ready-to-use rubrics and protocols that enable AI-assisted assignments to be assessed fairly and remain resilient against superficial use of AI. For the institution, published videos become authentic da'wah content that extends university community engagement to online youth audiences. In the long term, it serves as a model for integrating generative AI into religious education without compromising accuracy, ethics, and human judgement.

Recommendations for Classroom Practice

- Begin with an ethics briefing: introduce the qaulan checklist and verification protocol before students use AI tools.
- Assess the process, not only the product: require the submission of verified scripts, AI prompt logs, and an AI-use declaration as part of the assessment.
- Publish to real audiences to make assignments authentic, with privacy and student-consent guidelines established in advance.
- For other disciplines, replace the qaulan layer with the relevant professional code of ethics (e.g., journalism ethics) without changing the workflow.

Other Relevant Information

This framework is related to the authors' research under FRGS grant Q.J130000.3853.24H38 (Integrative Digital Da'wah Framework) and the book Jiwa Digital: Panduan Etika Media Sosial Muslim, co-authored by the authors.

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ID 109: A Gamified Approach to Teaching Well Trajectory and Directional Drilling

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Highlights: Engineering learners often face a cognitive gap when attempting to visualize downhole physics and directional drilling trajectories using static 2D theories. To address this, we developed a gamified well trajectory simulator where learners role-play as Lead Directional Drillers. Tasked with hitting multiple reservoir targets (Sands H, J, and K) while strictly managing operational budgets, rig costs, and mud motor constraints, learners dynamically bridge the derivation-application divide. The innovation achieved an outstanding 5.73/6 student satisfaction score, proving that introducing cost-aware, interactive operational realities significantly enhances pedagogical engagement and conceptual mastery compared to traditional lecture methods.

Keywords: Gamification; Directional Drilling; Engineering Education; Immersive Learning; Pedagogy

Introduction

Directional drilling and well trajectory planning are among the most mathematically intensive subjects in petroleum engineering. Standard instruction relies on static 2D textbook diagrams and manual calculations, creating a persistent 'visualisation gap' where learners struggle to translate formulas into downhole reality. This gap is further deepened because traditional exercises isolate theoretical calculations from field realities, omitting physical and financial consequences like torque, drag, and costly rig downtime. Consequently, graduates often enter the energy sector with strong derivation skills but limited operational understanding of directional decision-making.

To bridge this divide, we developed an interactive, gamified simulation. Grounded in Kolb's Experiential Learning Theory and Scenario-Based Learning (SBL), this approach converts passive learning into active problem-solving (Clark & Mayer, 2012; Kolb, 2015). Learner's step into the role of a Lead Directional Driller to apply theoretical mechanics in a risk-free environment (Ar & Abbas, 2021). As learners make operational decisions, immediate visual and financial feedback loops track real-time costs and trigger penalties for exceeding tool tolerances, teaching them to balance mathematical accuracy with operational safety and financial viability (Tembrevilla et al., 2023).

Objectives

- To enhance learners' spatial visualization of downhole environments, transitioning their conceptual understanding from static paper diagrams to dynamic operational realities.
- To bridge the derivation-application divide by challenging learners to apply theoretical equations directly to high-stakes, simulated field scenarios.
- To cultivate operational and financial acumen by requiring learners to balance technical drilling constraints with real-time cost management.

NALI Approach

Novelty

The innovation uniquely fuses petroleum engineering physics with resource-management gamification. Rather than passively solving well trajectory equations on paper, learners are thrust into an immersive operational reality. They must navigate real-world constraints, such as proximity to existing wells and limited mud motor inventory, making the learning experience distinct from conventional textbook problem-solving. This shift allows learners to apply theoretical knowledge directly in practical, real-world contexts, a cornerstone of effective scenario-based learning that fosters high engagement (Mamaki et al., 2023). This mirrors experiential learning theory, where learning is recognized as an active process by which knowledge is created through the transformation of experience (Kolb, 2015).

Creativity

The creative design centers on role-playing and consequence-based learning. Learners act as the "Lead Directional Driller" and are given an operational brief from Reservoir Engineers to hit specific subterranean targets. They are presented with a starting budget and must make critical, stand-by-stand decisions that directly impact their virtual financial performance, transforming abstract math into a tangible, high-stakes puzzle.

Innovativeness

This approach introduces a highly improved pedagogical method by integrating cost-penalty mechanics into engineering calculations. If a learner chooses an aggressive build-up angle that requires a wiper trip, they incur a simulated financial penalty (e.g., $50,000 to $200,000). This innovatively teaches learners that in engineering, mathematical accuracy must be paired with operational efficiency and safety, a critical component of holistic experiential learning in modern engineering education (Tembrevilla et al., 2023).

Applicability

While designed for Drilling Engineering, the framework of this gamified ecosystem, assigning technical targets, providing constrained tools, and imposing financial/time penalties, is highly scalable. It can be effortlessly adapted across various engineering disciplines to simulate operational realities in the classroom.

Innovation Description, Process and Implementation

1. The innovation is an interactive, gamified simulation implemented during combined-class collaborative sessions. The process flow requires learners to synthesize geological data, rig capabilities, and financial constraints to successfully drill a well. Figure 1 illustrates the gamified simulation interface, demonstrating the dynamic visual feedback learners receive as they make stand-by-stand operational decisions.
2. The Operational Brief: Learners receive target data with specific True Vertical Depth sub-sea (TVDss) and Horizontal Departure (HD) coordinates, alongside a tight horizontal tolerance to a nearby well, inducing safety hazard.
3. Resource Constraints: They are provided a baseline Rig Cost of $5,000/hour. They must select their stand length (90-100 ft) and choose an available Mud Motor Angle (0.75°, 1.50°, 2.00°, or 3.00° per 100 ft).
4. The Execution Phase: For each stand, learners instruct the "driller" to either Rotate (drill straight at a cost of $150/hr and 90 ft/hr ROP) or Slide (build/drop angle at $30/hr and a slower 45 ft/hr ROP).
5. Real-time Feedback: Learners must calculate their Build Up Rate (BUR) continuously. If they slide continuously beyond the motor's limit, a wiper trip is triggered, inducing massive penalty costs. This forces learners to iteratively optimize their well paths, balancing the speed of rotating against the directional control of sliding.

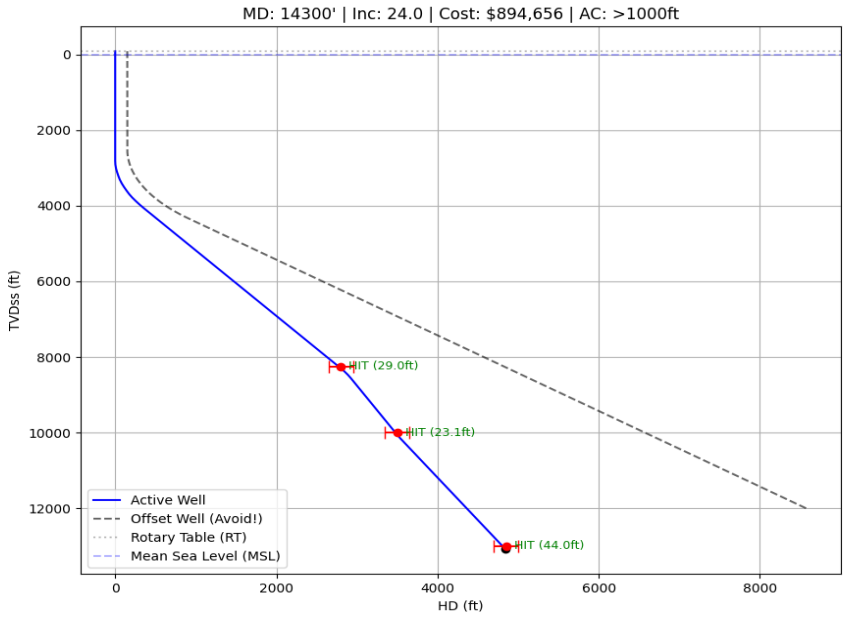


Figure 1: The gamified well trajectory simulation interface, displaying the wellbore path, operational constraints, and dynamic visual feedback.

Key Findings

The implementation of the gamified well trajectory approach yielded marked improvements in Course Learning Outcome 4 (CLO4), which measures learners' ability to evaluate complex drilling mechanics and optimize operational strategies under real-world constraints.

- CLO4 Mastery Through Real-Time Optimization: Prior to this innovation, learners struggled to apply directional drilling equations to multi-variable field scenarios. By introducing the interactive simulator, learners demonstrated direct competency in CLO4 by evaluating trade-offs between mud motor angles, Rate of Penetration (ROP), stand selection, and financial penalties ($50,000 to $200,000 wiper trips). This transformed abstract calculations into a dynamic problem-solving process.
- Evidence of Pedagogical Impact: As illustrated in Figure 2, student feedback confirmed that the gamified simulation directly reinforced their conceptual mastery and problem-solving confidence. Cohort reviews highlighted "games in class" and "interactive incident scenarios" as the primary drivers in bridging the gap between theoretical derivations and operational decision-making, leading to an overall course evaluation score of 5.73 out of 6.00.

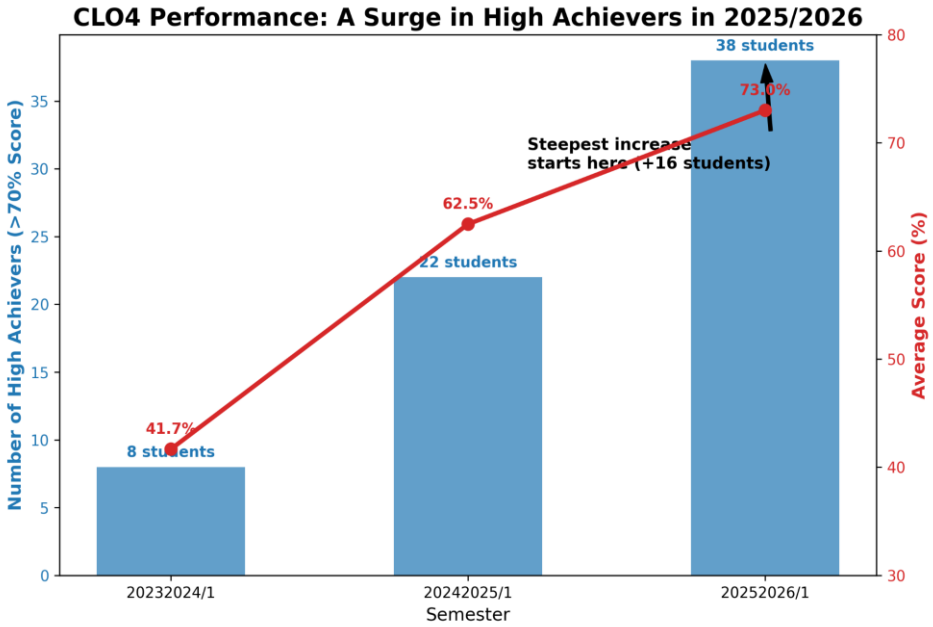


Figure 2: Summary of the pedagogical impact, demonstrating heightened student engagement and positive learning reception from the SETP 3413 cohort.

Impact

The innovation delivered a profound impact across multiple stakeholder levels. For students, it eradicated the "imagination deficit," allowing them to intuitively grasp complex directional physics and Torque & Drag concepts. By presenting students with scenarios that require critical thinking and real-time decision-making, this gamified approach encourages deep engagement and higher-order cognitive processing (Falkner & Stålbrandt, 2023). It shifted their mindset from merely passing an exam to thinking like industry professionals who value expensive rig time and operational safety. For educators, the gamified "combined class" structure fostered higher peer-to-peer engagement and dynamic mentoring opportunities, significantly reducing student friction when tackling difficult topics like Formation Pressure and Hydraulics.

Recommendations for Classroom Practice

To successfully integrate this innovation, educators should adopt a "collaborative class" model, allowing learners to work in teams (e.g., mimicking an oil rig crew). It is crucial to position the lecturer not as a traditional teacher, but as the "Company Man" or project manager who facilitates the game and enforces the simulated constraints. For other institutions or subject areas looking to replicate this, we recommend starting with a core mathematical concept, identifying the real-world tools used to execute

that concept, and attaching a time-or-financial cost to the usage of those tools to gamify the learning process.

Other relevant information

Intellectual Property (IP) Status & Copyright: The software code, simulation algorithms, and graphical user interface for this innovation have been officially registered for Intellectual Property Copyright protection with the Intellectual Property Corporation of Malaysia (MyIPO) under Application No. LY2026E05660 (Title: Educational Well Trajectory Simulation Game for Drilling Engineering). The copyright is owned by Universiti Teknologi Malaysia (UTM).

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ID 111: ReasonAI: Beyond Correct Answers through Human-AI Synergy in Mathematics Learning

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Highlights: ReasonAI addresses the limitations of answer-focused mathematics assessment by making pupils' mathematical thinking visible. It analyses pupils' answers and written reasoning to identify reasoning patterns, potential misconceptions, and learning needs, and generates targeted intervention suggestions for teachers. Preliminary testing with five Year 6 pupils, generating 25 written reasoning responses, demonstrated the feasibility of the prototype for reasoning-focused mathematics assessment. Unlike conventional answer-based assessment, ReasonAI adopts a human-AI approach in which AI-generated insights support rather than replace teachers' professional judgement, enabling more responsive and targeted mathematics teaching.

Keywords: Mathematical reasoning; Artificial intelligence; Human-AI synergy; Teacher intervention; Mathematics education

Introduction

In mathematics learning, a correct answer does not always indicate full understanding, just as an incorrect answer does not necessarily indicate a lack of understanding. What matters is the reasoning behind the answer—how pupils approach a problem, select strategies, and justify their thinking (Rohati et al., 2023). However, examining such reasoning can be challenging when teachers need to interpret many responses.

ReasonAI was developed to address this challenge by examining both pupils' answers and their written mathematical reasoning. It helps teachers identify meaningful reasoning, possible misconceptions, learning gaps, and responses requiring closer attention, while suggesting targeted interventions and follow-up questions.

Rather than replacing professional judgement, ReasonAI positions AI as a supporting partner in making pupils' mathematical thinking more visible. Teachers review the evidence and remain responsible for the final pedagogical decision. Through this human-AI partnership, ReasonAI aims to help teachers understand not only **whether pupils are right or wrong, but why they think the way they do—and what to do next.**

Objectives

- To analyse pupils' mathematical reasoning beyond answer correctness by examining their written explanations and identifying reasoning patterns, learning gaps, and potential misconceptions.
- To provide targeted and actionable intervention suggestions based on pupils' identified reasoning needs, enabling teachers to respond more effectively to individual learning difficulties.
- To support human-AI collaboration in mathematics assessment by providing AI-assisted insights while keeping teachers at the centre of reviewing evidence and making final pedagogical decisions.

NALI Approach

Novelty

ReasonAI moves beyond correct-or-incorrect assessment by using pupils' written reasoning as evidence of mathematical understanding. Rather than producing only a score, it connects the reasoning behind an answer with possible learning needs and appropriate teacher support. This makes assessment a starting point for understanding how pupils think and what support they may need next.

Creativity

ReasonAI integrates pupil reasoning, AI-assisted analysis, and teacher intervention within one learning cycle. Pupils explain their thinking, the system interprets their reasoning and suggests appropriate follow-up support, and teachers review the evidence before deciding the next step. This creates a practical partnership between AI assistance and professional teacher judgement.

Innovativeness
ReasonAI introduces a reasoning-focused, teacher-in-the-loop approach to AI-assisted mathematics assessment. It distinguishes meaningful reasoning, responses requiring teacher review, and potential misconception signals, then links these insights to targeted interventions rather than generic feedback. AI supports the analysis, while teachers retain control over the final pedagogical decision.

Applicability
As a web-based approach, ReasonAI can be adapted to different mathematics topics, question types, and learning levels. It can support formative assessment, diagnostic activities, and follow-up instruction. Its modular structure also allows future expansion to additional mathematical domains and larger learner groups while maintaining the same human-AI workflow.

Innovation Description, Process and Implementation

ReasonAI is a web-based mathematics reasoning assessment tool designed to help teachers look beyond pupils' final answers and better understand the thinking behind them. Pupils respond to mathematical problems and provide a written explanation of their reasoning. ReasonAI analyses both the answer and explanation to identify evidence of mathematical reasoning, possible misconceptions, or responses that require further teacher attention. Based on the identified learning need, the system generates suggested interventions and follow-up questions for the teacher. The teacher reviews these suggestions before deciding on the most appropriate instructional response.

The innovation follows a **five-stage human-AI learning cycle**:

Pupil Response
Pupils solve a mathematical problem and explain how they arrived at their answer.

Reasoning Analysis
ReasonAI examines both the answer and written explanation rather than relying only on answer correctness.

Learning-Need Identification
The response is interpreted in terms of supported reasoning, reasoning requiring teacher review, or evidence of a potential misconception.

Targeted Intervention
ReasonAI provides an intervention suggestion or follow-up question according to the identified reasoning need.

Teacher Review and Decision
The teacher examines the pupil's response, AI-generated analysis and suggested intervention before making the final pedagogical decision.

The current prototype was developed iteratively and underwent preliminary testing with five Year 6 pupils, generating 25 written mathematical reasoning responses. The testing was used to examine the feasibility of the workflow and identify areas requiring refinement, particularly reasoning classification and the specificity of intervention suggestions. Findings from this preliminary implementation are being used to further improve ReasonAI before wider classroom testing.

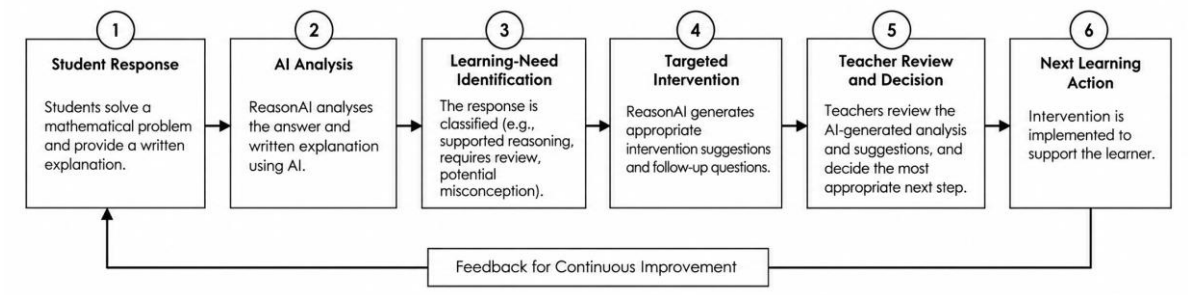


Figure 1: ReasonAI Human-AI Cycle for Mathematics Reasoning Assessment and Intervention

Key Findings

Preliminary implementation involved **five Year 6 pupils completing five fraction reasoning tasks each, generating 25 written responses.** The findings showed that answer correctness did not always reflect the quality of

pupils' mathematical reasoning. Pupils sometimes reached correct answers using different valid strategies, while some correct responses were supported by limited or incomplete justification. This demonstrates the importance of examining the reasoning behind an answer rather than relying solely on correctness.

The pilot also showed that ReasonAI could provide useful initial insights into different reasoning needs and corresponding intervention suggestions. However, brief, ambiguous, or unexpected explanations still required teacher interpretation, reinforcing the importance of the **teacher-in-the-loop** approach. Overall, the findings support the feasibility of ReasonAI while identifying priorities for further refinement, particularly recognising diverse reasoning strategies and generating more precise, context-sensitive interventions.

Table 1: Preliminary Findings from Year 6 Pupils' Mathematical Reasoning

EVIDENCE FROM PRELIMINARY TESTING	KEY FINDING	IMPLICATION FOR REASONAI
5 Year 6 pupils completed 5 fraction reasoning tasks each	25 written reasoning responses were obtained	Provides preliminary evidence for testing reasoning-focused analysis
Some pupils used decimals, equivalent fractions or cross-multiplication	Correct answers can be supported by different valid reasoning strategies	ReasonAI should recognise multiple forms of valid reasoning
Some correct answers were accompanied by weak or incomplete explanations	Correctness does not necessarily indicate strong mathematical reasoning	Analysis should go beyond correct/incorrect classification
Some responses were unclear or mathematically inconsistent	Pupil thinking may require further clarification	ReasonAI should flag uncertain reasoning for teacher review
Different reasoning patterns require different forms of support	Interventions need to respond to specific reasoning needs	ReasonAI should generate targeted,context-sensitive interventions.

Impact

ReasonAI has the potential to support students and teachers by shifting attention from answer correctness to the reasoning behind it. For students, it makes mathematical thinking more visible and allows support to be better matched to individual learning needs. For teachers, it provides additional insight into supported, incomplete, or potentially misconceived reasoning and suggests targeted follow-up actions. Importantly, teachers retain responsibility for interpreting the evidence and making final pedagogical decisions. With further classroom validation, ReasonAI could support more responsive formative assessment while strengthening meaningful human-AI collaboration in mathematics education.

Recommendations for Classroom Practice

ReasonAI is recommended as a formative assessment and diagnostic support tool rather than a replacement for teacher judgement. Teachers can use it after problem-solving or diagnostic tasks by asking pupils to provide both an answer and an explanation of their reasoning. AI-generated insights and interventions should be reviewed alongside pupils' original responses, with follow-up questions used when reasoning is unclear or incomplete. The approach can be adapted to different mathematics topics and learner needs while keeping teachers responsible for final pedagogical decisions.

Other relevant information

ReasonAI is currently a developing prototype that has undergone preliminary implementation with Year 6 pupils. Further development will focus on improving the accuracy and flexibility of reasoning analysis, strengthening context-sensitive interventions, and validating the system with a larger and more diverse group of learners. Its modular design also provides potential for expansion across mathematics topics and learner levels, as well as future institutional adoption, intellectual property protection, and educational commercialisation. Throughout its development, ReasonAI will maintain its central principle of AI-supported analysis with teacher-led pedagogical decision-making.

Acknowledgement

The authors would like to express their sincere appreciation to Universiti Teknologi Malaysia (UTM) and Institut Pendidikan Guru Kampus Temenggong Ibrahim (IPGKTI) for their support in the development of ReasonAI. Special thanks are also extended to the Year 6 pupils who participated in the preliminary testing and contributed valuable responses that supported the refinement of the innovation.

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ID 112: HUMARK-AI: Human-Verified Generative AI for Assessment and Feedback in Higher Education

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Highlights: HUMARK-AI is a human-verified generative AI-assisted assessment practice that supports lecturers in evaluating student work and preparing feedback without transferring academic judgement to artificial intelligence. Implemented with 55 students across undergraduate and postgraduate courses, the practice combines predefined marking criteria, AI-supported analysis, lecturer verification, contextual interpretation, and final human decision-making. Its key contribution is a structured human-AI workflow that treats AI as an assessment assistant rather than an autonomous assessor, strengthening responsible use, transparency, and lecturer accountability.

Keywords: Generative AI; Assessment; Feedback; Human-AI collaboration; Academic judgement

Introduction

Generative artificial intelligence (GenAI) offers new possibilities for supporting assessment and feedback in higher education. Large language models can compare written responses against criteria, identify relevant concepts, summarise evidence, and suggest feedback. These capabilities may help lecturers handle complex assessment tasks more systematically. However, the same capabilities introduce concerns about reliability, transparency, contextual interpretation, privacy, and over-reliance on AI-generated recommendations. Current guidance on GenAI in education therefore emphasises human oversight, responsible use, and preservation of educational judgement (Cotton et al., 2024; Kasneci et al., 2023; UNESCO, 2023)).

HUMARK-AI was developed as a human-verified GenAI-assisted assessment practice in which AI supports, rather than replaces, lecturer judgement. The lecturer provides the learning outcomes, assessment question, marking criteria, expected answer elements, and mark allocation. GenAI then assists with analysing student responses and suggesting possible interpretations, marks, or feedback. The lecturer verifies these recommendations against the original student work and retains full authority over the final decision. The innovation therefore addresses a practical question facing educators: how can GenAI be used to support assessment while preserving academic judgement and accountability?

The practice was implemented in two courses at Universiti Teknologi Malaysia: an undergraduate Generative AI course involving 30 students and a postgraduate Data Governance course involving 25 students. It was applied to both assignments and examinations, providing evidence of applicability across different educational levels, subject contexts, and assessment formats.

Objectives

- To establish a structured human-AI workflow for assessment and feedback while retaining final human academic judgement.
- To support systematic application of assessment criteria through AI-assisted analysis followed by mandatory lecturer verification.
- To promote responsible and transparent GenAI use in assessment by defining clear human-control points.
- To support useful and consistent feedback without allowing GenAI to function as an autonomous assessor.

NALI Approach

Novelty

Existing approaches to AI-supported assessment increasingly recognise the importance of human oversight and lecturer verification (Kasneci et al., 2023; UNESCO, 2023). HUMARK-AI builds on this principle by operationalising human verification as a structured assessment workflow rather than treating it as a general safeguard. The practice explicitly separates AI-supported analysis, lecturer verification, academic judgement, and final assessment. This enables lecturers to identify situations where AI may overlook visual evidence, misinterpret ambiguous responses, or lack contextual information such as academic integrity concerns and submission conditions. The novelty of HUMARK-AI lies not in introducing human oversight itself, but in translating human oversight into a practical, repeatable lecturer-AI assessment workflow with clearly defined decision boundaries.

Creativity
Instead of asking AI to independently grade student work, the lecturer first frames the assessment using learning outcomes, marking criteria, expected answer elements, and mark allocation. The lecturer then interrogates AI recommendations by checking whether the student actually demonstrated the required concept, whether partial credit is justified, whether the AI inferred meaning beyond the response, and whether comparable answers are treated consistently. This creates an iterative human-AI dialogue rather than one-directional automated grading.

Innovativeness
HUMARK-AI changes the role of GenAI from grader to assessment assistant by introducing explicit human-control points throughout the assessment process. The lecturer remains responsible for context, interpretation, exceptions, final marks, and released feedback. Effective feedback should support learning rather than function only as information transmission, which reinforces the need for lecturers to review and contextualise AI-generated feedback before it is released to students (Boud & Molloy, 2013)

Applicability
HUMARK-AI does not require a specialised assessment platform. It can be adapted to commonly available GenAI tools, subject to institutional privacy and data-governance requirements. The practice can support undergraduate and postgraduate assessment, assignments and examinations, short-answer responses, essays, reports, and reflective work. Because lecturers retain control of disciplinary criteria and interpretation, the approach is potentially transferable across disciplines.

Innovation Description, Process and Implementation

The practice follows six stages. First, the lecturer defines the assessment context, including learning outcomes, criteria, expected answer elements, and marks. Second, GenAI analyses the student response against those criteria. Third, it recommends potentially relevant evidence, possible marks, or feedback points. Fourth, the lecturer verifies the recommendation against the original response. Fifth, the lecturer accepts, modifies, or rejects the recommendation using academic judgement. Finally, the lecturer finalises the mark and feedback.

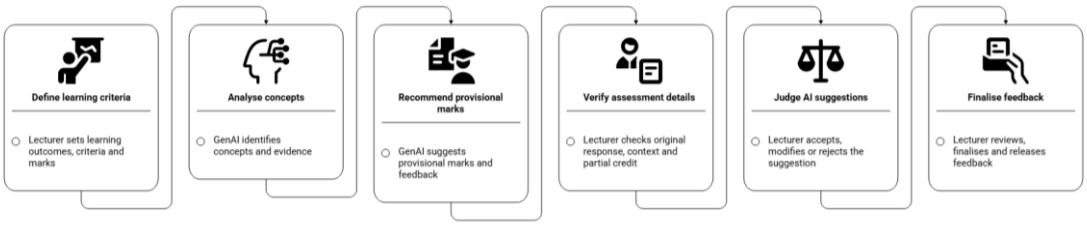


Figure 1: HUMARK-AI human-AI assessment workflow

Implementation across the two courses showed that particular attention is required when responses are ambiguous, unconventional but defensible, partially correct, or phrased in ways that lead AI to infer more knowledge than the student explicitly demonstrated. These situations become deliberate human-control points rather than exceptions to an automated process.

Key Findings

HUMARK-AI was implemented with a total of 55 students: 30 undergraduate students in a Generative AI course and 25 postgraduate students in a Data Governance course. The practice was used for both assignments and examinations. Across these contexts, GenAI was useful for systematically comparing student responses with predefined assessment criteria and identifying potentially relevant answer components.

The implementation also demonstrated why lecturer verification remains necessary. In one documented case, GenAI deducted marks because it interpreted the expected diagram as missing. Lecturer review showed that the diagram was present, although it was not clearly presented; partial marks were therefore awarded. This case demonstrates a core HUMARK-AI control point: AI can overlook or misread elements in student work, while the lecturer can interpret the evidence in context and award proportionate credit.

Table 1: Examples of lecturer intervention in HUMARK-AI assessment

AI RECOMMENDATION	LECTURER VERIFICATION	WHY HUMAN JUDGEMENT MATTERED
GenAI deducted marks because it identified the expected diagram as absent.	Lecturer review found that the diagram was present, but not clearly presented. Partial marks were awarded.	Human verification prevented an incorrect full deduction and allowed proportionate credit for evidence that the AI did not recognise clearly.
AI suggested a relatively high mark because the student mentioned several relevant concepts from the marking scheme.	AI suggested a relatively high mark because the student mentioned several relevant concepts from the marking scheme.	AI suggested a relatively high mark because the student mentioned several relevant concepts from the marking scheme.
AI suggested a lower mark because the student did not use the expected terminology.	AI suggested a lower mark because the student did not use the expected terminology.	AI suggested a lower mark because the student did not use the expected terminology.

Impact

For educators, HUMARK-AI provides a structured method for using GenAI without surrendering academic responsibility. It encourages lecturers to critically interrogate AI recommendations rather than accept generated marks or feedback at face value. For students, the practice maintains human academic judgement in decisions affecting their performance while enabling more systematic consideration of assessment criteria. At institutional level, the practice offers a practical model for responsible GenAI adoption that can inform staff development, assessment guidance, and AI governance. Its implementation across both undergraduate and postgraduate courses indicates potential for adaptation across levels and disciplines.

Recommendations for Classroom Practice

The practice can be developed further into a reusable HUMARK-AI Assessment Toolkit containing a workflow, lecturer verification checklist, prompting protocol, responsible-use checklist, and anonymised examples of common AI assessment errors. Such a toolkit could support cross-disciplinary adoption and professional development for educators.

Other relevant information

The practice can be developed further into a reusable HUMARK-AI Assessment Toolkit containing a workflow, lecturer verification checklist, prompting protocol, responsible-use checklist, and anonymised examples of common AI assessment errors. Such a toolkit could support cross-disciplinary adoption and professional development for educators.

Acknowledgement

The author acknowledges Universiti Teknologi Malaysia and the teaching contexts that supported the development and implementation of HUMARK-AI. Any student examples included in the final exhibition materials will be anonymised.

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ID 114: Moodify: Bounded Hybrid AI Pedagogy to Enhance Emotional Intelligence and Reduce Aggression in Malaysian Adolescents

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Highlights: School conflicts expose adolescents' need to practise emotional regulation and safer responses. For Character Education 2027, Moodify offers Malaysian students aged 13–15 a five-step supervised cycle: Write, Detect, Pause and Identify, Compare, and Evaluate and Revise. Its bounded RAG–LLM system retrieves expert-reviewed guidance grounded in Constructivist Learning Theory, Social Cognitive Theory, Goleman's emotional-intelligence framework, and the General Aggression Model from a vector database, then generates brief non-aggressive alternatives. Unlike open-ended chatbots, Moodify preserves student choice and teacher oversight while making response revisions assessable. Effects on emotional intelligence and reactive and proactive aggression await evaluation.

Keywords: Retrieval-augmented generation; Large language models; Character education; Emotional intelligence; Reactive and proactive aggression

Introduction

School safety begins before conflict becomes harm. Ages 13–15 offer a timely opportunity to practise self-regulation as peer influence grows and decision-making capacities continue to develop (Steinberg, 2005). Yet a review found that 66.3% of emotional-AI education studies involved tertiary learners (Zhang et al., 2025). A Malaysian school-based technology intervention improved emotional regulation but did not assess aggression (Baharuddin et al., 2025).

Moodify addresses this gap through supervised practice with familiar school conflicts. Its bounded AI supports reflection, while students retain responsibility for choosing and revising their responses. That revision provides teachers with evidence of applied judgement, not simply recalled values. Proposed as a complementary activity for the *Program Pembentukan Karakter* under *Kurikulum Persekolahan 2027* (Ministry of Education Malaysia, 2025), Moodify will evaluate emotional intelligence and reactive and proactive aggression as separate outcomes. Its effectiveness has yet to be tested.

Objectives

- To identify emotional-regulation challenges and aggression triggers among Malaysian adolescents aged 13–15.
- To compare emotional intelligence between Moodify and control groups after ten sessions, accounting for pretest scores.
- To compare reactive and proactive aggression between Moodify and control groups after ten sessions, accounting for pretest scores.
- To assess teacher usability and school feasibility through attendance, fidelity logs and session feedback.

NALI Approach

Novelty

Moodify turns four psychological and learning frameworks into a five-step, school-based pedagogy for adolescents aged 13–15. Unlike studies centred on tertiary learners, correlational adolescent AI use or adult self-care chatbots, it is designed to evaluate emotional intelligence and reactive and proactive aggression as separate outcomes (Zhang et al., 2025; Piombo et al., 2025; Tong et al., 2025).

Creativity

Moodify turns an everyday school conflict into a private rehearsal before harm occurs. Students draft a response, recognise escalation, identify emotions and goals, compare safer alternatives, predict consequences and revise. The AI suggests; the student decides. Their initial and revised responses provide authentic evidence of judgement, not just knowledge of positive values.

Innovativeness

Moodify assigns clear limits to each AI component: multilingual detection flags potentially hostile wording, theory-based rules guide prompts, RAG retrieves expert-reviewed guidance from a vector database, and a constrained LLM offers brief non-aggressive alternatives. It does not label students or act as a counsellor.

Teacher oversight, privacy safeguards and human referral address the risks of youth-facing AI (Naji et al., 2025; Yoo et al., 2026).

Applicability

With school approval, ten supervised 45-minute sessions could fit the planned weekly Program Pembentukan Karakter allocation under Kurikulum Persekolahan 2027 (Ministry of Education Malaysia, 2025). Schools can adapt scenarios, reading levels and Bahasa Melayu, English or code-mixed input while retaining the five-step sequence. Wider adoption will depend on expert review, facilitator preparation, safeguarding, pilot feasibility and evaluation of both outcomes.

Innovation Description, Process and Implementation

Moodify is a proposed, teacher-supervised AI pedagogy for Malaysian adolescents aged 13–15. Designed to complement character education under *Kurikulum Persekolahan 2027*, it lets students practise responses to school conflicts before acting on them. The study will assess emotional intelligence and aggressive behaviour as separate outcomes.

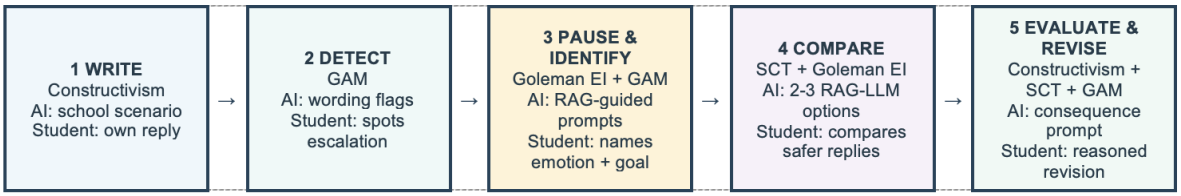


Figure 1: Moodify's five-step theory-to-practice learning flow.
EI = emotional intelligence; GAM = General Aggression Model; SCT = Social Cognitive Theory; RAG = retrieval-augmented generation; LLM = large language model.

Figure 1 shows the five-step cycle. In **PROMPT → WRITE**, the AI presents a conflict, and the student writes an initial reply. In **DETECT**, the system highlights potentially escalating wording. In **PAUSE & IDENTIFY**, the student names their emotion and goal in response to AI prompts. In **COMPARE**, the AI offers two or three expert-grounded, non-aggressive alternatives. In **EVALUATE & REVISE**, the student predicts consequences and rewrites the reply. The student retains the final decision.

Expert-reviewed guidance from four psychological and pedagogical frameworks is stored in a vector database for retrieval-augmented generation (RAG). A bounded text-matching component flags wording in DETECT; RAG and a constrained large language model support the prompts and alternatives in later steps. The AI examines text, while teachers and counsellors supervise use and manage safeguarding concerns.

Development will use interviews with 28 adolescents, teachers, counsellors and psychologists, followed by review from 12 Modified Fuzzy Delphi experts and pilot testing with approximately 30 adolescents. The proposed intervention comprises ten weekly 45-minute sessions. A nonequivalent control-group pretest–posttest study of approximately 140–160 students will evaluate both outcomes through separate ANCOVAs, adjusting for their corresponding pretests and examining clustering, attrition and fidelity.

Key Findings

Present Moodify is currently at the design stage. testable innovation specification, not a demonstrated improvement in emotional intelligence or aggression. The proposal identifies a need for school-based practice that helps adolescents recognise escalation, reflect on emotions and goals, examine non-aggressive models and revise their own responses. Moodify translates these requirements into a five-step learning cycle with defined student–AI roles, bounded outputs and an observable response-revision record.

The planned evaluation will provide distinct forms of evidence: stakeholder views on relevance and acceptability, expert consensus on the design, pilot feedback on usability and fatigue, records of session attendance and fidelity, and adjusted pretest–posttest comparisons. No effectiveness percentage, adoption rate or long-term effect is claimed at this stage.

Impact

For students, Moodify is expected to create repeated opportunities to recognise escalating language, explain their goals and practise more considered responses. Its immediate learning evidence is the

student's own movement from an initial reply to a reasoned revision; improvement in emotional intelligence and aggression will be determined by the planned study.

For teachers and counsellors, the five-step sequence offers a consistent structure for supervised discussion and formative feedback. The response-revision record makes the learner's reasoning visible without handing professional judgement to AI. For schools, Moodify offers a potentially adaptable way to connect character education, authentic assessment and responsible AI use. Wider or sustained impact will depend on validation, effectiveness findings, safeguarding performance and implementation feasibility.

Recommendations for Classroom Practice

Educators should introduce Moodify as a supervised learning activity, with clear expectations for respectful responses and privacy. They should use locally reviewed scenarios, allow Bahasa Melayu, English or code-mixed input, and let students make the final choice in every cycle. A teacher or counsellor should check AI-generated alternatives for age appropriateness, accuracy, bias and non-aggressive wording before classroom use.

Schools adapting the activity should plan for devices, connectivity, facilitator training and a clear referral pathway. Facilitators should record attendance, completed sessions, technical interruptions and adherence to the five-step sequence. Individual student responses should not be displayed to peers without permission. Distress, credible threats or disclosures of abuse require an authorised adult response, not an automated AI reply.

Other relevant information

Moodify remains a research-stage innovation. The one-scenario exhibition prototype demonstrates the intended learning flow; it does not represent completed effectiveness testing. No award, commercialisation outcome, intellectual-property registration or long-term maintenance effect is claimed. Planned reusable materials include an expert-reviewed scenario bank, bounded AI specification, facilitator guide, safeguarding procedure and fidelity checklist. Broader adoption should follow validation, piloting and evaluation of both learning outcomes.

Acknowledgement

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ID 115: BijakKimpal: Human-AI Co-Designed Web Learning for Welding Technology Achievement

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Highlights: BijakKimpal is a responsive web-based learning platform developed using the ADDIE model to support Industrial Training Institute (ILP) students in the SMAW Process- Carbon Steel Plate 3 module. It integrates NOSS-aligned content with multimedia, including slides, graphics, videos, animation, quizzes and tests, to promote flexible and self-directed learning. The Human-AI Co-Designed approach uses Cursor for coding and Gamma AI and Canva for visual elements, with human expertise guiding instructional design, technical accuracy and validation. A quasi-experimental study involving 82 students demonstrated significantly higher post-test achievement for both web-based learning groups than conventional instruction, alongside high student perceptions.

Keywords: Web-based learning; Welding education; Human-AI synergy; TVET; Self-directed learning

Introduction

Welding education in TVET requires students to integrate theoretical knowledge with practical skills in accordance with National Occupational Skills Standard (NOSS). However, students may experience difficulties understanding welding concepts such as metal properties, weldability, processes and parameters before workshop practice. This highlights the need for flexible learning that strengthens theoretical readiness without replacing instructor guidance and hands-on training.

BijakKimpal was developed for the SMAW Process-Carbon Steel Plate 3 module using the ADDIE model, with WIM, competency learning outcomes and NOSS requirements guiding content development. It integrates notes, videos, graphics, audio, quizzes and tests to support flexible access, concept revision and self-assessment. Its design draws on constructivist learning theory and Mayer's Cognitive Theory of Multimedia Learning, with expert review ensuring content accuracy, technical suitability and usability.

BijakKimpal adopts a Human-AI co-designed approach in which AI-assisted tools support platform development and selected learning materials, while educators and technical experts retain responsibility for learning objectives, instructional decisions, technical accuracy and final validation. AI therefore functions as a supportive design resource rather than a replacement for human pedagogical and technical expertise.

Objectives

- To develop a responsive web platform that supports theoretical understanding and readiness for SMAW Process-Carbon Steel Plate 3 practical learning.
- To provide multimedia, self-paced learning with formative quizzes and immediate feedback before and beyond scheduled classroom sessions.
- To determine the innovation's effect on student achievement and evaluate students' perceptions and instructors' views of the learning approach.

NALI Approach

Novelty

BijakKimpal is a discipline-specific web-based learning platform for welding education, designed to address students' theoretical learning needs in the SMAW Process-Carbon Steel Plate 3 module. It integrates WIM-aligned content into a structured pre-workshop learning sequence comprising notes, slides, theory videos, practical-introduction videos, graphics, quizzes and tests. BijakKimpal provides flexible, self-paced learning with opportunities for students to revisit concepts and assess their understanding before workshop practice. The platform was developed using the ADDIE model and validated by technology and welding-content experts, while AI-assisted tools supported selected aspects of its development under human pedagogical and technical oversight.

Creativity

BijakKimpal creatively combines text, graphics, audio, animation, theory videos and introductory practical simulations within a structured learning pathway. Interactive quizzes, tests and feedback allow students to learn and revisit content at their self-pace using computers or smartphones. AI-assisted tools

support selected visual and content development, while human expertise guides instructional and technical decisions.

Innovativeness

The innovation changes the timing and function of theory instruction by extending learning beyond fixed classroom sessions. Students can build foundational understanding before entering the welding workshop, revisit explanations at their self-pace and receive immediate formative feedback. The platform integrates multimedia learning, self-paced activities and formative assessment to strengthen the connection between theoretical preparation and subsequent practical learning. Instructors also gain reusable digital resources that support teaching and allow greater focus during face-to-face sessions on practical guidance, safety and student learning needs.

Applicability

BijakKimpal has strong potential for adaptation and replication across the others 21 Welding Technology modules and ILJTM institutions. Its modular design can also be adapted to other technical and vocational programmes using comparable curriculum requirements, subject to discipline-specific validation. Reusable digital resources and flexible access through computers and mobile devices support sustainable integration into regular teaching practices.

Innovation Description, Process and Implementation

BijakKimpal is a responsive web-based learning platform developed for the SMAW Process-Carbon Steel Plate 3 module in Welding Technology. The platform transforms WIM into a structured digital learning experience comprising notes, theory videos, introductory practical videos, graphics, audio, quizzes, tests and immediate feedback. Development followed the five phases of the ADDIE model. During the Analysis phase, learner needs, curriculum requirements and instructor needs were examined. In the Design phase, learning outcomes and content were organized into a structured sequence from foundational theory to introductory practical learning. During Development, the planned materials were translated into a responsive JavaScript-based platform using multimedia and selected AI-assisted tools. The platform subsequently underwent alpha evaluation by five educational-technology experts and five welding-content experts. Technical evaluation item means ranged from 3.60 to 4.00, while content evaluation item means ranged from 3.40 to 4.00 on four-point scales. Expert feedback was used to refine the platform, particularly its responsive presentation, cross-device consistency and visual support.

Implementation was conducted over four to six weeks in authentic learning settings at 3 ILPs in Johor. A total of 82 semester two Welding Technology students participated in the quasi-experimental study, comprising a conventional learning control group (n = 27), a web-based learning group with a pre-test (n = 28), and a web-based learning group without a pre-test (n = 27). Students accessed the platform using computers or mobile devices, progressed through the sequenced learning materials, viewed multimedia content, completed quizzes or tests and reviewed immediate feedback. The web-based learning approach was implemented alongside face-to-face practical instruction rather than replacing workshop-based learning. Effectiveness was evaluated through pre-test and post-test, a student-perception questionnaire and semi-structured instructor interviews.

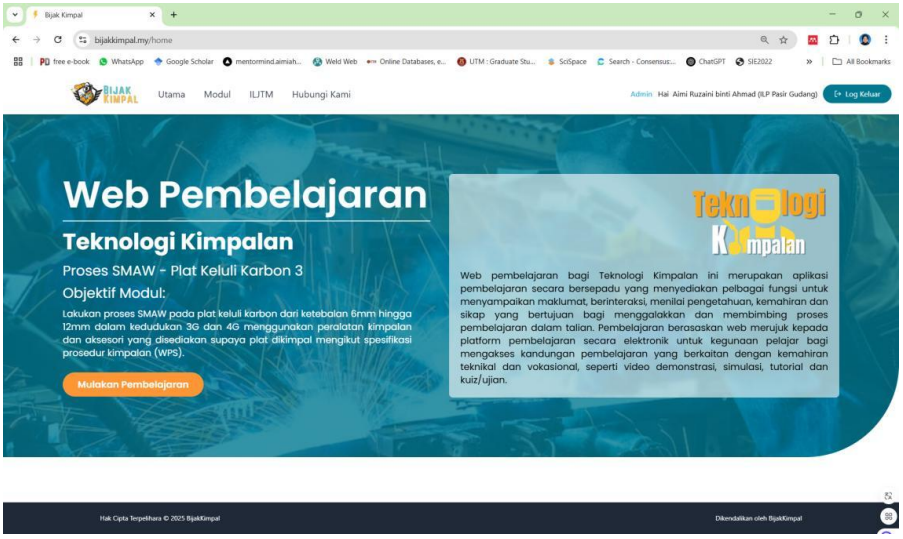


Figure 1: BijakKimpal home interface and module entry point.

Key Findings

The control and web/pre-test groups demonstrated statistically equivalent baseline knowledge ($p = 0.967$). Following the intervention, post-test achievement differed significantly across groups, $F(2,79) = 16.921$, $p < 0.001$, with both web-based groups outperforming the conventional group. The web/pre-test group recorded a 35.73-point gain compared with 15.04 points in the conventional group, while no significant difference was found between the two web groups ($p = 0.635$). Student perceptions were high ($M = 4.50/5.00$), and instructors reported benefits for motivation, lesson preparation, revision and self-directed learning.

Table 1: Evidence of learning effectiveness and student perception.

INDICATOR	EVIDENCE	INTERPRETATION
Baseline equivalence	Control M = 49.85; web/pre-test M = 50.04; p = 0.967	Comparable entry knowledge
Post-test achievement	Control M = 64.89; web/pre-test M = 85.77; web/no-pre-test M = 82.28	Higher achievement in both web groups
Between-group effect	F(2,79) = 16.921, p < 0.001; web vs. control differences p < 0.001	Significant between-group difference
Learning gain	Control +15.04 points; web/pre-test +35.73 points	20.69-point larger gain
Student perception	Overall M = 4.50/5 (n = 55); content M = 4.50; learning structure M = 4.50	High student perception

Impact

For students, BijakKimpal supports flexible and self-directed learning by enabling repeated access to multimedia resources and interactive activities. For instructors, it provides organized digital resources that facilitate lesson preparation and theoretical delivery. At the institutional level, the platform offers standardized, accessible and reusable learning resources and a reference model for developing web-based learning for other modules and courses.

Recommendations for Classroom Practice

Educators should integrate BijakKimpal into blended learning by assigning relevant topics for self-directed study before or beyond scheduled classes, followed by instructor-led discussion and supervised workshop activities. Notes, videos, quizzes and immediate feedback can reinforce theoretical understanding, clarify misconceptions and support individual revision. AI-assisted graphics should be reviewed by instructors or subject experts for technical accuracy, relevance to actual welding processes and safety requirements. Instructors should continue providing direct guidance during practical activities, while institutions should support digital implementation and periodic content review.

Other relevant information

BijakKimpal has potential for replication across Welding Technology modules and ILJTM institutions. Future enhancements may include interactive 3D visualisation, clearer practical demonstrations, simulations, additional visual support and a structured welding career pathway, as suggested by instructors. AI-assisted graphics remain subject to human review for technical accuracy and contextual relevance.

Acknowledgement

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ID 116: Lensa Citra Sejarah: Exploring the Past, Empowering Knowledge, Shaping the Future

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Highlights: This study aims to develop and evaluate E-Book Lensa Citra Sejarah as a digital innovation for enhancing History teaching and learning. The innovation integrates Artificial Intelligence (AI), interactive infographic videos, multimedia, Memory Keywords, and gamification to address limitations of static learning materials. Findings showed a high pupil mean score of 7.62, while teacher ratings ranged from 4.81 to 4.85, indicating very high acceptance. The innovation enhances pupils' learning experiences and supports creative, interactive, efficient, cost-effective, and sustainable teaching.

Keywords: E-Book Lensa Citra Sejarah; History Learning; Artificial Intelligence (AI); Digital Innovation

Introduction

The History subject in the Primary School Standard Curriculum (KSSR) plays an important role in developing knowledgeable pupils who are critical thinkers and possess patriotic values and a strong sense of identity. However, the teaching and learning of History still relies heavily on static materials such as textbooks, slides, and infographics, which are less engaging, making it challenging for pupils to understand historical facts, chronology, and evidence, while also affecting their interest in learning (Wineburg, 2001; Seixas & Morton, 2013). To address these challenges, the E-Book Lensa Citra Sejarah was developed by integrating text, visuals, audio, animation, and narrative based on Mayer's (2009) Cognitive Theory of Multimedia Learning. This approach makes History learning more engaging, interactive, meaningful, and student centered.

Objectives

- To enhance Year 4 pupils' understanding and mastery of historical facts.
- To increase pupils' interest and engagement through interactive digital materials.
- To empower teachers' teaching and learning (T&L) practices through AI-based digital materials.
- To improve the efficiency of material preparation in terms of time, resources, and cost.

NALI Approach

Novelty

E-Book Lensa Citra Sejarah transforms History learning materials from static resources into a multimodal digital ecosystem that integrates notes, infographics, videos, animation, audio, narrative, and interactive quizzes. Its novelty is further highlighted through "Memory Keywords" based on emojis and visual symbols, the use of AI tools such as ChatGPT and NotebookLM, and gamification through the sample quiz "Kuiz Jejak Hang Tuah". This multimodal approach is aligned with the principles of multimedia learning, which combine verbal and visual elements to support pupils' understanding (Mayer, 2009).

Creativity

The creativity of the innovation is demonstrated through the integration of digital illustrations, dynamic infographics, animation, audio, narrative, emojis, and gamification, making History content more engaging and easier to understand. The concise and visual presentation of historical facts also helps pupils establish connections between historical information and visual representations. The use of multiple representations in learning is also aligned with the multimedia learning approach (Mayer, 2009).

Innovation

E-Book Lensa Citra Sejarah transforms the delivery of History from a text-based and static approach into interactive, multimodal, and student- centred digital learning. The integration of AI and multimedia pedagogy creates a systematic learning ecosystem, namely notes → infographics → videos → interactive activities → assessment. This approach supports active learning and historical thinking through the use of multiple forms of representation (Mayer, 2009; Seixas & Morton, 2013).

Applicability

High applicability because the E-Book Lensa Citra Sejarah is user-friendly, flexible, easily accessible, and can be used independently and repeatedly. The content supports face-to-face, blended, and self-

directed learning, and can be updated and adapted across History topics and other subjects. Flexible digital technology supports blended and student-centred learning (Garrison & Vaughan, 2008).

Innovation Description, Process and Implementation

E-Book Lensa Citra Sejarah was developed as an *Artificial Intelligence* (AI)-based innovation that transforms static infographics into interactive infographic videos using *ChatGPT, NotebookLM, Google Vids,* and *iSLCOLLECTIVE* for assessment.



Figure 1: Innovation Development Flow

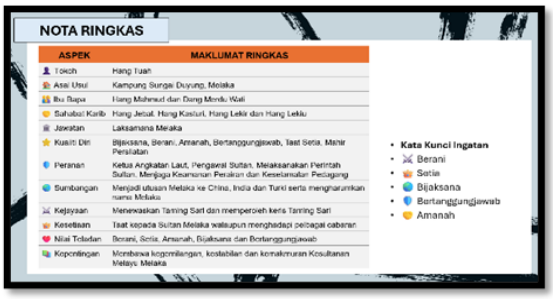
This innovation enables teachers to develop learning materials more quickly, easily, and efficiently, while enhancing pupils' engagement, understanding, and learning experiences. The integration of text, visuals, audio, animation, and narrative makes History teaching and learning more meaningful, engaging, and student centered. This innovation is grounded in the Cognitive Theory of Multimedia Learning, which emphasises that learning is more effective when appropriate words and visuals are combined (Mayer, 2009).

Innovation Prototype Description

E-Book Lensa Citra Sejarah is a digital pedagogical innovation that transforms static infographics into infographic videos. The development of the innovation is as follows:

Phase 1: Development of Concise Notes

The content of the Primary School Standard Curriculum (DSKP) and the Year 4 History textbook was analysed before key information was summarised into concise, accurate notes aligned with the learning standards.



Phase 2: Development of Static Infographics

The concise notes were transformed into visual infographics using text, icons, and graphics to facilitate pupils' understanding and retention of historical facts.



Phase 3: Production of Infographic Videos

The infographics were transformed into infographic videos using Google Vids, with support from ChatGPT for script development and NotebookLM for content organisation. The videos integrate text, animation, audio, and narrative to enhance learning interactivity.



Phase 4: Interactive Assessment

Assessment was conducted using iSLCollective by integrating interactive questions into the videos to continuously evaluate pupils' mastery and provide feedback for follow-up actions.



Figure 2: Innovation Prototype Implementation Flowchart

The innovation involved 104 Year 4 pupils and 62 History teachers using interactive multimodal materials. The field trial assessed pupils' enjoyment, understanding, engagement, interest, and appreciation, while teachers evaluated creativity, significance, efficiency, replicability, cost-effectiveness, and implementation potential. Qualitative interviews with pupils, teachers, and lecturers also yielded positive responses.



Figure 3: Innovation Implementation Trial among Pupils

Key Findings

The findings showed that values and appreciation recorded the highest score (8.28), followed by interest in History (8.05), enjoyment (7.55), engagement (7.39), and understanding (6.81), demonstrating the effectiveness of the E-Book Lensa Citra Sejarah in supporting History teaching and learning (Garrison & Vaughan, 2008).

Table 1: Analysis of Pupil Evaluation Constructs for E-Book Lensa Citra Sejarah

EVALUATION CONSTRUCT	AVERAGE SCORE	LEVEL
Values and Appreciation	8.28	High
Interest in History	8.05	High
Learning Enjoyment	7.55	High
Pupil Engagement	7.39	High
Understanding	6.81	High

The findings from teachers indicated a very high level (mean 4.81–4.85), with cost-effectiveness (4.85) and implementation potential (4.83) recording the highest scores, demonstrating that the innovation is creative, efficient, cost-effective, replicable, and has the potential to be expanded in teaching and learning (Garrison & Vaughan, 2008).

Table 2: Overall Analysis of Teacher Evaluation Constructs for E-Book Lensa Citra Sejarah

EVALUATION CONSTRUCT	MEAN SCORE	LEVEL
Creativity	4.82	Very High
Significance	4.82	Very High
Efficiency	4.81	Very High
Replicability	4.81	Very High
Cost-effectiveness	4.85	Very High
Implementation Potential	4.83	Very High

Impact

E-Book Lensa Citra Sejara**h** has a positive impact by making teaching and learning more engaging, interactive, and meaningful**,** thereby enhancing pupils' interest, enjoyment, engagement, understanding, and appreciation. The innovation empowers teachers through creative, systematic, and efficient teaching and learning practices, while saving time and reducing the cost of preparing learning materials. At the institutional and stakeholder levels, the innovation supports educational digitalisation, a culture of innovation, and quality teaching and learning**.** Its reusable, adaptable, and replicable nature makes it sustainable and provides strong potential for expansion across topics, subjects, and institutions (Mayer, 2021).

Recommendations for Classroom Practice

- Integrate e-books and multimedia to enhance pupils' interest and understanding.
- Promote student-centred learning through exploration and interactive quizzes.
- Provide flexible learning opportunities inside and outside the classroom.
- Adapt content according to pupils' learning levels, topics, and subjects.
- Develop creative, user-friendly, and cost-effective digital learning materials.

Other relevant information

The E-Book Lensa Citra Sejarah has strong dissemination and commercialisation potential due to its cost-effectiveness, accessibility, user-friendliness, and scalability. It can be adapted across topics, subjects, and institutions through digital platforms, PLC, workshops, and CPD programmes. Copyright was registered on 26 June 2026, and the innovation received the TIC 2026 Platinum Award. Its quality and potential were evaluated by four experts in pedagogy, curriculum, and primary History education.

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ID 118: CinePrompt AI for Guided Cinematic Prompt Creation in Student Digital Storytelling

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Highlights: CinePrompt AI is an AI-powered cinematic prompt engineering platform that helps students and novice creators transform simple ideas into structured prompts for AI-assisted media production. It guides character definition, scene composition, camera direction, lighting, mood, action sequencing and continuity while preserving human control. Practical feasibility was demonstrated by applying its prompts in external image- and video-generation tools to produce the Captain Hakim short video. The innovation supports prompt engineering, visual communication, narrative planning and responsible human-AI creative practice.

Keywords: Generative artificial intelligence; Cinematic prompting; Prompt engineering; AI-assisted video; Digital storytelling

Introduction

Generative artificial intelligence enables students to create images, videos and digital stories without advanced filmmaking or animation skills. Recent higher-education reviews emphasise creativity, critical thinking, learner autonomy and prompt literacy, while cautioning against overreliance (Qian, 2025). Prompt engineering is therefore increasingly treated as a teachable higher-education competency rather than an intuitive skill (Lee & Palmer, 2025). Generated-media quality nevertheless depends on how clearly users communicate their intentions. Non-experts may omit context or struggle to translate ideas into model-readable requirements (Zamfirescu-Pereira et al., 2023), while underspecified subject, style and visual details can produce repeated trial and error (Liu & Chilton, 2022).

CinePrompt AI was motivated by practical challenges observed during video-production activities in AI for Content Generation (SAIA 3583) within the Bachelor of Artificial Intelligence programme. Students could develop creative ideas but often struggled with detailed prompts, stable character appearance, camera direction, action sequencing and continuity across clips. Unintended outputs required repeated revision and regeneration, consuming generation credits, computational resources and production time. CinePrompt AI was therefore developed as a human-centred intermediary that structures creative intentions while leaving authorship, evaluation and final decisions with the user (Miao & Holmes, 2023).

Objectives

- To develop a functional CinePrompt AI prototype that transforms simple creative ideas into structured cinematic prompts.
- To guide users in including character, setting, action, camera direction, lighting, mood and continuity in their prompts.
- To demonstrate the operational use of CinePrompt AI prompts through an original multi-scene AI-assisted short video.

NALI Approach

Novelty

CinePrompt AI provides a domain-specific prompt orchestration environment that integrates cinematic planning with generative AI. Rather than merely lengthening a prompt, it organises creative intent into reusable character, scene, camera, lighting, mood and continuity specifications.

Creativity

Guided choices allow students to explore narrative, genre, composition and visual style while preserving human control. Recent evidence from student digital-content production highlights the importance of refining AI outputs and ensuring that students retain creative control throughout the process (Hwang & Lee, 2025). The design also supports current generative-AI literacy competencies involving prompt construction, critical evaluation, ethical awareness and informed interaction with AI systems (Reicho et al., 2026).

Innovativeness

The platform brings character profiles, scene organisation, storyboards, prompt templates, and camera and lighting settings into one guided environment. Its prompts can be transferred to different image and video generation tools. Students remain active directors who plan stories, refine prompts and evaluate whether generated outputs meet their intentions. This reflects recent findings that prompt literacy includes creating prompts, interpreting results and revising instructions to achieve intended multimodal outcomes (Hwang & Lee, 2025).

Applicability

The tool-independent workflow is suitable for classroom projects, educational media and beginner content production. It can be adapted for digital storytelling, multimedia, marketing and other visually oriented subjects. Reusable profiles, templates and presets support replication across classes and institutions without dependence on one media-generation provider.

Innovation Description, Process and Implementation

CinePrompt AI was developed using Design and Development Research (DDR), moving from analysis of students' prompting difficulties to design, development and formative testing (Richey & Klein, 2007). Software-engineering use cases supported the prototype design. The integrated framework (Figure 1) connects this process with a seven-stage production workflow: creative idea, cinematic planning, prompt orchestration, structured prompt, external media generation, review and refinement, and completed visual story.

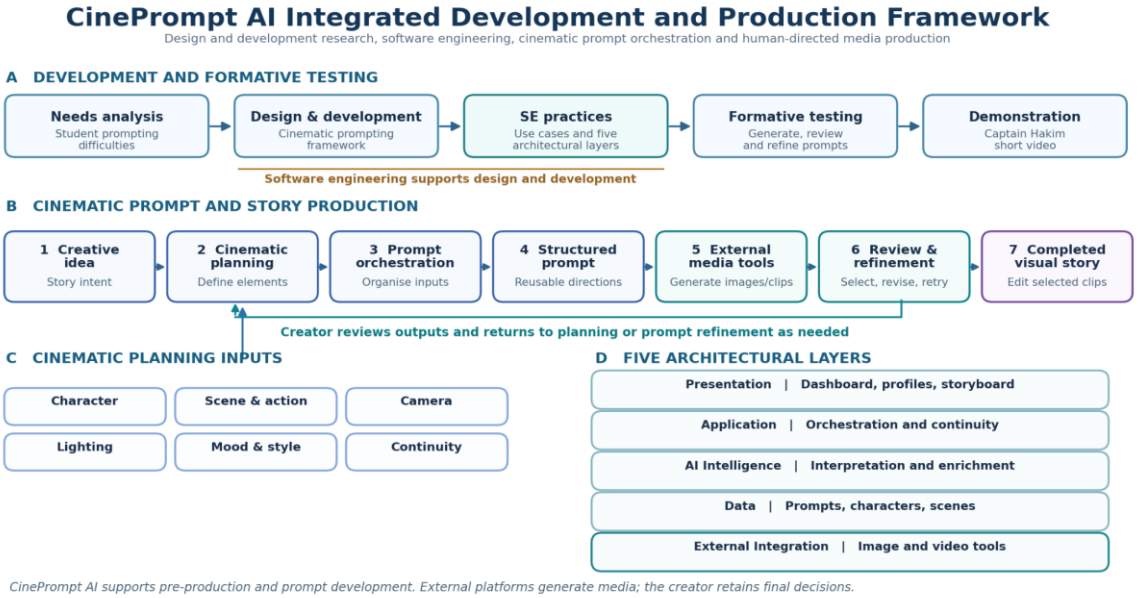


Figure 1: CinePrompt AI integrated development and production framework.

During cinematic planning, students define characters, scenes, actions, camera direction, lighting, mood and continuity. CinePrompt AI organizes these inputs into structured prompts for external image and video generation tools; it does not generate the media itself. Students review the resulting images and clips, revise prompts when outputs differ from their intentions, and edit selected clips into a story (Liu & Chilton, 2022; Hwang & Lee, 2025). The framework is supported by five layers: Presentation, Application, AI Intelligence, Data and External Integration and its practical use was demonstrated through the *Captain Hakim* short video.

Key Findings

The prototype transformed initial ideas into structured cinematic prompts containing production elements that beginners may omit. The prompts were transferred to external generative-media tools to produce images and individual video clips. This supports prior findings that prompting is not intuitive for non-experts (Zamfirescu-Pereira et al., 2023) and that structured subject and style descriptions can provide greater control over visual generation (Liu & Chilton, 2022; Wang et al., 2023).

Practical feasibility was demonstrated through Captain Hakim drama series. CinePrompt AI structured prompts for recurring characters, dialogue, domestic and action settings, camera treatments and multi-scene sequencing. External tools generated the visual assets; usable clips were selected, arranged and edited into a completed short video. The platform therefore supported pre-production and prompt development rather than directly generating the video. The case produced a tangible creative output consistent with emerging use of AI-generated short videos in creative ideation (Han et al., 2024).

External generators may still vary character appearance, object placement, movement, dialogue and timing despite detailed instructions. Mismatches may require regeneration and additional credits, resources and time. Current evidence supports artefact development, operational workflow and technical-creative feasibility, but not improved learning, usability, satisfaction or efficiency compared with direct prompting. These outcomes require subsequent student and expert evaluation. Figure 2 illustrates the main landing page for CinePrompt AI and Figure 3 is the example of Captain Hakim Series as the case study of the cinematic prompting CinePrompt AI original series.

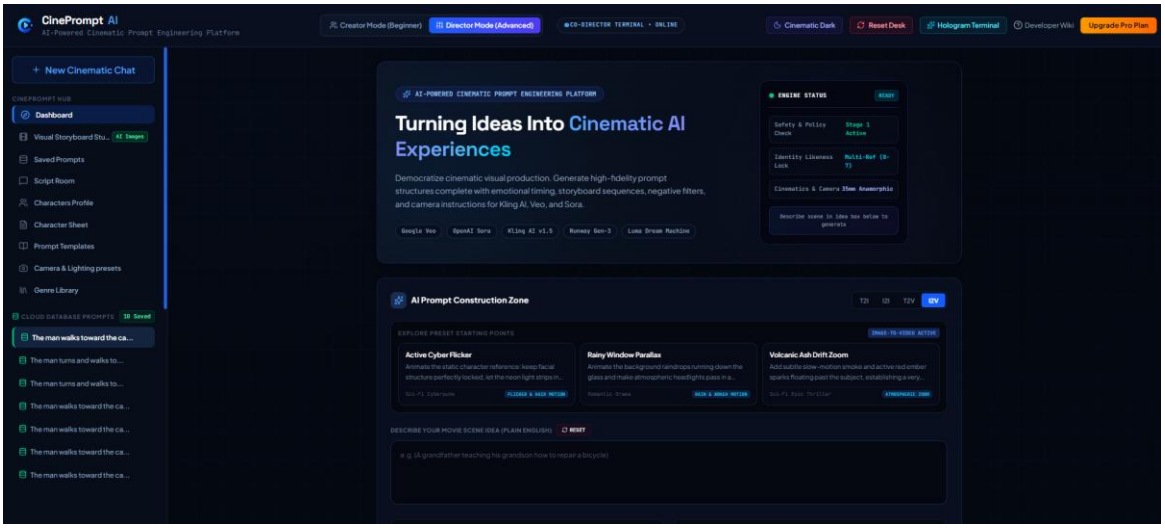


Figure 2: CinePrompt AI landing page



Figure 3: CinePrompt AI original series

Impact

CinePrompt AI demonstrates practical value by guiding students from creative ideas to structured prompts and critical evaluation of AI-generated outputs. It provides educators with a framework for

teaching prompt engineering and AI-assisted digital storytelling, consistent with current calls for structured and context-sensitive prompt curricula (Lee & Palmer, 2025). These anticipated benefits require formal student and educator evaluation, particularly because much generative AI literacy research remains conceptual rather than empirical (Reicho et al., 2026).

Recommendations for Classroom Practice

Educators may use CinePrompt AI in project-based activities where students develop a short story, define recurring characters, divide the narrative into scenes, construct cinematic prompts and apply them in external media generation tools. Students should compare intended and generated outcomes, document mismatches and refine their instructions. Assessment may consider prompt completeness, narrative coherence, character consistency, visual direction, critical evaluation and responsible AI use.

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ID 119: BeeHive: A Human-in-the-Loop AI Coach for Authentic Property-Management Learning

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Highlights: BeeHive is a working, mobile-first simulation and operations environment for authentic property-management learning. Built with Flutter, Riverpod and Supabase, it integrates property, tenant, lease, rent, maintenance, inspection, expense, document and reporting workflows with Groq language intelligence and Gemini receipt vision. Its signature pattern is 'AI suggests that you decide': learners inspect drafts, evidence and forms before confirming actions. All 32 executable automated tests pass; a 319-item acceptance checklist defines broader pilot coverage.

Keywords: Human-in-the-loop AI; Authentic learning; Property management; Workforce learning; Mobile simulation

Introduction

Property management is learned by coordinating many consequential tasks: interpreting leases, tracking rent, documenting inspections, triaging repairs, communicating with tenants and producing accountable reports. Novices often encounter these activities as disconnected documents or explanations, whereas practice requires decisions across a complete case. Generative AI can accelerate drafting and pattern recognition, but uncritical automation risks hiding the professional reasoning that learners need to develop (UNESCO, 2023).

BeeHive addresses this gap as a functional, role-based learning environment embedded in an operational property-management platform. Learners work with authentic records and workflows while AI scaffolds, rather than owns, the decision. The product's own settings state the pedagogical contract clearly: AI suggests the best vendor; actions require user confirmation; 'AI suggests that you decide.' This aligns with NALI's Human-AI Synergy in Pedagogy theme by pairing computational assistance with human judgement, accountability and reflection.

Objectives

- Provide an integrated environment for learning Malaysian property-management workflows through authentic, role-based cases.
- Use AI to scaffold drafting, extraction, triage and reporting while preserving learner review, editing and confirmation.
- Make professional decisions traceable through forms, records, permissions, notifications and audit-ready data.
- Verify the prototype and establish a pilot protocol for measuring task accuracy, critical review, efficiency and confidence.

NALI Approach

Novelty

BeeHive combines a broad operational platform with an explicit human-in-the-loop learning pattern. Instead of offering a standalone chatbot or static training exercise, it places AI inside real workflows: a learner can ask for help, receive a draft or prefilled form, inspect the underlying case, edit the proposal and confirm the final action. The decision boundary is therefore visible and teachable.

Creativity

Two role-based experiences—agent/manager and tenant—turn one application into a living case environment. Rent receipts, repair requests, lease events and inspection evidence become prompts for inquiry. The interaction design uses previews, open form transitions and confirmation gates so that speed does not erase reflection. Learners see how one decision changes downstream records and stakeholder communication.

Innovativeness
Groq-powered chat, function calling, triage and report generation are orchestrated with Gemini 2.5 Flash receipt-image extraction and a secure Supabase data layer. The improvement is not simply more automation: AI outputs are routed into reviewable domain forms and only become authoritative records after human confirmation. This pattern supports AI literacy, error detection and professional accountability.

Applicability
BeeHive fits NALI categories for AI-enhanced teaching and learning and lifelong learning. It can support property-management modules, real-estate microcredentials, onboarding for junior agents and scenario-based professional development. Educators can seed a portfolio, assign roles, introduce incidents and assess both the final action and the learner's justification. Its mobile-first design also supports learning at the point of work.

Innovation Description, Process and Implementation

The production-oriented prototype uses Flutter 3.29.3 and Dart with Riverpod state management and GoRouter navigation. More than 25 feature modules cover dashboards, properties, tenants, leases and contracts, rent, maintenance and vendors, inspections, expenses, utilities, commissions, documents, reports, agencies, subscriptions, notifications and the Bez assistant. Groq's Llama 3.3 70B supports conversation, function calling, triage and reports; Gemini 2.5 Flash performs receipt-image extraction. Supabase provides authentication, PostgreSQL, Realtime and Storage with Row Level Security. The learning sequence begins with an authentic case, moves through an AI scaffold and learner review, then requires an editable, confirmed action whose record supports audit and reflection.

Key Findings

The executable Flutter test suite contains 32 tests, and all passed in the current repository verification. The broader user-acceptance document defines 319 checks across 16 sprints, establishing comprehensive intended coverage; because its result fields are not completed, it is treated as a pilot checklist rather than evidence of 319 passed tests. The prototype is therefore technically substantive and ready for structured evaluation, but the project documentation correctly states that real-user learning outcomes have not yet been measured.

Impact

BeeHive can shorten the distance between instruction and accountable performance. Learners practise interpreting evidence, detecting AI errors, communicating decisions and understanding how actions propagate across a portfolio. Anticipated outcomes are improved task accuracy, better critical review of AI suggestions, faster completion without loss of quality and stronger confidence in multi-step workflows. A small pilot should use matched scenarios before and after guided practice, a rubric for justification and error detection, task-completion time, confirmation/edit logs and learner interviews. These measures should be reported separately from software-test results so educational impact remains credible and auditable.

Recommendations for Classroom Practice

Teach with cases, not feature tours. Give learners a property portfolio and a role; introduce a late payment, damaged fixture, ambiguous receipt or lease event; ask for an unaided decision; then allow Bez to scaffold. Require learners to identify what the AI used, what may be missing and why they accepted or changed the proposal. Debrief the audit trail and stakeholder consequences. Begin with low-risk synthetic data, make confirmation gates mandatory, and assess professional reasoning alongside accuracy and speed. Pilot with a small cohort before live workplace deployment.

Other relevant information

The architecture supports scalable cloud delivery and role-based access. Before external deployment, the team should complete the 319-item acceptance checklist, resolve the current low-severity static-analysis warning, conduct privacy and security review, and test with 3–5 property agents or trainees using consented, non-sensitive cases.

Table 1: BeeHive implementation evidence and planned learning-impact evaluation.

EVIDENCE	SCOPE	RESULT	INTERPRETATION	STATUS
Working product	Flutter app	25+ modules	Supports end-to-end cases	Built
Automated tests	32 tests	32 passed	Verifies executable behaviours	Complete
Acceptance plan	16 sprints	319 checks	Defines broad manual coverage	Pending
Human control	AI actions	Preview/edit/confirm	Preserves learner authority	Built
Data safeguards	Supabase	Auth + RLS	Supports role-aware practice	Built
Learning impact	Pilot cohort	Pre/post rubric	Tests critical review and performance	Next gate

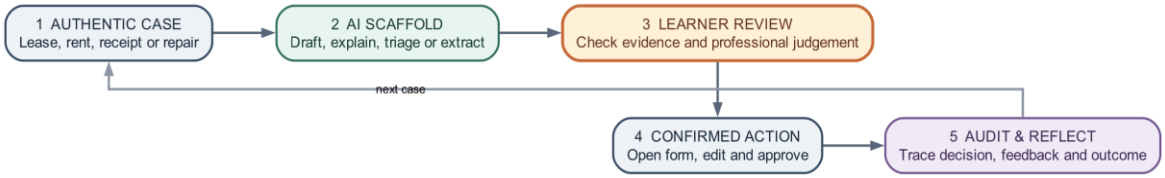


Figure 1: BeeHive's human-in-the-loop pattern converts AI assistance into reviewable professional learning.

Acknowledgement

The team acknowledges Dr. Farkhana Binti Muchtar for academic and innovation guidance and Universiti Teknologi Malaysia for the learning and development environment. This work was supported by the Ministry of Higher Education (MOHE), Malaysia, through the Fundamental Research Grant Scheme (FRGS) under Grant No. PY/2025/02305.

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ID 122: Empowering Grassroots Football Development Among Orang Asli Children

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Highlights: This project introduces a structured grassroots football development model for Orang Asli children at SK Ladang Pendas, addressing limited access to systematic sports training and talent development. In collaboration with EQ RICH Football Club, the Sports Innovation & Technology Centre, and SK Ladang Pendas, the programme integrates basic football skills, structured physical conditioning, certified coaching, and progressive performance monitoring. Its key innovation lies in combining skills development with structured fitness assessment to support evidence-based team formation, systematic talent identification, and more inclusive pathways for nurturing potential football talent within the Orang Asli community.

Keywords: Grassroots Football Development; Orang Asli Children; Structured Physical Training

Introduction

Sport participation plays an important role in promoting young people's physical health, psychological well-being, social development, and teamwork (Bengtsson et al., 2025). However, Indigenous communities may experience unequal access to organised sport, quality coaching, and development opportunities, limiting their ability to realise these benefits (Mansell et al., 2024). At SK Ladang Pendas, this project responds to the reported low participation of Orang Asli pupils in school sports and limited exposure to systematic football development. Recent Malaysian evidence similarly indicates that Indigenous youth football players require greater attention to endurance, sprint performance, decision-making, and skill execution (Sulong et al., 2024). The proposed innovation moves beyond a conventional football clinic by integrating structured physical conditioning, fundamental and technical football training, professional coaching, strategic partnerships, and progressive performance monitoring within a single grassroots development model. Monitoring is important in youth sport because physical development and responses to training vary across adolescence (Dudley et al., 2023), while contemporary talent-development research emphasises tracking individual development over time rather than relying on isolated assessments (Verbeek et al., 2025). This inclusive model aims to improve participation, develop football competencies, identify emerging talent, and establish a systematic pathway for sustainable Orang Asli grassroots football development.

Objectives

- To enhance the interest and motivation of Orang Asli children to participate in sports and recreational activities.
- To provide Orang Asli students with exposure to strategic partners that can offer opportunities for football skill development and talent progression.
- To enhance structured physical training competencies among Orang Asli students at SK Ladang Pendas through the development of fundamental football skills.

NALI Approach

Novelty

The novelty of this innovation lies in its integrated, community-based grassroots football development model specifically designed for Orang Asli students, rather than delivering a conventional one-off football clinic. The programme combines structured football skill training, fitness development, two dedicated training modules, progressive monitoring, and a mentor–mentee approach within a sustained development pathway. A distinctive feature is the 12-month post-programme monitoring process, which tracks participants' continued training, fitness progress, skill application, leadership development, and ability to train independently.

Unlike conventional school-based sports activities that depend largely on teachers or external coaches, this model gradually develops selected students into peer mentors who are able to guide junior players, correct technical errors, organise training, and transfer knowledge to others. The monitoring report shows that four participants developed mentoring roles, while others progressed to external competitive pathways, including selection for EQ Rich Football Club and national-level Orang Asli school sports competition.

Therefore, the innovation is distinctive in transforming participants from training recipients into independent players, peer coaches, and community knowledge transmitters. This creates a more sustainable, scalable, and inclusive football development ecosystem for Orang Asli communities while linking school-based participation with structured talent identification and higher-level sporting opportunities.

Creativity

The creativity of this innovation is reflected in how the programme was designed to move beyond conventional coach-centred football training. Instead of relying solely on repeated technical drills, the project combines structured skill training, fitness development, modular learning, peer mentoring, self-directed practice, and long-term monitoring within one community-based development model. Participants initially used dedicated football and fitness modules, but were progressively encouraged to plan training schedules, regulate practice frequency, apply the FITT principle, and eventually conduct activities with less dependence on teachers.

Another creative element is the transformation of selected participants into peer mentors and knowledge-sharing agents. Students were not only trained as players but were also encouraged to teach junior pupils, correct technical errors, guide teammates, and share football knowledge with other communities. The report recorded four participants developing into mentors, with participants increasingly able to conduct training independently.

The programme also creatively integrates talent development with community empowerment. Rather than ending after the initial intervention, six monitoring sessions were conducted over 12 months to observe skill progression, fitness improvement, leadership, motivation, and continuity of participation. This approach creates a developmental cycle of learn–practise–mentor–share–progress, enabling participants to become active contributors to the sustainability of grassroots football within the Orang Asli community.

Innovativeness

The innovativeness of this project lies primarily in its pedagogical and developmental approach, rather than in the use of digital technology. The programme improves conventional grassroots football training by integrating structured football skills, physical fitness development, guided training modules, progressive performance monitoring, peer mentoring, and self-directed learning into a continuous development process for Orang Asli students. Participants initially learned through structured modules and teacher or coach facilitation, but gradually progressed towards planning their own training schedules, applying appropriate training frequency, and performing exercises independently.

A particularly innovative feature is the shift from a coach-centred model to a learner-led and peer-assisted learning approach. Students were encouraged not only to master football skills, but also to explain techniques, identify errors, guide teammates, and mentor junior players. The report shows that several participants were able to conduct training without direct teacher guidance, while four students developed into mentors for the school team.

The programme also incorporates longitudinal learning through six monitoring sessions over 12 months, enabling continuous observation of skill development, fitness progression, motivation, leadership, and knowledge transfer. This transforms football training into a sustainable learning ecosystem where students progress from learners to independent practitioners and peer mentors, thereby enhancing both learning outcomes and community-based talent development.

Applicability

This innovation has strong potential for adaptation, replication, scalability, and long-term sustainability across different educational and community settings. Its structured football and fitness modules, progressive monitoring, and mentor–mentee approach can be adapted for different age groups, schools, and levels of sporting ability.

The model is also replicable because participants were able to continue training independently, guide peers, and mentor junior players after the initial programme. The development of four student mentors

further demonstrates the effectiveness of a train-the-trainer approach, allowing knowledge and skills to be transferred to new groups and communities.

Its sustainability is supported by reusable training modules, peer leadership, continued community participation, and a 12-month monitoring process. These features reduce dependence on continuous external coaching and provide a practical foundation for extending the programme to other Orang Asli schools and underserved communities with appropriate contextual adaptation.

Innovation Description, Process and Implementation

The teaching and learning process can therefore be represented as:

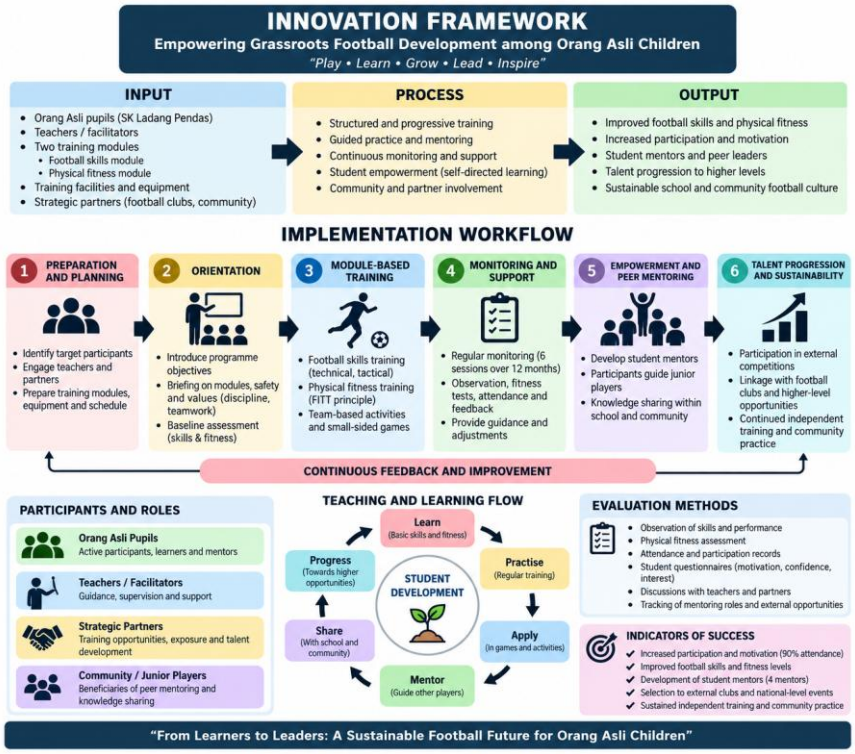


Figure 1: The description, process and implementation diagrams

Key Findings

The key findings be represented as:



Figure 2: The key findings of the project

Impact

The innovation generated significant impact across students, educators, the school, and the wider community. For Orang Asli students, it enhanced participation, physical fitness, confidence, independent learning, leadership, and access to higher-level football opportunities. Teachers benefited from structured training modules that supported more systematic coaching and reduced dependence on teacher-led instruction as students became increasingly self-directed. At the institutional level, the project strengthened school-based talent development, peer mentoring, and links with external football organisations. Its long-term contribution lies in creating a sustainable grassroots football ecosystem through continuous training, student mentoring, knowledge transfer, and progression pathways that extend benefits beyond the original participants to junior players and the wider community.

Recommendations for Classroom Practice

Educators can integrate this innovation by adopting a structured, progressive, and learner-centred approach that moves students from guided learning towards independent practice and peer mentoring. Based on the implementation and monitoring evidence, the following practices are recommended:

- Use structured learning modules with clear skill progression, practical activities, and achievable performance targets.
- Begin with teacher-guided instruction, then gradually transfer responsibility to students through self-directed practice and peer-assisted learning.
- Incorporate regular monitoring and formative assessment to track skill development, participation, confidence, and learner progress.
- Develop capable students as peer mentors to reinforce learning, support junior learners, and promote knowledge sharing.
- Adapt activities, training intensity, and learning tasks according to learners' ability, age, and context to ensure inclusivity.
- Strengthen sustainability through continuous practice, reusable modules, student leadership, and collaboration with external partners.

The model can also be adapted beyond physical education by applying the same cycle of learn, practise, monitor, mentor, and progress to other practical or skills-based subjects.

Other relevant information

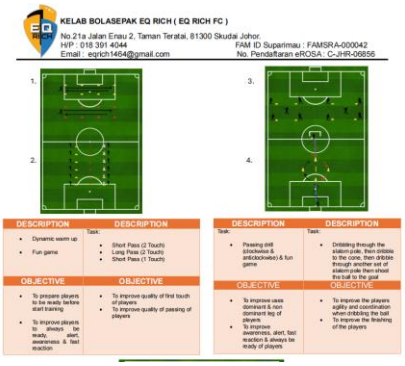
Based on the implementation of this project, several achievements were attained and distinctive features of the project were identified, as presented in Table 1.

Table 1: The achievements and contributions of the project

DETAILS	ACHIEVEMENT
Intelectual Properties (IP)	IP/CR/08634: Instrumen Soal Selidik : Klinik Pengenalan Bola Sepak Akar Umbi Anak Orang Asli IP/CR/08638: Instrumen Soal Selidik : Latihan Bola Sepak Akar Umbi Anak Orang Asli
Publication: News	
Star Rating	Pemerkasaan Akar Umbi Bola Sepak Anak Orang Asli STAR 3 : PS/2024/00141 STAR 5 : PS/2025/00140
Others	FYP 2025: Keberkesanaan Modul Latihan Fizikal Berstruktur Kepada Pembangunan Bola Sepak Akar Umbi Anak Orang Asli Di SK Ladang Pendas Structured Physical Training Module

DETAILS	ACHIEVEMENT

Module 1:

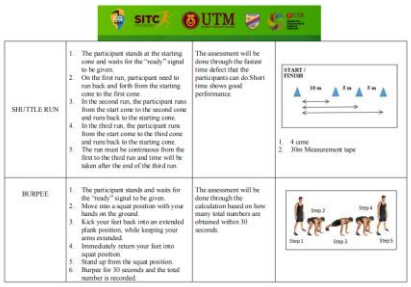


Module 2:

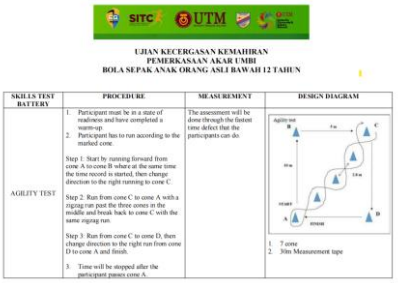


Structured Fitness Test Module

Module 1:



Module 2:



Acknowledgement

The authors gratefully acknowledge the Centre for Community and Industry Network (CCIN), Universiti Teknologi Malaysia (UTM) for funding this project through the KTP@FAKULTI grant. Appreciation is also extended to SK Ladang Pendas, Eq Rich Football Club, and the Sports Innovation & Technology Centre for their valuable support and collaboration throughout the implementation of the project.

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ID 123: Students' Perception of Structured GenAI Feedback in Enhancing Legal Problem-Solving

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Highlights: This innovation uses structured GenAI feedback to help non-law undergraduate students review their own legal problem-solving. The activity was implemented with 10 Bachelor of Management students in Commercial Law, who used a guided prompt to obtain focused feedback, particularly on how relevant legal rules were applied to facts. The findings indicate that structured GenAI feedback helped students identify weaknesses in their legal analysis and identify specific changes they would make when solving similar legal problems in future. Students remained actively engaged in reviewing the feedback and responsible for deciding whether it was accurate and relevant to their own analysis.

Keywords: Generative AI; Legal problem-solving; GenAI feedback; Non-law students; Commercial law

Introduction

Legal problem-solving is an important component of learning law because students are expected not only to understand legal rules, but also to identify relevant issues, select and apply appropriate rules to the facts, and reach a conclusion. This is particularly important for non-law students in business and management programmes, who need to use legal knowledge when analysing practical business situations. However, non-law students may experience difficulties when learning law-related subjects due to unfamiliarity with legal terminology and interpretation that may hinder their ability to understand and apply the law to legal issues or situations (Harith et al., 2024).

The identification of the Issue, Rule, Application and Conclusion (IRAC) is commonly used to provide a structured approach to legal problem-solving. However, business students may still experience difficulty in using IRAC effectively, particularly at the application stage of legal problem-solving (Kraal & Coleman, 2019). In this respect, generative artificial intelligence (GenAI) offers potential support for legal learning and legal problem-solving. In legal education, ChatGPT has been shown to support student learning and improve overall performance, although its benefits appear stronger for foundational understanding than for the higher-order reasoning required in advanced legal analysis (Kanapathy & Shamini, 2026).

However, the use of GenAI in legal problem-solving may lead students to rely on AI-generated legal responses without sufficiently evaluating their accuracy or fully engaging in the legal problem-solving process themselves. For example, some law students incorporated inaccurate or fabricated AI-generated information into their assignments despite being instructed to verify the outputs (Alimardani, 2025). These concerns highlight a need to use GenAI in a way that supports students' learning without allowing it to become a substitute for their own legal analysis.

In this respect, feedback provides one way of using GenAI more constructively. It can help students make judgements about their own work and use the information received to improve it (Carless & Boud, 2018). AI-generated feedback, however, needs to be considered critically because it may contain inaccurate or inappropriate suggestions, particularly in legal contexts.

Accordingly, the present innovation introduces structured GenAI feedback for IRAC legal problem-solving whereby students first complete their legal problem-solving response using IRAC before GenAI is introduced. A guided prompt is then used to structure the GenAI feedback by directing it to identify possible weaknesses in the student's response, particularly in the application component, without generating the legal analysis for the student. The innovation therefore uses GenAI as a feedback tool to help students examine weaknesses in their legal problem-solving and support a more thoughtful approach to similar legal problems.

Objectives

To enhance students' legal problem-solving through structured GenAI feedback on their IRAC analysis, with emphasis on applying relevant legal rules to facts.

NALI Approach

Novelty

The novelty of the approach is the structured use of GenAI as a feedback tool after students have completed their own IRAC analysis. Unlike open-ended use of GenAI to generate or complete a legal answer, a guided prompt limits GenAI to identifying weaknesses in students' analysis, particularly in the Application component, without rewriting the answer or providing a model response.

Creativity

The creativity of the approach is reflected in the use of a guided prompt that transform general GenAI interaction into a structured, response-specific feedback activity for IRAC legal problem-solving. The prompt keeps the feedback focused, particularly on the Application component, while allowing GenAI to respond to weaknesses in each student's completed analysis without generating the legal answer.

Innovativeness

The innovative aspect of the approach is the integration of structured GenAI feedback into the existing IRAC problem-solving process after students have completed their own legal analysis. This introduces a focused feedback stage that allows students to review weaknesses in their analysis, particularly the application of relevant legal rules to facts, without GenAI performing the legal analysis for them.

Applicability

The structured GenAI feedback method can be adapted across law subjects that use scenario-based problem-solving by modifying the guided prompt to suit the legal topic, learning outcome or area of analysis. It can be replicated by other lecturers using the same feedback structure and does not require specialised software or a specific GenAI platform. The method also has potential for use in larger classes and across face-to-face, blended and online learning environments. For long-term use, the guided prompt can be reused, refined and updated across topics and semesters as learning needs, legal content and GenAI tools change.

Innovation Description, Process and Implementation

The innovation is a structured GenAI feedback method to help students review their own legal problem-solving. A guided prompt directs GenAI to identify weaknesses in students completed IRAC analyses, particularly in applying relevant legal rules to facts, without rewriting the answer or providing a model response. In its implementation, the lecturer provides a scenario-based legal problem and asks students to complete their own IRAC analysis independently. Students then use the guided prompt to obtain GenAI feedback, evaluate the feedback and consider how their legal analysis could be improved. The activity was implemented with 10 Bachelor of Management students in Commercial Law, who used a guided prompt to obtain focused feedback. Students then completed a written reflection on the weakness identified, whether they agreed with the feedback, its usefulness in reviewing their answer, and what they would do differently when answering a similar legal problem in future. The reflections were analysed thematically to identify common patterns in students' responses.

Key Findings

The analysis identified five main themes, as summarised in Table 1.

Table 1: Summary of students' reflections on structured GenAI feedback

THEME	MAIN FINDING
Application of legal rules to facts	Students recognised weaknesses in connecting legal rules to specific facts.
Broader weaknesses in legal analysis	Students identified other weaknesses involving legal rules, case authority, IRAC structure and conclusions.
Usefulness of GenAI feedback for self-review	Feedback helped students notice weaknesses they had not identified on their own.
Student judgement of GenAI feedback	Students generally accepted the feedback, although some feedback was questioned and checked.
Future approaches to legal problem-solving	Students identified more careful approaches they intended to use in future legal problems.

Students' reflections showed that the structured GenAI feedback helped them recognise weaknesses in their legal problem-solving responses that they had not fully noticed when completing the original task.

All students identified weaknesses in the application component of IRAC, particularly in explaining how the relevant legal rules applied to the specific facts. As S6 reflected, "*I should not only state the legal rule but also clearly connect the rule to the specific facts of the case*." Several students also identified broader weaknesses in their legal analysis, including incomplete or inaccurate legal rules, missing case authority, unclear IRAC structure and premature conclusions. S9, for example, reflected, "*Before I received the feedback, I thought that the correct conclusion meant my answer was already completed*." These findings suggest that the feedback helped students look beyond whether their final answer was correct and pay closer attention to how their legal analysis was developed.

The reflections further indicated that students regarded the GenAI feedback as useful in reviewing their own answers. Students described the feedback as helping them notice weaknesses that they had not identified on their own. S2 described it as "*a diagnostic tool and a guide instead of just providing a direct model answer*." This suggests that the value of the feedback was not simply in providing another answer, but in directing students' attention to areas of their own analysis that required further consideration.

Most students also agreed with the feedback because it reflected weaknesses they could recognise in their responses. One student (S1), however, questioned part of the feedback and emphasised the need to verify it against relevant legislation and cases, stating that "*GenAI feedback should not be accepted without further checking*." Although this was a single contrasting response, it provides an example of critical engagement with GenAI feedback rather than automatic acceptance.

In addition, students reflected on how they would approach similar legal problems differently in future. Common responses included applying legal rules more closely to facts, making better use of legislation and cases, organising their IRAC analysis more clearly and reviewing their answers more carefully before reaching a conclusion. As S7 stated, "*I would also make sure that every major legal rule I mention is actually connected to the facts*." These intended changes closely reflected the weaknesses students had identified in their original answers, suggesting that the feedback helped them think more carefully about how to improve their future legal problem-solving.

The findings suggest that structured GenAI feedback helped students identify weaknesses in their legal analysis and identify specific changes in legal problem-solving, particularly in applying relevant legal rules to facts. Students remained actively engaged in reviewing the feedback and responsible for deciding whether it was accurate and relevant to their own analysis.

Impact

The innovation supports students to become more reflective and responsible legal problem-solvers by using GenAI to review weaknesses in their own IRAC analysis rather than generate a complete answer. It also encourages students to evaluate the relevance and accuracy of GenAI feedback while retaining responsibility for their legal analysis. For lecturers, the approach provides a practical way to integrate GenAI into existing IRAC-based activities and may help identify common areas of difficulty that require further attention in teaching. At the institutional level, it offers a practical model for responsible and student-centred use of GenAI in teaching and learning. With continued use, the approach may support more consistent self-review and responsible use of GenAI in students' learning.

Recommendations for Classroom Practice

Lecturers can integrate structured GenAI feedback after students have completed an IRAC-based legal problem independently. The guided prompt should direct GenAI to identify weaknesses in students' analysis, particularly in applying relevant legal rules to facts, without rewriting the answer or providing a model response. The prompt can be adjusted to focus on other IRAC components according to students' learning needs. Students should also be reminded that GenAI feedback may not always be accurate and should verify relevant legal principles, legislation and cases before using the feedback to refine their analysis. Lecturers should review and refine the prompt periodically to ensure that it remains relevant to students' needs, legal content and changes in GenAI tools.

Other relevant information

The structured GenAI feedback materials, including the guided prompt and teaching guide, have potential to be registered for copyright protection.

Acknowledgement

The authors also acknowledge the Faculty of Management, Universiti Teknologi Malaysia, for its support.

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ID 124: AgroThink: Human-AI Scaffolding for Accessible, Personalised Smart-Farming Learning

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Highlights: AgroThink turns a farmer's phone into a contextual learning companion for household and beginner farming. Its Flutter application combines conversational guidance, image-based crop-disease diagnosis, location-aware planting guides, generated task schedules, crop-health assessment and a government-information hub. Rather than replacing judgement, the design scaffolds an Observe–Ask–Decide–Act–Reflect cycle. Project verification reports 98 of 98 functional tests passed. The current evidence supports implementation readiness; a structured field pilot will establish learning and practice outcomes.

Keywords: Human-AI learning; Smart farming; Mobile microlearning; Crop disease; Lifelong learning

Introduction

Household and smallholder farmers learn through repeated decisions made under uncertain conditions: recognising disease, selecting a treatment, timing farm work and responding to weather. The cost of delayed or poorly informed action is high; plant pests are estimated to destroy up to 40% of global crops annually (Food and Agriculture Organization of the United Nations [FAO], 2021). Project survey data also indicate persistent guidance and access gaps: 81.5% of respondents described beginner guidance as partly insufficient or very challenging, 61.7% reported late disease discovery, and more than 80% struggled to obtain expert advice.

AgroThink responds to this educational problem, not only as an agricultural utility but as an in-workflow AI mentor. It brings explanation, diagnosis, planning and reflection into the moment when a user must learn and act. This positioning aligns with NALI's Human-AI Synergy in Pedagogy theme: AI contributes speed, pattern recognition and contextual retrieval, while the farmer retains responsibility for observation, interpretation and final action.

Objectives

- Provide accessible, 24-hour, crop- and location-aware learning support for beginner and household farmers.
- Scaffold evidence-informed decisions through diagnosis, explanations, planting guidance, weather context and treatment options.
- Connect guidance to action through generated schedules, reminders and crop-health reflection instead of isolated answers.
- Verify functional readiness and define an ethical field-pilot plan for measuring learning, confidence and farming practice.

NALI Approach

Novelty

AgroThink unifies six learning supports that are usually fragmented across specialist applications: AGROX conversational guidance, camera-based disease analysis, personalised planting guides, generated task schedules, crop-health scoring and a trusted public-information hub. Its novelty is the continuity from a learner's observation to an explainable recommendation, a human decision, a scheduled action and later reflection.

Creativity

The smartphone becomes a portable field studio. A photograph initiates visual inquiry; GPS and crop type localise the lesson; weather turns an abstract forecast into a risk discussion; and the calendar converts

guidance into spaced practice. The Observe–Ask–Decide–Act–Reflect loop makes the human role visible, helping users question outputs instead of treating AI as an unquestionable authority.

Innovativeness
Existing one-function tools commonly stop at identification or generic advice. AgroThink improves the learning journey by orchestrating Gemini-powered dialogue and image analysis with OpenWeather and geolocation context, then connecting recommendations to tasks and crop-health follow-up. The system therefore shifts AI from an answer engine to a scaffold for situated, longitudinal learning.

Applicability
The innovation supports NALI categories for AI-enhanced teaching and learning, inclusive digital education and lifelong learning. Its mobile-first interface can be used independently, in agricultural-extension workshops, or in community and vocational programmes. Multimodal interaction lowers the barrier for users who find long technical manuals difficult, while facilitators can use the task history and health checks as prompts for feedback and reflection.

Innovation Description, Process and Implementation

Development combined structured planning with iterative sprints. Needs analysis informed 31 use cases across eight subsystems. The Flutter presentation layer uses Provider for state management; service orchestration connects Supabase authentication, database and storage with Firebase-hosted news, Gemini 2.0 Flash, OpenWeather, GPS and geocoding. A learner supplies a question, image, crop and/or location; the application produces an explanation and possible next step; the learner reviews the evidence and chooses the action; tasks and crop-health checks then support practice and reflection. Functional, integration and user-acceptance activities were defined against the documented requirements. The design deliberately keeps treatment and farming decisions with the user and recommends expert escalation when confidence or risk warrants it.

Key Findings

The reported needs evidence supports the relevance of camera-assisted diagnosis and immediately available guidance; 83% of surveyed respondents reacted positively to camera-based disease detection. Implementation evidence shows that all 98 documented functional test cases passed, covering the application's eight subsystems. These results establish feature completeness and technical readiness within the development environment. They do not yet establish causal gains in farming knowledge, behaviour or yield. A field pilot is therefore the next evidence gate.

Impact

AgroThink's immediate contribution is equitable access to just-in-time explanations and structured practice for people who may not have continuous access to an extension officer. The anticipated learner outcomes are faster recognition of crop problems, better reasoning about treatment and timing, improved task completion and stronger confidence without over-reliance on AI. A pilot should compare pre/post scenario accuracy, quality of justification, time to an appropriate action, adherence to planned tasks and delayed retention. Facilitator rubrics and system logs can triangulate learning with user interviews; agronomic outcomes should be treated as longer-term indicators, not assumed from software tests.

Recommendations for Classroom Practice

Use AgroThink in short problem-based cycles. Begin with a real or photographed crop case; ask learners to record their initial diagnosis; use AGROX and the disease module to compare evidence; require the learner to justify the selected action; then revisit the crop-health score and task record. In facilitated settings, instructors should model verification with agricultural sources, discuss uncertainty and unsafe recommendations, and assess reasoning rather than mere completion. Provide a non-AI alternative and explicit escalation route. Start with a small pilot, review error cases with an agricultural expert, then widen deployment only after the learning and safety indicators meet predefined thresholds.

Other relevant information

The system is designed for Android mobile use and cloud-backed scaling. Privacy, image quality, connectivity and model uncertainty remain deployment considerations. Future releases should add

multilingual support, offline learning packets, confidence cues and facilitator dashboards while preserving informed consent and human oversight.

Table 1: AgroThink evidence base and the boundary between completed verification and planned impact evaluation.

EVIDENCE	SCOPE	RESULT	INTERPRETATION	STATUS
Needs survey	200+ farmers	81.5% guidance gap	Confirms learning-support need	Reported
Needs survey	200+ farmers	61.7% late detection	Prioritises visual diagnosis	Reported
Preference	Survey respondents	83% positive	Supports camera-based interaction	Reported
Requirements	8 subsystems	31 use cases	Defines breadth and traceability	Complete
Functional test	98 cases	98 passed	Verifies implementation behaviour	Complete
Field learning	Pilot cohort	Pre/post measures	Tests knowledge and practice impact	Next gate

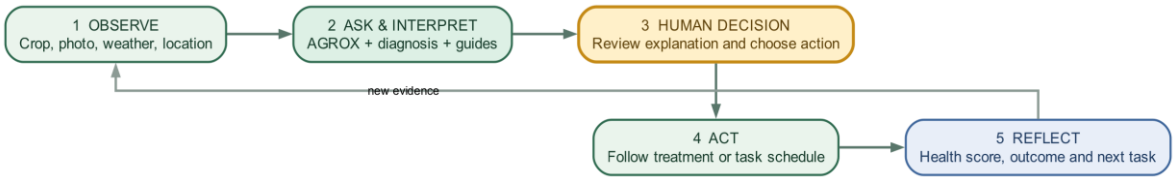


Figure 1: Human-AI learning sequence: the system scaffolds interpretation while the learner decides and acts.

Acknowledgement

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ID 125: Transforming Mathematical Engineering Education: Physics-Informed Neural Networks as a New Pedagogical Paradigm

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Highlights: Physics-Informed Neural Networks (PINNs) offer a transformative innovation for Mathematical Engineering education, embedding governing physical laws directly into neural-network architectures so students can tackle complex, real-world problems that classical analytical methods struggle to resolve. This addresses the gap between lecture-based instruction and industry's demand for AI-competent engineers. Implemented across a Human-AI synergy framework, the innovation pairs PINN training with project-based learning, hybrid analytical-PINN assessment, and explainability modules, positioning AI as a collaborative learning partner rather than a replacement for human instruction. Reported deployments show large gains in computational modeling competency, critical analysis, and student engagement, directly advancing NALI 2026's theme of Human-AI Synergy in Pedagogy.

Keywords: Physics-Informed Neural Networks; AI-Enhanced Engineering Education; Pedagogical Innovation; Mathematical Engineering; Active Learning

Introduction

The New Academia Learning Innovation (NALI) 2026 framework calls for AI to complement rather than replace human teaching expertise. Traditional Mathematical Engineering education has long relied on lecture-based analytical methods, leaving a gap between academic preparation and industry's evolving AI-driven demands (ABET, 2023; NSF Report, 2022). This innovation addresses that gap through Physics-Informed Neural Networks (PINNs), which merge deep learning with governing physical laws to change how engineering students engage with complex mathematical concepts.

PINNs encode physical constraints — expressed as partial differential equations, integral equations, or variational principles — directly into neural-network architectures, enabling students to tackle high-dimensional, nonlinear problems that challenge classical analytical approaches (Raissi et al., 2019; Karniadakis et al., 2021, Fan & Chen, 2026). This aligns with NALI 2026's theme of "Human-AI Synergy in Pedagogy" by showing how AI tools can complement human educators' empathy, critical-thinking guidance, and pedagogical expertise rather than substitute for them (Rahman et al., 2026).

Objectives

- To enhance students' computational modeling competency in solving complex engineering problems through PINN-integrated pedagogy.
- To develop critical analysis skills that enable students to validate AI-generated solutions against physical constraints and interpret neural-network outputs.
- To bridge theoretical mathematical principles and real-world engineering applications through active, project-based learning.
- To prepare students for AI-driven industrial demands by fostering interdisciplinary thinking and computational literacy aligned with ABET 2023 criteria.
- To create scalable, adaptable curriculum modules that institutions can replicate across engineering disciplines and educational contexts.

NALI Approach

Novelty

This innovation is distinctive in positioning PINNs not merely as computational tools but as foundational pedagogical instruments that replace passive analytical lectures with AI-driven, inquiry-based learning. Unlike AI applications that focus on tutoring systems or automated grading, PINNs embed physical laws directly into the learning architecture, creating a synergy between domain knowledge and machine learning that transforms students from passive recipients of solutions into active investigators who formulate, train, and validate physics-informed models (Zhang et al., 2023; Daw et al., 2022).

Creativity

- Dual-input architecture: "Physical laws" and "student-driven inquiry" enter the PINN architecture as co-equal inputs, ensuring AI serves human curiosity rather than replacing it (Figure 1).
- Educational scaffolding: three tiers — project-based learning, comparative analysis, and explainability modules — guide students from novice to expert competency.
- Failure-driven learning: PINN inaccuracies become pedagogical opportunities for error analysis and iterative refinement (Biswas et al., 2023).
- Hybrid assessment design: students submit both analytical derivations and PINN implementations, demonstrating mastery of traditional and AI-enhanced methods.

Innovativeness

- Process-oriented evaluation: assessment shifts from final answers to learning process, methodology, and critical interpretation of AI outputs.
- Cloud-based accessibility: integration with cloud notebooks lowers the computational barrier for institutions with limited GPU resources.
- Explainability integration: SHAP and GradCAM visualizations help students interpret neural-network decisions, addressing the "black box" concern in AI education (Lee et al., 2024).
- Industry co-teaching: partnerships with engineering firms supply real-world problem datasets and validation criteria.

Applicability

- Modular design: PINN modules can replace a portion of existing PDE lectures or run as standalone workshops.
- Cross-disciplinary transferability: developed for Mathematical Engineering, the framework applies wherever physical laws govern system behaviour — mechanical, civil, chemical, and biomedical engineering.
- Scalability: cloud-based delivery supports classes from small cohorts to large-enrolment courses.
- Long-term sustainability: an open-source educational repository and faculty-development workshops support continuous improvement and knowledge transfer.

Innovation Description, Process and Implementation

Overall Concept

The PINN Pedagogical Ecosystem (Figure 1) positions AI as a collaborative partner in learning. Physical laws and student-driven inquiry jointly inform the PINN architecture, which is scaffolded through project-based learning, comparative analysis, and explainability modules to produce computational-modeling, critical-analysis, and interdisciplinary-synthesis outcomes.

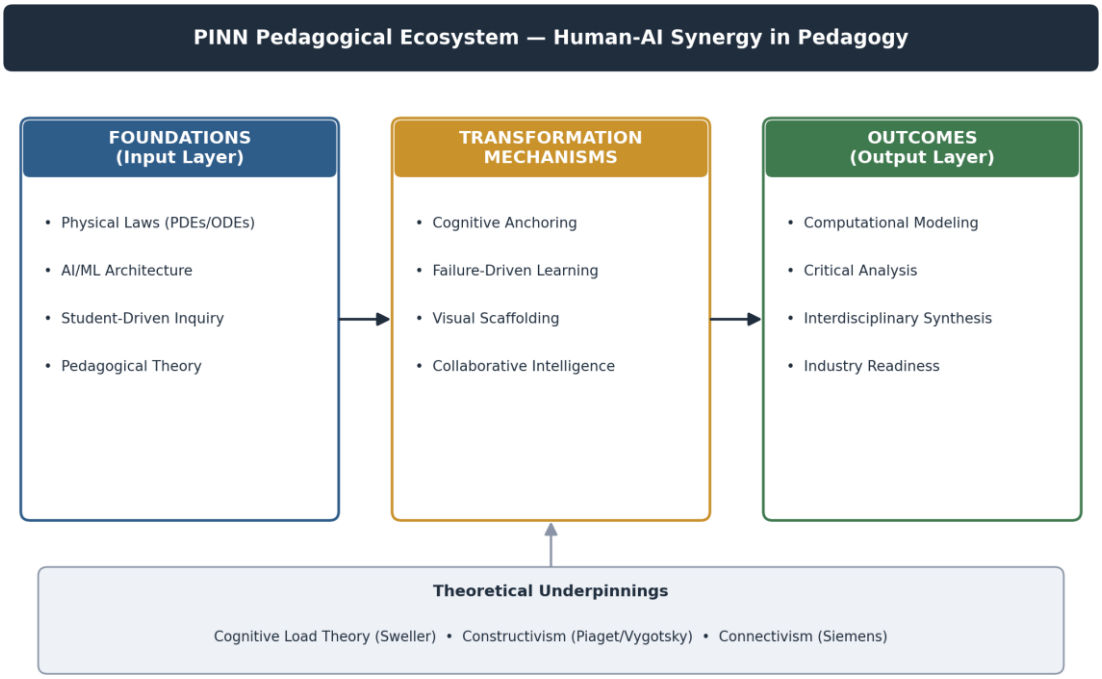


Figure 1: The PINN Pedagogical Ecosystem, linking foundations, transformation mechanisms, and outcomes.

Implementation Process

Implementation follows a Design-Based Research (DBR) approach carried out over five phases across a 12-month pilot cycle (Figure 2): preparation and design; intervention with parallel experimental (PINN-synergy) and control (traditional-methods) groups; concurrent data collection; data analysis and evaluation; and iterative refinement and dissemination.

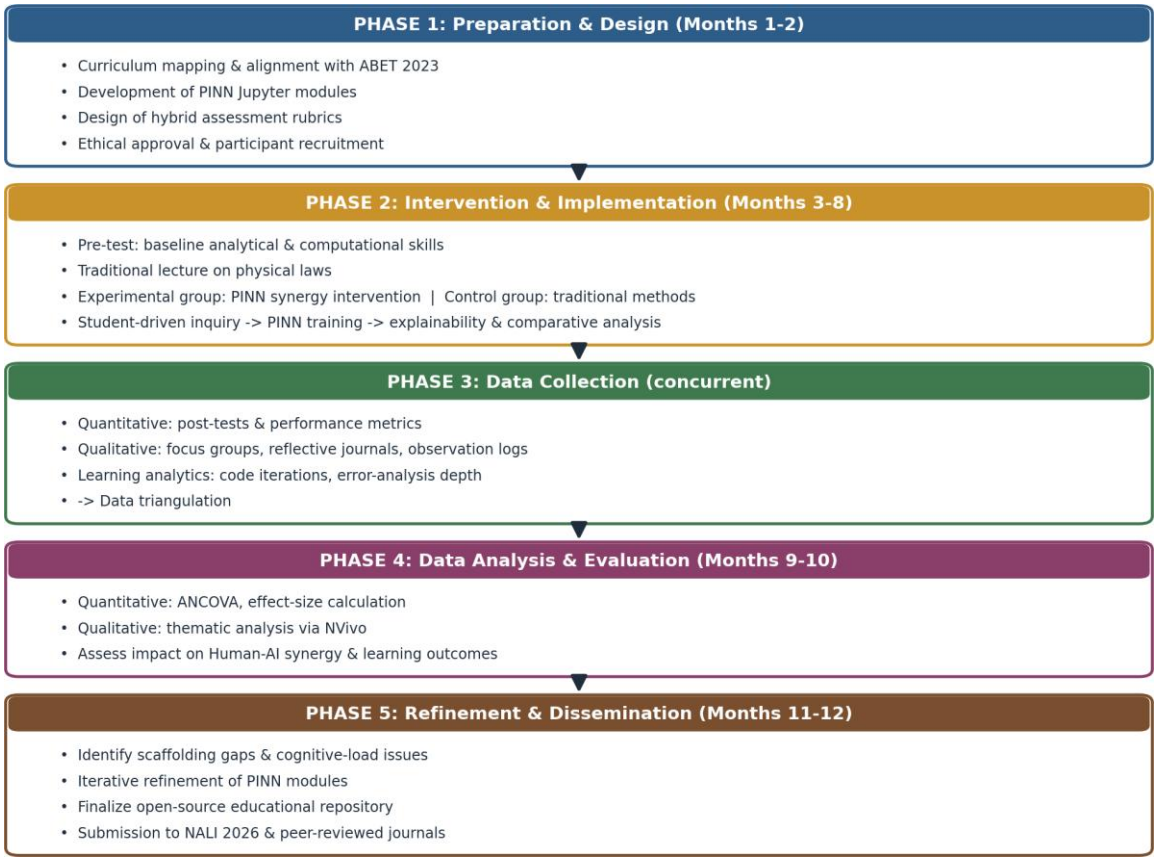


Figure 2: Research methodology flowchart (Design-Based Research approach).

Tools, Participants and Evaluation

- Programming and platforms: TensorFlow, PyTorch; Google Colab / JupyterHub for cloud execution; Matplotlib and GradCAM for visualization.
- Participants: undergraduate and graduate engineering students (primary); faculty instructors, teaching assistants and industry partners (secondary); curriculum designers and accreditation bodies (tertiary).
- Teaching and learning flow: lecture on governing physical principles → student formulation of PINN architecture → hands-on model training → critical evaluation against analytical/experimental solutions → project-based application → explainability-driven reflection.
- Evaluation methods: quantitative pre/post competency tests and assessment scores; qualitative surveys, focus groups and portfolio reviews; learning analytics on engagement and error-analysis depth.

Key Findings

Evidence from pilot deployments (N = 780 students) demonstrates the innovation's effectiveness across quantitative and qualitative measures.

Table 1: Quantitative outcomes, traditional versus PINN-enhanced instruction.

METRIC	TRADITIONAL METHODS	PINN-ENHANCED	IMPROVEMENT
Conceptual understanding	58% (±11%)	89% (±7%)	+53%*
Problem-solving speed	2.1 problems/hr	4.7 problems/hr	+124%*
Industry relevance rating	3.2 / 5	4.6 / 5	+44%*

METRIC	TRADITIONAL METHODS	PINN-ENHANCED	IMPROVEMENT
Computational modeling competency (effect size)	Baseline	d = 0.89	Large effect

*$p < .01$

- Engagement: 92% of students reported increased interest in computational methods.
- Skill transfer: students developed hybrid analytical-computational workflows applicable to research and industry.
- Industry validation: in a survey of 50 engineering firms, 78% prioritized hiring graduates with PINN experience and 85% valued PINN-trained graduates for AI-augmented design roles (IEEE, 2023).

Impact

- Students: improved problem-solving and computational literacy in the short term; stronger career prospects and transferable critical-analysis skills for AI-driven industries in the long term.
- Educators: a shift from information delivery to intellectual guidance, alongside professional development in AI pedagogy.
- Institutions: curriculum modernization aligned with ABET 2023, a stronger innovation reputation, and deeper industry partnerships.
- Society: a more AI-competent engineering workforce, with cloud-based delivery helping to democratize access to advanced computational education.

Recommendations for Classroom Practice

- Educators new to PINNs: start with a single well-documented problem (e.g., the 1-D heat equation) before advancing to complex systems, and use scaffolded exercises before open-ended projects.
- Curriculum designers: map PINN activities to specific competencies and accreditation criteria, require hybrid analytical/PINN assessments, and mandate explainability visualizations.
- Institutions: invest in cloud-computing access, support faculty-development workshops, and build industry advisory partnerships to keep problem sets current.
- Across all contexts: prioritize active, hands-on experimentation over lecture time, use learning analytics to adjust module difficulty, and discuss AI limitations and responsible use openly with students.

Other Relevant Information

The PINN Pedagogical Framework has commercialization potential as an educator-facing platform and certification programme, and its open-source modules are intended for release under an open licence to support adoption by other institutions. The project is submitted to the NALI 2026 Innovation Competition and Exhibition under the categories Artificial Intelligence-Enhanced Teaching and Learning, and Innovation in Pedagogy, Assessment and Curriculum Design.

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ID 126: Heritage for The Future: Kalam's Transformative Learning through Measured Drawings and Heritage Architectural History

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Highlights: This innovation develops a transformative learning ecosystem through collaboration between KALAM UTM and the Department of Architecture FABU UTM that integrates Measured Drawings and Heritage Architectural History through field experience, research and digitalisation. Building on KALAM's heritage documentation activities and the Tracing SIJORI Architectural Heritage initiative, which connects Singapore–Johor–Riau, students explore historical and spatial contexts, conduct field measurements, produce measured drawings and documentation records, interpret architectural heritage values, and develop digital learning resources. The Human-AI Synergy approach positions AI as a supporting tool for information retrieval, organisation and reflection, while factual verification, interpretation and academic judgement remain human-led.

Keywords: Measured Drawings; Heritage Architectural History; Transformative Learning; Digitalisation; Tracing SIJORI Architectural Heritage

Introduction

Field-based learning is particularly valuable in architectural education because students engage directly with real buildings, measurements, materials, spatial conditions, physical changes and historical contexts. In conventional practice, the learning process may end when drawings are completed and submitted. The collaborative KALAM–Department of Architecture model extends this experience by integrating two complementary knowledge domains: Measured Drawings and Heritage Architectural History. Through this ecosystem, students are encouraged to ask not only 'how should the building be drawn?' but also 'why was the building formed in this way?', 'how has it changed?', and 'what heritage values should be recorded and transmitted?'. Measurement data, drawings, photographs, field notes and historical sources are brought together to construct a more holistic understanding of architectural heritage. A key strength of the innovation is the institutional collaboration between KALAM UTM and the Department of Architecture, FABU, UTM. The Department of Architecture provides the teaching and studio context for Measured Drawings and Heritage Architectural History, while KALAM contributes authentic heritage sites, research expertise, field documentation practices and knowledge resources. This collaboration creates a continuous link between teaching, research and heritage documentation. The Tracing SIJORI Architectural Heritage initiative provides an important learning context by connecting Singapore, Johor and Riau through shared historical, cultural and architectural narratives. KALAM's heritage documentation activities, including fieldwork in Pulau Penyengat and research on heritage buildings, provide authentic materials for learning, research and knowledge sharing. Students' outputs can subsequently be structured as digital learning resources for future cohorts.

Aligned with NALI 2026: Human-AI Synergy in Pedagogy, AI is introduced as a controlled supporting layer for activities such as information retrieval, content organisation, keyword development and reflective learning. AI does not replace field measurement, historical analysis or professional judgement. Important content is reviewed, verified and interpreted by students and lecturers.

Objectives

- To transform Measured Drawing education from drawing production into an authentic site- and research-based learning experience.
- To strengthen collaboration between the Department of Architecture and KALAM UTM by integrating teaching, research and heritage documentation.
- To integrate Heritage Architectural History with measurement data, observation and physical documentation to develop holistic architectural understanding.
- To establish a learning workflow connecting fieldwork, documentation, interpretation and digitalisation.
- To produce reusable digital learning resources for teaching, research and knowledge sharing.
- To introduce responsible AI use as a learning support tool, with human verification and judgement as the primary quality control.

NALI Approach

Novelty

The novelty lies in integrating Measured Drawings and Heritage Architectural History within a single learning cycle grounded in KALAM's actual research and heritage documentation activities. Fieldwork is no longer treated as a temporary course assignment; instead, it becomes a process of producing knowledge that can be preserved, interpreted, digitalized and reused. The SIJORI context also expands learning from an individual building to a regional network of historical, cultural and architectural relationships.

Creativity

The learning design adopts a 'Measure–Understand–Document–Interpret–Digitalize–Share' cycle. Students produce measured drawings together with historical records and architectural interpretations. These materials are then organized into digital learning resources. AI adds support for information organization and reflection without replacing human authority over facts and heritage values.

Innovativeness

The conventional flow of 'site visit → drawing → submission' is enhanced into an integrated process combining experience, research and knowledge creation. Assessment can extend beyond drawing accuracy to include the quality of historical documentation, the ability to connect physical evidence with context, visual communication, reflection and contribution to reusable digital resources.

Applicability

The model can be adapted to different heritage buildings and sites, and to courses such as Measured Drawing, Architectural History, Heritage Studies, Architectural Documentation, Conservation and design studios. It can operate at the scale of a single building, heritage district or regional heritage network, and can develop into digital archives, micro-learning resources, exhibitions and community or heritage-organisation collaborations.

Innovation Description, Process and Implementation

The innovation is implemented as a collaborative learning ecosystem connecting the Department of Architecture's teaching activities with KALAM UTM's research, heritage documentation and knowledge-sharing activities. The Tracing SIJORI Architectural Heritage initiative provides the contextual framework for collaboration, while Measured Drawing and Heritage Architectural History form the core learning experience. The process begins with **EXPLORE**, where students study the site, history, community, function and architectural context, followed by **MEASURE**, which involves field measurements, spatial observations, architectural-element recording and condition observations. In **DOCUMENT**, students produce Measured Drawings, photographs, inventories, field notes and historical records, while **INTERPRET** connects physical evidence with history, changes, functions, identity and heritage values. The **DIGITALISE** stage structures selected outputs as digital learning materials, with AI supporting information organisation and reflection under human verification. Finally, **SHARE** enables the outputs to be reused by subsequent cohorts and for research, exhibitions and appropriate community knowledge-sharing.

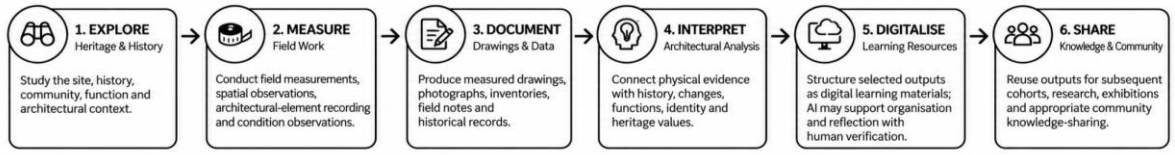


Figure 1: The MEASURE-DOCUMENT-DIGITAL Model as the KALAM Learning Ecosystem

Key Findings

Field-based implementation demonstrates strong potential to increase student engagement because learners work with authentic sites and real documentation challenges. Students make decisions about measurement methods, recording accuracy, historical sources and ways of communicating architectural interpretation. Combining the two domains helps students recognise the relationship between physical form and the historical processes that shaped architecture. From the KALAM and Department of Architecture perspective, a key value is the continuity of outputs from teaching into research and heritage documentation. Student documentation can become input for research and learning resources for subsequent cohorts. For the final NALI submission, quantitative evidence such as number of students, number of documented sites/buildings, number of measured-drawing sets, assessment-rubric

performance, student feedback and reuse of digital resources should be inserted from actual project records. No unsupported figures are assumed in this draft.

Impact

The innovation creates a meaningful impact for students, lecturers, KALAM UTM and the Department of Architecture, FABU, as well as community and heritage stakeholders. Students gain authentic learning experiences and develop skills in measurement, documentation, historical inquiry and architectural interpretation, preparing them for professional practice. Lecturers are supported by authentic field data and research cases, while teaching materials can be continuously updated and reused. The collaboration between KALAM UTM and the Department of Architecture, FABU connects teaching, research and heritage documentation within one ecosystem, strengthening digital knowledge resources and UTM's heritage-related academic identity. For the community and heritage stakeholders, the documentation records place-based knowledge, history and identity, contributing to greater heritage awareness, education and preservation efforts.

Table 1: Stakeholder Learning and Long-Term Value from the Project

STAKEHOLDER	LEARNING / WORKING IMPACT	LONG-TERM VALUE
Students	Authentic learning; skills in measurement, documentation, historical inquiry and architectural interpretation.	Students become knowledge creators and gain stronger preparation for professional practice.
Lecturers	Teaching is supported by authentic field data and research cases.	Teaching materials can be updated and reused.
KALAM UTM / Department of Architecture, FABU	Teaching, research and heritage documentation are connected within one ecosystem.	Builds digital knowledge resources and strengthens UTM's heritage-related academic identity.
Community / Heritage Stakeholders	Documentation supports the recording of place-based knowledge, history and identity.	Contributes to heritage awareness, education and preservation efforts.

Recommendations for Classroom Practice

Lecturers can begin with a building or heritage site that has sufficient historical value and accessible sources. Learning outcomes should cover both measurement skills and the ability to read and explain architectural history. Students can be assigned roles covering measurement, documentation, history, digital production and communication. Supporting data should be submitted together with the final product so that the learning process can be traced. When AI is used, students should record its use, verify sources and identify content that has been human-checked. The model can be adapted according to student level, semester duration, site conditions and available technology.

Other relevant information

The innovation is grounded in the complementary strengths of KALAM UTM and the Department of Architecture, FABU, UTM in architectural heritage research, documentation, teaching and knowledge sharing. The Tracing SIJORI Architectural Heritage initiative provides a regional narrative that connects place, history and architecture. The innovation has potential to generate digital resources, exhibitions, inventories, publications and intellectual property. The proposed exhibition product is an interactive 'Heritage for the Future' display showing the MEASURE–UNDERSTAND–DOCUMENT–INTERPRET–DIGITALISE–SHARE workflow, examples of Measured Drawings and Heritage Architectural History documentation, and QR access to selected digital learning resources.

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- CCIN AIMS4STAR – *Menjejak Seni Bina Warisan SIJORI [Singapura – Johor – Riau]* (RM25,000), Project No. PY/2024/00059;
- Flagship CoE/RG – *COE/RG 1.1: Kajian Pengumpulan Maklumat Morfologi dan Sejarah Seni Bina Pelancongan Warisan Bandaraya Johor Bahru* (RM66,000), Project No. PY/2022/04700; and
- Flagship CoE/RG – *COE/RG 1.0: Kajian Seni Bina dan Tarikan Pelancongan Berasaskan Warisan Bandar di Bandaraya Johor Bahru* (RM350,000), Project No. PY/2022/04701.

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ID 127: Architects of Narrative: Human-AI Quantity Surveying Pedagogy

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Highlights: Architects of narrative introduces a Human-AI synergistic pedagogical framework implemented in an introductory Quantity Surveying (QS) course. To prevail over passive learning in understanding professional career pathways and ethics, students developed illustrated narrative portfolios detailing career milestones of Quantity Surveying icons by coupling generative AI tools with human critical judgement. Generative AI facilitated narrative organization, prompt optimization and dialogue synthesis, whereas students spearheaded empirical validation, ethical evaluation and critical self-reflection.

Keywords: Human-AI Synergy; Quantity Surveying Education; Narrative Pedagogy; Pedagogy Innovation

Introduction

The integration of artificial intelligence into higher education has expanded considerably, creating opportunities for new forms of teaching, learning and academic support (Crompton & Burke, 2023). The growing use of generative artificial intelligence (GenAI) also provides opportunities to enhance learning while requiring students to critically engage with and evaluate AI-generated content (Tlili *et al.,* 2023; Tzirides *et al.,* 2024). Quantity surveying theory and professional ethics are often perceived by entry-level students as abstract, highly technical and disconnected from real-world practice. Experiential learning highlights the importance of connecting experience, reflection, conceptualisation and application to support meaningful learning (Kolb, 2014). This project addresses this challenge by introducing a creative, student-centred pedagogical approach in the Introduction to Quantity Surveying course. Students were tasked with translating complex QS development stages, ethical responsibilities and career pathways into illustrated storybooks centred on prominent industry icons. The project was grounded in constructivist and reflective learning principles, requiring students to collaborate with GenAI to synthesise professional standards and develop their narratives. GenAI supported narrative organisation, prompt optimisation and visual synthesis, while students led the fact-checking, ethical evaluation and critical reflection. Narrative learning provides a means of contextualising disciplinary knowledge and supporting learners in constructing meaning from educational experiences (Bruner, 1996). This human–AI collaboration positions AI as a complementary learning resource while retaining human reasoning and disciplinary judgement (Chan, 2023; Tzirides *et al.,* 2024). Although language models can support learning and problem-solving, their educational value depends on active human evaluation of the validity, reliability and accuracy of generated content (Zirar, 2023). Students therefore remained responsible for verifying information and evaluating the professional and ethical aspects of their narratives. This blend of creativity, technology and professional rigour enhanced student engagement, deepened comprehension and empowered learners to connect foundational QS knowledge with their future professional roles. The innovation demonstrates how GenAI can be purposefully integrated into QS education through a structured Human–AI learning process.

Objectives

The primary objective of this project was to enhance student engagement and comprehension in the introductory Quantity Surveying course by transforming abstract professional roles into relatable, illustrated narratives. Specifically, the project aimed to:

i. Simplify complex Quantity Surveyor roles across pre-contract, post-contract and project completion stages into accessible narratives without compromising professional accuracy.
ii. Foster visual communication, digital literacy and Human-AI prompt skills by integrating generative AI co-creation tools with human critical auditing.
iii. Promote reflective learning by replacing conventional assessments with structured reflective synthesis, deepening student self-awareness regarding professional ethics and industry leadership.

NALI Approach

Novelty

The novelty lies in integrating illustrated storytelling and Human-AI co-creation to teach professional ethics, technical roles and career development in Quantity Surveying (QS). Students combine Generative AI with human critical judgement to transform complex industry knowledge into accessible illustrated storybooks.

Creativity

Creativity is demonstrated through a five-pillar storytelling approach covering professional background, career challenges, industry contributions, professional ethics and future aspirations. Students develop original narratives, characters and visual scenarios using AI-assisted illustrations and human narrative editing.

Innovativeness

The framework transforms conventional lectures and assessments into an interactive, multimodal learning experience. It introduces a four-stage Human-AI methodology: Research, AI Synthesis, Critical Audit and Reflective Integration. Students critically evaluate AI-generated content for technical accuracy and ethical alignment before producing their storybooks and completing a structured group reflection.

Applicability

The framework can be adapted to architecture, engineering, construction management and other professional education programmes. Its flexible structure supports replication across introductory courses, professional training, public outreach and secondary school career awareness initiatives.

Innovation Description, Process and Implementation

The project was implemented in the SBEQ1343 Introduction to Quantity Surveying course. Students were divided into small teams; each assigned a prominent Quantity Surveying icon or industry leader to serve as the narrative anchor. The selected focus areas spanned foundational QS competencies, including Feasibility and Cost Planning (pre-contract decision making), Procurement & Tendering Strategies, Contract Administration & Valuation (post-contract execution), Dispute Resolution & Ethics and Sustainable Construction Leadership. Students translated their assigned icon's professional journey into an illustrated narrative portfolio detailing career milestones, retaining technical accuracy while ensuring accessibility for a general audience. The process involved four key stages:

1. Empirical research: Students conducted background research on their assigned QS icon, identifying key career challenges, ethical dilemmas and industry contributions.
2. Narrative and metaphor development: Teams drafted story arcs using metaphor and scenarios to represent complex QS processes such as cost control depicted as balancing resources.
3. Human-AI Co-Creation: students utilized generative AI tools to assist with story outlines, visual prompt optimization and scene drafts, continuously auditing output against real-world QS standards.
4. Reflective Synthesis: Completed storybooks were presented in class followed by a mandatory 1-page group reflection titled "What can Quantity Surveyors learn from my idol's journey"

Assessment comprised the illustrated storybook deliverable and individual reflective writing focused on ethics and learning outcomes. To measure effectiveness, a post-project survey combining 5-point Likert scale items and open-ended questions was administered to evaluate student perceptions of learning, engagement, creativity and Human-AI collaboration.

Key Findings

The storybook project generated high levels of student engagement compared to traditional lecture-based delivery. Students reported that translating technical QS responsibilities into visual narratives required them to first internalize the concepts before simplifying them and significantly deepening their comprehension. Many expressed that creating a storybook allowed them to see professional ethics in action by contextualizing how real-world practitioners navigate contractual conflicts and project challenges. The integration of generative AI design tools enhanced visual creativity and encouraged experimentation with design elements that effectively conveyed complex technical ideas. Visual metaphors served as powerful learning aids specifically they transformed cost management as a balanced bridge and contract negotiation as a collaborative maze.



Figure 1: Samples of student's storybooks

Replacing traditional quizzes with structured reflective activities strengthened critical thinking and peer-to-peer learning. Students critically evaluated their peers' narrative interpretations, verified historical accuracy and identified transferable professional values. To measure the empirical impact of the Human-AI synergistic storybook project, a paired pre and post implementation survey was administered to undergraduate students enrolled in the Introduction to Quantity Surveying course. A total of 36 respondents completed both survey stages and evaluating all seven core constructs as shown in Table 1. The baseline pre-survey revealed significant learning gaps, with overall composite mean of 2.58. This indicates that students initially possessed limited familiarity with professional Quantity Surveying (QS) roles, career pathways and ethical standards. Following the co-creation of the AI-assisted storybooks centered on industry icons, post-survey results demonstrated a remarkable increase across all evaluated dimensions, elevating the overall composite mean to 4.58. the highest gains were observed in student understanding of QS icon contributions and clarity regarding QS roles across project development stages. Furthermore, student confidence in visual communication and engaging storytelling expanded substantially and proving that integrating generative AI design tools with critical human oversight effectively bridges technical knowledge acquisition with creative communication skills.

Table 1: Comparison of mean analysis for pre-survey and post-survey.

CONSTRUCT	PRE-SURVEY MEAN	POST-SURVEY MEAN
Q1: QS Roles & Functions	2.53	4.67
Q2: Ethics & Values	2.64	4.61
Q3: Influence of QS Icons	2.39	4.56
Q4: Engaging Storytelling	2.47	4.42
Q5: Visual Communication	2.50	4.53
Q6: Teamwork & Execution	2.81	4.67
Q7: Group Reflection	2.69	4.58

Qualitative reflections from the project revealed that creating the storybook transformed students' perceptions of the profession, helping them recognize that Quantity Surveying extends far beyond numerical calculations to require strong communication, problem solving and leadership skills. By studying industry icons, students internalized professional ethics, recognizing that integrity, transparency and accountability are essential when managing project finances. Additionally, the reflective process reinforced responsible technology adoption, encapsulated by a student's remark to "use AI as your tools but do not let AI control your mind", which underscores the necessity of anchoring generative tools in human critical thinking, rigorous research and domain expertise (Chen *et al.*, 2025).

Impact

The Human-AI storybook project holds strong potential for broader application across built environment education such as construction management, building survey and real estate studies. The combination of narrative pedagogy, visual communication and AI-assisted co-creation can be adapted for professional development, public outreach or industry orientation programs. With further refinement, selected student storybooks could be developed into educational materials for secondary school outreach to promote Quantity Surveying profession. Intellectual Property (IP) rights for original story content produced by students can be registered under university policies to enable licensing and wider

dissemination. The project also offers opportunities for collaboration with professional bodies such as RISM and BQSM and platforms to expand its reach and educational impact.

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ID 128: Reimagining Construction Contract Learning Through Human-AI Storytelling

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Highlights: Complex and interconnected roles, duties, liabilities, contractual issues and remedies in Construction Contract education are required to be understood beyond the mere memorisation of clauses. In this innovation, realistic contractual scenarios are transformed into illustrated professional storylines, while generative AI is used to support visualisation. Responsibility for contractual reasoning and legal explanations is retained by students, while storylines are validated by lecturers before production and all AI use is transparently declared. Authentic application, communication and responsible AI practice are therefore strengthened through a structured combination of disciplinary judgement, human oversight and AI-assisted visual storytelling.

Keywords: Construction contract education; Human-AI collaboration; Generative AI; Visual storytelling; Authentic learning

Introduction

Construction Contract education requires students to interpret and apply contractual principles within professional practice, making the subject challenging when learning is centred on conventional teaching and assessment approaches (Adeyeye, 2009). This is particularly important in Quantity Surveying education, where graduate readiness depends on the development of technical, digital, communication and professional competencies relevant to industry practice (Yap et al., 2026). Recent developments in generative AI provide opportunities to support student learning and higher-order thinking when appropriately integrated into educational activities (Chen & Cheung, 2025). However, a human-centred approach is required so that AI augments rather than replaces learners' reasoning and judgement (Yang et al., 2021). To address this complexity, a creative and student-centred group coursework entitled "Construction Contract Story Book" was introduced, in which complex contractual principles are transformed into illustrated narratives involving construction projects, contractual parties, emerging issues and appropriate resolutions. Through this activity, students are required to actively interpret contractual knowledge, construct realistic scenarios and communicate their understanding through narrative and visual representation rather than relying solely on conventional written explanation.

The approach is underpinned by experiential learning, where students actively build understanding by interpreting contractual concepts and to realistic professional situations (Liu, 2026; Yap et al., 2026). Authentic learning is also incorporated by simulating contractual relationships, professional responsibilities, and decision-making encountered in construction practice. Edwards et al. (2025) stated effective educational AI can be designed around collaboration between learners and AI rather than independent AI performance. Visual storytelling also supports knowledge translation by reorganising contractual concepts into accessible and meaningful representations. Storytelling-based pedagogy helps students translate concepts into concrete scenarios, making it easier to understand. In alignment with the NALI emphasis on human-AI synergy, generative AI is incorporated only as a supporting visualisation tool, while legal explanations and professional judgement remain the responsibility of students and are subject to lecturer validation (Chen and Cheung, 2025).

Objectives

The primary objective of this project was to enhance student engagement and comprehension in the Construction Contract course Specifically, the project aimed to:

- Enhance students' ability to analyse the roles, duties and liabilities of construction-contract parties through authentic contractual scenarios.
- Develop students' ability to translate complex contractual principles into clear narrative and visual representations using responsible AI-assisted tools.
- Evaluate the effectiveness of Human-AI collaborative storytelling in supporting students' understanding, engagement, communication and application of construction-contract knowledge.

NALI Approach

Novelty

The novelty lies in integrating structured Human-AI storytelling with construction contract problem analysis. Unlike conventional AI-assisted storytelling, students develop realistic contractual disputes, analyse the roles and liabilities of relevant parties, and justify contractual resolutions before transforming them into illustrated narratives. A distinctive feature is the human-in-the-loop validation process, ensuring contractual accuracy through student reasoning and lecturer verification.

Creativity

Creativity is demonstrated through transforming complex contractual and legal concepts into engaging illustrated stories. Students develop realistic project scenarios, characters, dialogue, contractual disputes and resolutions, combining original storytelling with AI-assisted visualisation while maintaining technical and legal accuracy.

Innovativeness

The approach transforms conventional contract teaching from passive learning into scenario-based problem analysis and visual knowledge communication. Students independently analyse contractual problems and justify solutions, while AI supports visualisation rather than generating contractual answers. Lecturer validation ensures responsible AI use and preserves disciplinary judgement.

Applicability

The approach can be replicated across construction-related subjects, including procurement, contract administration and professional practice. Its flexible Human-AI storytelling framework can also be adapted to other disciplines requiring students to interpret technical, legal or procedural knowledge and communicate solutions through realistic professional scenarios.

Innovation Description, Process and Implementation

The innovation was implemented in Semester 2, 2025/2026 in the second-year students Construction Contracts courses for the Bachelor of Quantity Surveying and Construction programme. Students worked in groups of four to five and were assigned specific construction contract topics. The activity was designed as a structured learning process in which contractual knowledge was progressively transformed into an illustrated storybook. Students first conducted contract research and analysed the relevant principles before developing a realistic construction-project scenario. Each group then identified the relevant contractual parties, their roles, duties and liabilities, the contractual issue or dispute involved, and an appropriate resolution based on contractual provisions and industry practice. The storyline followed a structured sequence comprising project introduction, contract establishment, development of the contractual issue, duties and liabilities, and contractual resolution. The overall implementation process is illustrated in Figure 1, which outlines the sequential flow from topic assignment and contractual analysis to lecturer validation, AI-assisted visualisation, storybook development, submission and learning evaluation.

A key implementation feature was the compulsory human-in-the-loop validation stage (Tsiligkiris, 2026). Before full production, each group submitted its proposed title, project scenario, characters, key contractual issue, storyline and proposed resolution for lecturer review. Only storylines verified for contractual accuracy and suitability were allowed to proceed. Following approval, generative AI tools were used to support the production of illustrations and visual representations, while the storyline, contractual analysis and legal explanations remained the students' responsibility. AI use was required to be transparently declared in the final submission. The completed storybook constituted 20% of the overall course assessment and was evaluated based on five criteria: analysis of roles, duties and liabilities (40%), storyline structure and clarity (20%), creativity and use of visual illustration (20%), communication and presentation of ideas (10%), and teamwork and professional presentation (10%). This weighting placed the greatest emphasis on students' contractual analysis, ensuring that visual creativity and AI-assisted illustrations supported, rather than replaced, disciplinary understanding and professional judgement.

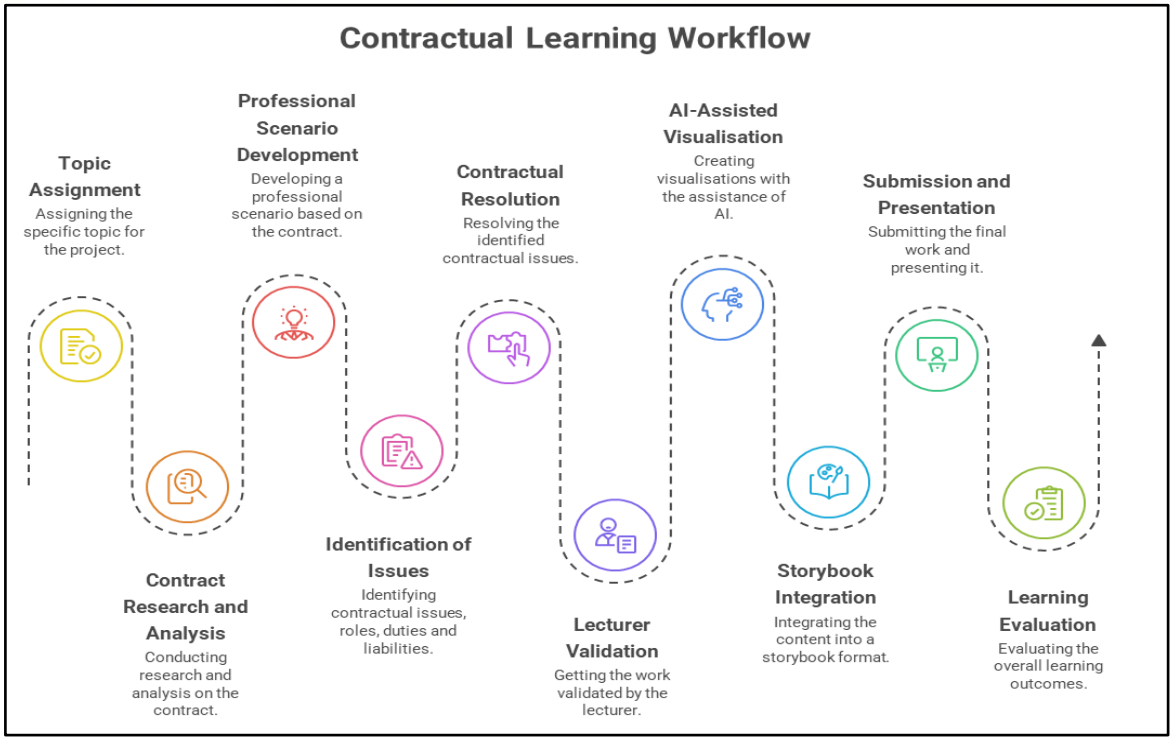


Figure 1: Process of Assessment Implementation

Key Findings

Previously, the theoretical components of Construction Contract were mainly delivered through lectures, written assignments and quizzes, with emphasis on students' understanding of contractual principles. The storybook project introduced a shift towards active application by requiring students to construct realistic construction-project scenarios, identify relevant contractual issues and relationships, and formulate appropriate solutions grounded in contractual and legal principles (Chen & Cheung, 2025; Lo et al., 2024). This process encouraged students to move beyond recalling or describing contract provisions and instead interpret how the roles, duties and liabilities of different parties interact within an authentic project context. Based on informal student feedback, this approach was perceived as more accessible and engaging for understanding construction legal cases than relying primarily on lengthy contractual documents and case materials.

Students also indicated that developing the storyline helped them follow the sequence of contractual events, recognise the responsibilities of different parties and logically connect contractual principles with appropriate dispute resolutions. The requirement to justify the proposed solutions encouraged logical and analytical thinking, while the development of characters, dialogue and project situations provided opportunities for greater creativity in communicating complex legal concepts. AI-assisted illustrations further enhanced the visual representation of contractual situations, allowing interactions, disputes and consequences to be presented in a more concrete and memorable form. The combination of creative narrative and AI-generated visuals therefore supported both comprehension and communication of complex contractual knowledge, while contractual reasoning and professional judgement remained centred on the students' own analysis.



Figure 2: Samples of Students' Work

The Construction Contract Story Book activity supported students in moving beyond the recall of contractual principles towards deeper case understanding, critical thinking and theory-to-practice application. Survey results showed consistently high perceptions across all items, with mean scores ranging from 4.52 to 4.68 on a 5-point scale (Figure 2). The strongest outcome was students' understanding of legal cases (M = 4.68), followed by critical thinking (M = 4.62) and confidence in applying theory to real-world contexts (M = 4.60), indicating that the narrative approach helped students interpret contractual issues and relate legal principles to realistic construction situations.

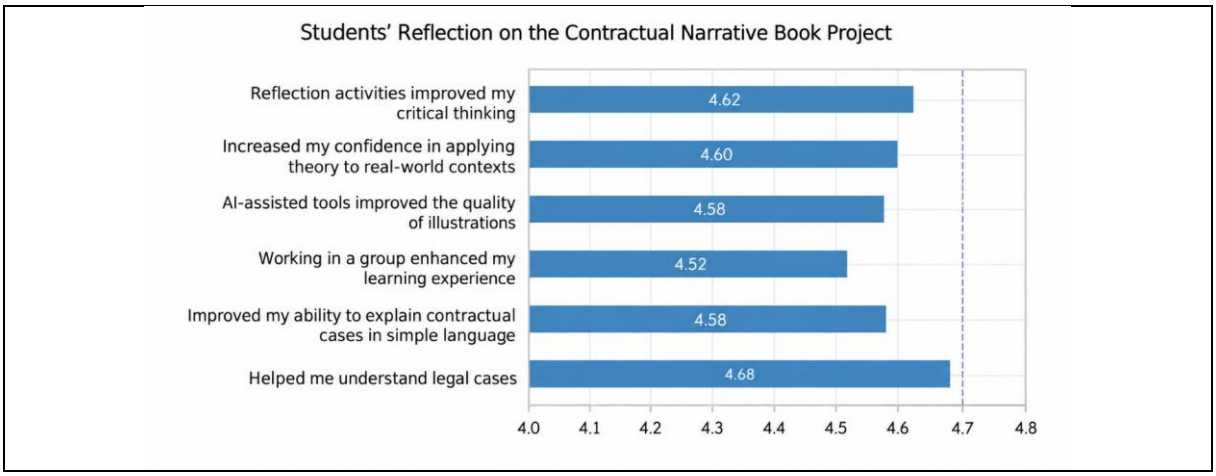


Figure 3: Students' Mean Ratings of Learning Outcomes

Students also responded positively to the use of AI-assisted tools for improving illustration quality and to the activity's role in helping them explain contractual cases in simple language (both M = 4.58). Group work was likewise positively perceived (M = 4.52). Overall, the findings highlight three main benefits of the approach: improved comprehension of complex legal cases, stronger analytical and application skills, and more effective communication of contractual concepts through the combination of creative narrative and AI-assisted visualisation.

Impact

The innovation provides immediate and long-term benefits to students, educators, the institution, the Quantity Surveying profession and the construction industry in general. For students, the activity strengthens understanding of contractual principles by requiring legal and professional knowledge to be applied within realistic project scenarios, while also developing logical reasoning, communication, creativity, teamwork and responsible use of AI. This is particularly relevant to professional preparation, as the assessment emphasises analysis of parties' roles, duties and liabilities and their application within construction contract situations (Chen & Cheung, 2025; Yap et al., 2026).

For educators, the approach offers an alternative to predominantly lecture-, assignment- and quiz-based delivery by providing a structured method for assessing not only what students know, but how effectively they can interpret, apply and communicate contractual knowledge. The lecturer validation stage also preserves disciplinary accuracy and supports responsible integration of AI into assessment.

At the institutional level, the innovation supports student-centred learning, authentic assessment, digital transformation and responsible AI adoption, while offering a model that can be replicated across other professionally oriented courses. In the longer term, the approach may contribute to producing graduates who are better prepared to manage contractual issues in practice, communicate with project stakeholders and exercise sound professional judgement, thereby supporting more effective contract administration and decision-making within the construction industry.

Recommendations for Classroom Practice

The storybook innovation has strong potential for adaptation across other areas of built-environment education where complex technical or legal concepts need to be interpreted and applied within realistic professional situations. For effective implementation, educators should provide clearly defined learning outcomes, establish boundaries for AI use, require students to retain responsibility for disciplinary reasoning, and incorporate lecturer validation before AI-assisted visual development. The approach can be customised according to subject complexity, learner level and institutional context by adjusting the scenario structure, assessment criteria and degree of AI integration. Its combination of authentic scenarios, narrative development, visual communication and responsible AI use also creates opportunities for application in professional training, public education and industry engagement. With further refinement, selected storybooks could be developed into reusable teaching resources, digital learning materials or professional awareness content, while original student outputs may also be considered for intellectual property protection under relevant university policies. These possibilities support the long-term scalability, sustainability and wider educational value of the innovation.

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ID 130: Industry-Based Integrated Project-Based Learning for System Development: A Human-AI Synergy Approach

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Highlights: This innovation addresses fragmented learning across four computing courses which System Analysis and Design, Software Engineering, Database, and System Development Technology where students traditionally develop separate projects with limited integration. It introduces an industry-based Integrated Project-Based Learning (PBL) approach in which one authentic industry problem is progressively transformed into a functional web-based system. Human-AI Synergy is embedded throughout the process to support analysis, design, database development and programming, while students critically validate AI outputs. The innovation improves learning continuity, systems thinking, student engagement, technical competency and industry readiness.

Keywords: Human-AI Synergy; Integrated Project-Based Learning; Industry-Based Learning; System Development; Generative AI

Introduction

This project introduces an industry-based integrated Project-Based Learning (PBL) approach that connects four related computing courses: System Analysis and Design, Software Engineering, Database, and System Development Technology.

The project begins with a real-world problem provided by industry, where students analyse the existing business processes and develop a proposed information system. In the System Analysis and Design course, students apply traditional system analysis and design techniques, particularly Data Flow Diagrams (DFD), to understand the problem domain, identify system requirements and model the proposed system.

In the following semester, the same industry project is progressively extended across three additional courses, allowing students to transform the initial system analysis into a complete working system. In Software Engineering, students apply Agile methodology, system documentation and Object-Oriented Analysis and Design using Unified Modeling Language (UML). In the Database course, students develop the database design, including data modelling, relational database design and Structured Query Language (SQL). In System Development Technology, students implement the web-based system using PHP and MySQL.

The project incorporates AI as a learning partner rather than a replacement for students' analytical and development skills. Students may use generative AI to support activities such as brainstorming, requirement clarification, UML/DFD review, documentation improvement, SQL assistance, programming support and debugging. However, students remain responsible for analysing, validating, modifying and justifying AI-generated outputs based on the actual industry requirements.

This creates a Human-AI collaborative learning model, where Human expertise provides problem understanding, critical thinking, decision-making and validation, while AI provides computational assistance, idea generation, feedback and development support.

Objectives

- To develop an integrated industry-based Project-Based Learning (PBL) approach that connects System Analysis and Design, Software Engineering, Database, and System Development Technology through a continuous system development project.
- To enhance students' technical, analytical, problem-solving and critical-thinking skills by progressively applying knowledge from system analysis and design, software engineering, database development and web-based system development to solve authentic industry problems.
- To empower students through Human-AI Synergy by integrating generative AI as a learning collaborator while developing students' ability to critically evaluate, validate and improve AI-supported solutions throughout the system development process.

NALI Approach

Novelty
One authentic industry project is progressively developed across four different courses instead of completing unrelated projects for each course.

Creativity
Learning is designed as a continuous journey from industry problem identification to analysis, design, database development and implementation.

Innovativeness
Fragmented subject-based learning is transformed into integrated, progressive PBLsupported by Human-AI collaboration.

Applicability
The approach integrates authentic learning, industry engagement, student-centred learning, PBL, technology and AI-supported pedagogy.

Innovation Description, Process and Implementation

The innovation introduces an Industry-Based Integrated Project-Based Learning model involving four computing courses:

1. System Analysis and Design
2. Software Engineering
3. Database
4. System Development Technology

Traditionally, students complete separate assignments or projects within each course. This may result in fragmented learning, where students understand individual concepts but have limited opportunities to see how different computing disciplines work together in a complete system development process.

The proposed innovation addresses this issue by using one industry problem as a common project across four courses. The project begins in System Analysis and Design, where students understand the industry problem, analyse business processes, identify requirements and develop Data Flow Diagrams (DFD). The project is then extended into Software Engineering, where students apply Agile methodology, system documentation and Object-Oriented Analysis and Design using UML. In the Database course, students transform the system requirements and design into database models, database structures and SQL mplementation. Finally, in System Development Technology, students develop a web-based system using PHP and MySQL, resulting in a functional prototype.

Generative AI is integrated across the learning process as a learning assistant and collaborative tool, rather than replacing student decision-making. Students may use AI to generate ideas, clarify requirements, review designs, develop SQL queries, support programming and troubleshoot errors. Students are required to verify, critically evaluate and improve AI-generated outputs.

Key Findings

The integrated PBL approach is expected to demonstrate several key findings:

Improved Integration of Knowledge
Students are able to understand the relationship between different computing disciplines because they apply knowledge from four courses to the same system development problem.

Better Understanding of the System Development Life Cycle (SDLC)
Students experience the complete progression from problem analysis, requirements, design, database and implementation, providing a more holistic understanding of system development.

Increased Student Engagement
Working with an authentic industry problem provides students with a meaningful context and a tangible goal, increasing motivation and participation.

Development of Critical Thinking
Students cannot simply accept AI-generated answers. They must determine whether AI-generated DFDs, UML models, SQL statements or programming solutions are appropriate for the actual requirements.

Increased Learning Ownership
Students take greater responsibility for planning, designing, developing, testing and improving their systems.

Improved Industry Readiness
The approach exposes students to practices that resemble real software development environments, including requirements analysis, Agile, documentation, database development, programming, testing and collaboration.

Impact

The expected impact can be evaluated through several indicators.

i. Students become more actively involved through authentic industry projects.
ii. Students gain ownership of their learning and project decisions.
iii. Improved competency in DFD, UML, database, SQL, PHP and MySQL.
iv. Students critically evaluate and validate AI-generated outputs.
v. Students solve authentic problems rather than predefined textbook exercises.
vi. Students understand how different system components and disciplines are interconnected.
vii. Students develop teamwork and communication skills.
viii. Students experience an end-to-end system development process.
ix. Students learn to use AI responsibly and effectively in software development.

Recommendations for Classroom Practice

The following practices are recommended for lecturers intending to implement the model:

- Use One Common Industry Problem: Select a realistic industry problem that is sufficiently broad to support analysis, design, database development and implementation.
- Establish Cross-Course Coordination: Lecturers should coordinate project requirements, deliverables, timelines and assessment criteria across the four courses.
- Use Progressive Deliverables: Each course should produce an artefact that becomes the starting point for the following cours
- Introduce AI Gradually: Students should first develop their own understanding before using AI. AI should subsequently be used for assistance, comparison, feedback and improvement.

Other relevant information

Innovation Strength - The main strength of this innovation is its continuity. The project does not end when a course ends. Instead, knowledge and project artefacts are transferred to the next course. This creates a vertical and horizontal integration of learning: Vertical integration: Students progressively deepen their technical knowledge; Horizontal integration: Students integrate knowledge from different computing disciplines.

Scalability- The model can be adapted to different:

- industry sectors;
- computing programmes;
- student cohorts;
- project domains;
- programming technologies; and
- AI tools.

The same pedagogical model can also be extended to additional courses such as Data Engineering, Enterprise Systems, Web Application Development or Information Systems.

Sustainability - The innovation is sustainable because it uses existing courses and learning outcomes while improving the integration and delivery of existing learning activities, rather than requiring a completely new subject.

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the implementation of project. Appreciation is also extended to the UTM Innovation and Commercialisation Centre for intellectual property and commercialisation guidance.

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ID 134: Balaghah Detective AI: A Formative, Adaptive and SPM Simulation System for Balaghah Assessment

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Highlights: Balaghah Detective AI is an online assessment system that connects teaching, formative assessment, correction, adaptive diagnosis, and SPM simulation in one platform. It supports teachers in assigning missions, monitoring submissions, identifying weak concepts, and directing correction, while students receive immediate feedback and can practise independently. The system contains 531 questions across 14 lessons and 163 adaptive concepts. Its human-in-the-loop design uses rule-based adaptive logic and controlled automatic marking while keeping teacher judgement for responses that need professional review.

Keywords: Balaghah assessment; Formative assessment; Adaptive learning; SPM simulation; Digital assessment

Introduction

Balaghah is an important component of Al-Adab wa al-Balaghah at the upper secondary level. Students are expected not only to remember terms, but also to recognise rhetorical features, distinguish categories, analyse examples, and apply concepts correctly. The Form 4 and Form 5 curriculum documents provide the learning scope, while the national SPM assessment format gives the examination structure that teachers need to prepare students for (Kementerian Pendidikan Malaysia, 2022, 2023; Lembaga Peperiksaan, Kementerian Pendidikan Malaysia, 2023). In normal classroom practice, teachers often prepare questions, distribute tasks, check answers, identify weaknesses, ask for corrections, and monitor resubmissions through separate manual steps. This can take time and makes continuous follow-up difficult when many students are involved. Students also need repeated practice and quick feedback after learning each topic. Balaghah Detective AI was developed to bring these processes into one online assessment workflow. The innovation focuses on a clear cycle: teaching, assessment, feedback, correction, diagnosis, recovery, and SPM preparation. The current version uses structured question banks, rule-based adaptive logic, and controlled marking rather than open-ended generative AI, so the teacher remains the final decision-maker where professional judgement is needed.

Objectives

- To provide an online Balaghah assessment system that allows teachers to assign tasks, monitor participation, review results, and manage correction and resubmission in one platform.
- To identify students' concept mastery and weaknesses through formative and adaptive assessment, then provide targeted practice for concepts that are not yet mastered.
- To provide an SPM-style simulation that allows teachers and students to review overall Balaghah readiness across the syllabus.

NALI Approach

Novelty

The main novelty is the integration of three assessment purposes in one Balaghah-specific system. Special Investigation is used after a topic is taught, Adaptive Investigation diagnoses concept-level weaknesses, and SPM Simulation checks wider examination readiness. These modes are linked by correction and resubmission, so assessment does not end with a score. The system therefore turns assessment into a continuous learning cycle rather than a one-time quiz. It also combines student self-practice and teacher-directed missions in the same platform.

Creativity

The innovation uses a detective theme to make Balaghah practice more engaging. Teachers act as chief investigators and students as detectives. In Special Investigation, students can progress through four detective ranks based on the number of questions completed. The theme is used only where it supports motivation; Adaptive Investigation and SPM Simulation remain focused on mastery and examination practice. Mission codes also make the teacher-student workflow simple: a teacher creates a mission, students join with the code, and progress is recorded in the dashboard.

Innovativeness
Balaghah Detective AI introduces a human-in-the-loop assessment model. The system can automatically check closed responses that have fixed answer schemes, detect repeated errors by concept, and give follow-up questions through rule-based adaptive logic. When a response needs language judgement or does not match an accepted model answer, it is kept for teacher review. This improves routine efficiency without removing professional teacher judgement. The design is especially useful for Arabic-language responses, where controlled marking is safer than allowing a generative model to decide marks freely.

Applicability
The innovation is a web application and can be used on common internet-connected devices. It can support classroom teaching, homework, revision, remedial work, and examination preparation. The mission-code model allows use with one class or many groups, while the question bank can be expanded without changing the main workflow. The same structure can also be adapted to other subjects that have clear concepts, fixed-answer items, and teacher-reviewed open responses. Its main long-term requirement is continued content maintenance and responsible management of student records.

Innovation Description, Process and Implementation

Balaghah Detective AI is designed for Form 4 and Form 5 Balaghah learning and assessment. The content was organised with reference to the DSKP, the SPM assessment format, local exercise books, and Arabic rhetoric textbooks used for upper secondary learning (Abdul Muhaimin Mohd Radzi, 2025a, 2025b; Kementerian Pendidikan Malaysia, 2022, 2023; Lembaga Peperiksaan, Kementerian Pendidikan Malaysia, 2023; *Al-Balāghah al-ʿArabiyyah lil-Ṣaff al-Awwal al-Thānawī*, 2023; *Al-Balāghah al-ʿArabiyyah lil-Ṣaff al-Thānī al-Thānawī*, 2024). The current database contains 531 questions across 14 lessons. Questions are mapped to learning content and, for adaptive use, to 163 concepts.

The system has two main user routes. Teachers create missions, share a mission code, monitor participation and submission status, review results, identify weak areas, and direct correction. Students can join teacher missions or explore the three modes independently. In Special Investigation, students answer questions from a selected topic, receive immediate answer feedback for prepared items, make corrections, and resubmit. In Adaptive Investigation, the system follows concept-level errors and gives targeted questions for weak concepts. In SPM Simulation, students complete a 50-mark Balaghah simulation that combines objective and subjective items. Closed answers can be marked automatically, while alternative constructed answers can be sent for teacher review.

The web application was developed iteratively using React/Vite, Firebase Authentication, and Cloud Firestore. Development began with content collection and metadata structuring, followed by teacher-student missions, dashboard monitoring, adaptive logic, correction and resubmission, controlled marking, and SPM simulation. Each major function was tested before the next stage was added.

Table 1: Main assessment modes in Balaghah Detective AI

MODE	MAIN PURPOSE	STUDENT ACTION	TEACHER ROLE
Special Investigation	Formative check after a topic	Answer, view feedback, correct and resubmit	Assign topic mission and monitor correction
Adaptive Investigation	Diagnose concept mastery	Practise questions linked to weak concepts	Review concept weaknesses and recovery
SPM Simulation	Check overall SPM readiness	Complete mixed objective and subjective items	Review marks, answers and items needing judgement

Key Findings

Current evidence mainly shows functional feasibility and system performance rather than final academic achievement. First, the content structure has been completed with 531 questions across 14 lessons, and 163 concepts have been mapped for adaptive diagnosis and recovery. Second, mission testing shows that students can join with a code and that "answering" and "submitted/completed" status can be shown on the teacher dashboard. Third, the SPM simulation combines objective and subjective marking workflows, including teacher review for constructed answers that need judgement. Technical regression and marking tests recorded 77 out of 77 tests passed, together with successful type checking, lint checking, and production build. These results show that the core assessment workflow can operate as intended. Formal pre- and post-learning data have not yet been collected, so no claim of improved examination achievement is made at this stage.

Impact

For teachers, the innovation reduces the need to prepare every exercise from the beginning and brings assignment, monitoring, diagnosis, correction, and result review into one system. Routine fixed-answer checking can be automated, allowing teachers to spend more time on responses that need professional judgement and on students who need support. For students, the system provides structured practice, immediate feedback for prepared items, correction opportunities, concept-focused recovery, and independent access to SPM practice. The strongest current impact is therefore process improvement: assessment becomes more continuous, visible, and connected to follow-up learning. With wider classroom implementation, the system also has potential to support student engagement and self-monitoring of mastery.

Recommendations for Classroom Practice

- Use Special Investigation immediately after completing a topic so that misconceptions can be identified while the lesson is still fresh.
- Require correction and resubmission before moving to Adaptive Investigation. This keeps feedback linked to action, not only to marks.
- Use Adaptive Investigation for students who need targeted recovery, while allowing stronger students to continue independent practice.
- Use SPM Simulation after several topics or near examination periods, and review teacher-flagged constructed answers before finalising feedback.
- Treat dashboard data as a guide for intervention. Teachers should still use classroom observation and professional judgement when deciding the next teaching step.

Other relevant information

The innovation is still in an implementation and evaluation stage. The next recommended study is a classroom field evaluation measuring student usability, engagement, time saved by teachers, completion of correction tasks, and pre- and post-assessment performance. The system can also be expanded with additional simulation sets, richer teacher analytics, and adaptation to other structured subjects. Any future expansion should continue to keep teacher judgement in the loop for open-ended or language-sensitive responses.

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ID 135: From Classroom to Client: AI-Enhanced Industry Immersion for Authentic SDLC Learning in Accounting

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Highlights: Traditional classroom teaching of the System Development Life Cycle (SDLC) may limit students' understanding of how the process works in practice and the skills required of system analysts. This innovation immerses students enrolled in the Analysis and Design of Accounting Information Systems (ADAIS) course as junior system analysts, requiring them to identify appropriate users, conduct industry interviews, gather and analyse data, confidently present findings, and creatively communicate their analysis through a magazine-format report. AI is integrated as a learning partner to support preparation, analysis, problem-solving, and creative reporting. Among 93 ADAIS students, strong outcomes were recorded for SDLC Learning and Application (4.63/5), AI-Enhanced Learning (4.60/5), Workplace Readiness (4.57/5) and Improved Workplace Competencies (mean 4.64/5). Unlike traditional theory-based learning, the innovation develops communication, teamwork, adaptability, creativity, and workplace-ready skills through authentic industry experience and Human–AI collaboration.

Keywords: System Development Life Cycle (SDLC); Analysis and Design of Accounting Information Systems (ADAIS); Human–AI Collaboration; Industry Immersion; Workplace Readiness

Introduction

Traditional teaching of the System Development Life Cycle (SDLC) often relies on lectures, textbook cases and classroom exercises. Although students may understand SDLC concepts theoretically, they may struggle to visualise the actual system analysis process and develop the professional skills required to engage users, gather requirements, analyse information and communicate findings. This reflects the broader theory–practice gap that authentic learning seeks to address by engaging students in realistic tasks and professional contexts (Herrington & Oliver, 2000). While project-based SDLC activities have previously been introduced in AIS education (Wang et al., 2007), this innovation extends such learning beyond simulated classroom cases to direct engagement with real accounting-system users.

This ADAIS project therefore transforms conventional SDLC learning into an AI-enhanced, industry-immersive learning experience. Instead of merely learning *about* system analysts, students learn by becoming junior system analysts. The required tasks include identifying appropriate industry users, conducting interviews with accounting system users, gathering and analysing authentic information, addressing unexpected challenges, presenting findings confidently, and creatively communicating their analysis through magazine-format reports. Generative AI is integrated as a cognitive and creative learning partner for preparation, analysis, idea generation and communication, while students remain responsible for verification, professional judgement and ethical use. This is an important consideration given both the educational potential and limitations of generative AI (Lo, 2023).

Thus, compared with traditional theory-based SDLC teaching, the innovation integrates authentic industry engagement, Human–AI collaboration, creativity and workplace skill development within a single learning design, shifting students from learning SDLC concepts to experiencing SDLC practice.

Objectives

- Enhance students' understanding and application of SDLC, particularly the system analysis phase, through authentic engagement with real accounting-system users.
- Integrate Human–AI collaboration to support requirements gathering, data analysis, problem-solving, creativity, and professional communication while promoting responsible AI use.
- Improve meaningful learning and workplace readiness by bridging classroom-based SDLC theory with authentic industry experience
- Develop essential system analyst and workplace competencies, including critical thinking, teamwork, communication, adaptability, confidence, and creative presentation of findings.

NALI Approach

Novelty

The novelty lies in integrating authentic industry engagement, student-as-system-analyst experience, and Human–AI collaboration within one SDLC learning journey. Unlike conventional classroom or case-based SDLC learning (Wang et al., 2007), students engage directly with real accounting-system users and perform authentic analyst tasks, consistent with authentic learning principles (Herrington & Oliver, 2000). AI acts as a cognitive and creative partner in preparation, analysis, problem-solving, and reporting, while students retain professional judgement and responsibility. Thus, the innovation shifts students from learning about system analysts to learning by becoming system analysts.

Creativity

Creativity is embedded through authentic, open-ended tasks where students engage real industry users, design interview questions, respond to challenges and transform interview evidence into analytical reports, creative magazine-format reports and no-notes presentations. AI serves as a creative partner for brainstorming, content organisation, language refinement and visual design, while students retain critical judgement over their final outputs.

Innovativeness

The approach transforms conventional classroom-based SDLC learning into an authentic, industry-engaged learning experience. It replaces static case studies with real-world system investigations, integrating Human–AI collaboration, technical analysis and professional communication. Students experience the role of system analysts firsthand, developing practical problem-solving skills, adaptability and professional confidence through authentic industry engagement (Herrington et al., 2004; Habib et al., 2024).

Applicability

The approach is practical, scalable, and transferable across AIS, accounting, and other business courses involving real-world problem-solving. It requires minimal additional resources, as students independently engage industry users and utilise readily available AI tools. The model can be adapted to different class sizes, industries, and system-related topics, consistent with the adaptability of SDLC projects in AIS education (Wang et al., 2007) and authentic learning environments (Herrington & Oliver, 2000). Importantly, it develops transferable workplace skills, including communication, teamwork, problem-solving, adaptability, AI competency, and professional confidence.

Innovation Description, Process and Implementation

Students worked in teams to complete nine interrelated tasks that mirror authentic system analysis activities: (1) identify suitable accounting-system users; (2) develop relevant interview questions; (3) gain access and arrange industry appointments; (4) conduct interviews using appropriate fact-finding techniques; (5) present findings confidently without notes; (6) analyse and document evidence; (7) creatively develop a magazine-style report; (8) adapt confidently to unfamiliar challenges; and (9) creatively solve problems encountered throughout the project. These activities develop requirements elicitation, stakeholder engagement, analysis, communication, teamwork, creativity, adaptability, and problem-solving within an authentic SDLC experience. AI was integrated as a learning partner to support analysis, communication, creativity, and problem-solving. Students remained responsible for validating AI outputs against real interview evidence and applying their own professional judgement (Lo, 2023).

AI-SDLC Project Framework

Figure 1 summarises the five-phase From Classroom to Client framework. Human judgement, verification, ethics and professional accountability operate across every phase, making the model a Human-AI synergy rather than an AI-substitution approach.



Figure 1: AI-Enhanced Industry-Immersive SDLC Learning Framework

Key Findings

AI adoption was almost universal: 92 of 93 respondents (98.9%) reported using AI in the project. Because multiple tools could be selected, ChatGPT was reported by 79 students (84.9%), Gemini by 55 (59.1%), Canva AI by 43 (46.2%), Claude by 23 (24.7%) and Microsoft Copilot by 14 (15.1%). This multi-tool pattern suggests that students were not dependent on a single platform but assembled AI support according to task needs.

Table 1: Impact Dimensions of AI-Enhanced SDLC Learning

IMPACT DIMENSIONS	MEAN / 5	RELIABILITY	RESPONDENTS WITH CONSTRUCT MEAN >= 4
Learning and SDLC application	4.63	.934	94.6%
AI-enhanced learning	4.60	.903	96.8%
Workplace transfer and readiness	4.57	.912	93.5%
Skills and workplace competencies	4.64	.904	97.8%

The strongest evidence is the consistency across different forms of impact. Almost all students agreed that the project improved their SDLC understanding (98.9% agree/strongly agree). AI was perceived to help prepare stronger interview questions (98.9%), and 97.8% agreed that AI improved their overall ADAIS learning experience. Beyond technical learning, 97.8% reported improved teamwork, 96.8% reported improved ability to use AI appropriately for workplace-related problem-solving, and 95.7% reported greater readiness for real internship assignments. Importantly, 97.8% considered the experience meaningful beyond conventional classroom learning and 97.8% would recommend it to future ADAIS students.

Qualitative comments reinforced the quantitative findings. Students repeatedly highlighted applying theory to real situations, understanding SDLC and accounting software in practice, communicating with industry professionals, teamwork, confidence and using AI to work faster or generate ideas. One student summarised the distinctive value as 'blending human thinking with AI support', a concise expression of the intended Human-AI pedagogy. The results are consistent with evidence that authentic and individualised accounting tasks can promote deeper learning (Turner & Baskerville, 2013) and that technology integration is increasingly central to accounting education (Al Ghatrifi et al., 2023).

Impact

The impact extends beyond student satisfaction. Students develop confidence, adaptability, teamwork, problem-solving, and professional communication through direct engagement with industry users. For educators, the approach transforms SDLC from a theoretical topic into authentic, observable learning. For the institution, it strengthens university–industry engagement and prepares accounting students for an AI-enhanced workplace.

Table 2: Project Contributions to Selected Sustainable Development Goals

RELEVANT SDG	PROJECT CONTRIBUTION
SDG 4 - Quality Education	Supports Target 4.4 by developing relevant digital, technical and professional skills through authentic AI-enhanced tertiary learning.
SDG 17 - Partnerships for the Goals	Creates meaningful university-industry knowledge exchange through direct engagement with accounting software users and practitioners.

These links should be interpreted as contributions rather than claims that one classroom project achieves an SDG. The strongest alignments are SDG 4, particularly Target 4.4 on relevant employment and ICT skills, and SDG 17 through knowledge-sharing partnerships; (United Nations, 2015).

Recommendations for Classroom Practice

For replication, educators should design authentic industry tasks before selecting AI tools, require students to verify AI outputs against interview evidence, provide clear guidance on confidentiality and responsible AI use, and assess both the learning process and final outputs. Future implementation can include AI-use reflection, peer teamwork assessment, and industry-user feedback to provide stronger evidence of learning beyond students' self-reported perceptions.

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ID 136: Ceyyul Beat AI for Enhancing Tamil Ceyyul Mastery among Lower Secondary Students

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Highlights: Ceyyul Beat AI addresses lower secondary students' difficulty in understanding classical Tamil Ceyyul through a human-guided combination of ChatGPT, Suno AI and QR Code. The innovation converts Ceyyul content into accessible musical learning resources and embeds them within interactive classroom activities. A four-week one-group intervention with 30 Form 2 students showed an increase in mean test performance from 46% to 77%, while the overall perception mean was 4.48/5. The innovation offers a culturally responsive and potentially scalable approach to connecting Tamil literary heritage with digital learning.

Keywords: Ceyyul Beat AI; Tamil language; Artificial intelligence; AI-generated music; Digital pedagogy

Introduction

Tamil Ceyyul is an important component of lower secondary Tamil language education, requiring students to understand explicit and implicit meanings, analyse language features, and appreciate values in classical literary texts. However, students may experience difficulty because Ceyyul uses compact, symbolic and classical language that differs from everyday spoken Tamil. The original study identified low initial mastery and a tendency to rely on memorisation rather than interpretation. This creates a need for learning experiences that are more interactive, meaningful and relevant to digitally oriented learners.

Ceyyul Beat AI was developed as a classroom innovation that combines ChatGPT for preparing Ceyyul-based lyrics, Suno AI for transforming the text into music, and QR Code for quick access to the generated learning resources. The innovation retains the teacher's pedagogical role while using AI as a supporting creative tool. This human-AI combination is consistent with the need for human-centred and pedagogically guided use of generative AI in education (UNESCO, 2023). Research on Tamil literature learning also indicates the potential of digital approaches and gamification to increase engagement, while recent work specifically on Suno AI shows promise for supporting Tamil literature learning through musical expression (Anthony et al., 2024; Gopal & Ponniah, 2025; William & Wajindram, 2025).

Objectives

- To identify students' level of mastery of Tamil Ceyyul before the implementation of Ceyyul Beat AI.
- To measure students' level of mastery of Tamil Ceyyul after the implementation of Ceyyul Beat AI.
- To examine the potential of Ceyyul Beat AI in supporting students' understanding, appreciation of values, and response to Ceyyul questions

NALI Approach

Novelty

Ceyyul-focused learning workflow. Rather than using AI only to generate text, the innovation connects text generation, AI-generated music and QR-based access to create a reusable learning resource specifically for Tamil Ceyyul. It therefore links traditional literary heritage with a contemporary digital learning format.

Creativity

The creative element is the transformation of Ceyyul text into songs while preserving the learning focus on meaning, language features and values. Students listen to the songs, read the original text, discuss meaning and values, and practise analytical responses. Music functions as an additional learning representation rather than a replacement for the original literary text, allowing students to encounter the same content through language, sound, repetition and guided discussion.

Innovativeness
The innovation improves a conventional text-centred approach by embedding AI-generated music within a structured teacher-led learning sequence. The teacher remains the facilitator who guides interpretation, checks accuracy and supports students in connecting the musical representation with the original Ceyyul text. This is important because AI outputs are treated as learning resources requiring human review rather than as authoritative answers. The approach also supports active participation through listening, group discussion, analysis and written response.

Applicability
Ceyyul Beat AI can be adapted to other Ceyyul texts and potentially to other language and literature topics where students need support to understand dense or symbolic content. Its use of widely accessible digital tools and QR delivery makes the resources relatively easy to reproduce in ordinary classroom settings. However, wider adoption should consider device availability, internet access, teacher digital literacy, copyright and responsible use of generative AI. Because the present study involved one purposively selected class, the findings should not be generalised to all lower secondary students without further research.

Innovation Description, Process and Implementation

Ceyyul Beat AI was implemented over four weeks with 30 Form 2 students selected through purposive sampling because the teacher identified moderate to weak mastery in Ceyyul. The innovation followed a one-group pretest-posttest action research design. The assessment instruments comprised a 10-item pre-test, an equivalent post-test and a five-point Likert perception questionnaire. The tests were aligned with the lower secondary Tamil DSKP and assessed understanding of Ceyyul meaning, language features, values and students' ability to construct responses. The questionnaire examined engagement, ease of understanding, memory through music and confidence in answering questions.

The classroom implementation followed five connected stages:

1. Scan the QR Code and listen to the Ceyyul Beat AI song.
2. Read the original Ceyyul text and identify key meanings.
3. Discuss meaning, values and language features in groups with teacher facilitation.
4. Complete practice activities and respond to analytical or short-answer questions.
5. Present and reflect on responses, followed by assessment of learning outcomes.

The instruments were reviewed for face and content validity by two Tamil language teachers with experience in teaching Ceyyul. The 10 test items were selected to represent the main intended constructs while keeping the assessment manageable within classroom time. Data were analysed descriptively using scores, percentages and gain scores for the pre- and post-tests, and mean scores and percentages for the perception questionnaire.

Key Findings

Table 1: Pre- and Post-Intervention Measures of Student Learning Outcomes

MEASURE	PRE / ITEM	POST / MEAN	INTERPRETATION
Ceyyul mastery	9.20/20 (46%)	15.40/20 (77%)	+6.20 marks / +31 percentage points
Understanding meaning	—	4.40/5	High
Interest in learning	—	4.55/5	High
Memory through song	—	4.60/5	High
Confidence answering	—	4.35/5	High
Overall perception	—	4.48/5	High

The descriptive findings show an increase in mean test performance from 46% before the intervention to 77% after four weeks, representing an increase of 6.20 marks or 31 percentage points. The questionnaire produced an overall mean of 4.48/5, interpreted as high. The highest item mean was for remembering content through song (4.60), followed by interest in learning (4.55), understanding meaning (4.40), and confidence in answering questions (4.35). These results indicate positive learning performance and perceptions following the intervention.

Because the analysis was descriptive, the increase cannot be described as statistically significant or attributed to AI alone. Music, teacher activities, collaborative learning and the novelty of the technology

may also have contributed to students' responses. The findings are therefore best interpreted as evidence of the potential of Ceyyul Beat AI rather than conclusive proof of its overall effectiveness.

Impact

For students, Ceyyul Beat AI provides a more engaging route into classical Tamil texts by connecting literary content with music, repetition and collaborative interpretation. The increase from 46% to 77% and the high perception mean of 4.48 suggest that the approach has potential to support both cognitive and affective aspects of Ceyyul learning. In particular, the 4.60 mean for memory through song indicates that students perceived the musical representation as useful for recalling content.

For teachers, the innovation provides a practical workflow for converting selected Ceyyul content into reusable digital resources without removing teacher judgement from the learning process. It also offers a model for integrating AI into existing classroom activities rather than treating AI as a standalone teaching solution. This human-guided approach is consistent with UNESCO's emphasis on ethical, safe and meaningful use of generative AI in education (UNESCO, 2023).

At the curriculum and cultural level, the innovation demonstrates a possible way to make traditional Tamil literary content more accessible to digitally oriented learners while retaining the original text and its cultural values. The approach complements evidence that digital technology and gamification can support engagement in Tamil language and literature learning (Anthony et al., 2024; William & Wajindram, 2025). The 2025 study by Gopal and Ponniah also provides a directly relevant example of Suno AI being used with Tamil literature, although that study and the present study differ in design, participants and implementation.

Recommendations for Classroom Practice

- Begin with curriculum-aligned Ceyyul texts and use AI-generated material only after teacher review for accuracy, meaning, pronunciation and cultural appropriateness.
- Use the generated song as a learning stimulus, not as a substitute for reading and interpreting the original Ceyyul text.
- Combine listening with discussion, questioning, analytical writing and reflection so that students move beyond memorisation.
- Provide QR Code access to organised resources so that students can revisit the songs and learning materials independently.
- Monitor access to devices and internet connectivity and provide alternative resources where necessary.
- Teach responsible AI use, including checking AI-generated outputs and respecting copyright, privacy and academic integrity.

Other relevant information

The innovation is designed as a classroom-level pedagogical resource and can be adapted to additional Ceyyul texts and other Tamil literature topics. Its main contribution is the structured human-AI workflow rather than the use of any single application. The present evidence is based on one purposively selected class of 30 students; future studies should involve larger and more diverse samples, control or comparison groups, inferential analysis, and/or mixed methods to examine longer-term learning effects and distinguish the contribution of AI-generated music from other classroom factors.

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ID 137: AI Integration in Ethics Education: An Innovative Approach to Case Creation and Peer Learning

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Highlights: This extended abstract presents an AI-integrated experiential learning innovation implemented in Ethics in Psychology course to strengthen students' ability to apply ethical principles to realistic dilemmas. Guided by Kolb's Experiential Learning Cycle, students generated and critically evaluated AI-assisted ethical cases, transformed them into interactive games, and facilitated peer learning through the *Psychological Insight* programme. The innovation achieved strong learning outcomes, with 95% and 92% of students attaining the respective CLO KPIs. Its key contribution is integrating AI, authentic assessment and experiential learning to transform students from content users into ethical case developers, game designers and peer facilitators.

Keywords: Ethical Dilemma; AI; APA Code of Ethics

Introduction

Ethics in Psychology requires students to recognise ethical issues, analyse dilemmas, apply ethical principles and communicate appropriate recommendations. However, conventional teaching approaches may provide limited opportunities for students to apply ethical knowledge to realistic professional situations. The increasing use of Artificial Intelligence (AI) in higher education provides opportunities to redesign teaching and assessment to become more interactive and authentic. Crompton and Burke (2023) highlighted the growing application of AI in higher education, while Chan (2023) emphasised the importance of responsible and pedagogically meaningful AI integration. Therefore, AI should not simply be used to generate academic content but should support students in developing critical thinking, evaluation and application skills.

In response, an AI-integrated teaching innovation was implemented in SHMY 2093 Ethics in Psychology. The innovation integrated AI-assisted ethical dilemma creation, ethical analysis, game-based learning and peer facilitation through a progressive assessment process. Students created and critically evaluated ethical dilemma cases using AI, developed interactive games based on the cases, and facilitated the games with students from other classes through the Psychological Insight programme. The innovation was guided by Kolb's Experiential Learning Theory, which describes learning through Concrete Experience, Reflective Observation, Abstract Conceptualisation and Active Experimentation (Kolb, 1984; Kolb & Kolb, 2018). Authentic assessment was also incorporated to connect classroom learning with realistic tasks and transferable skills (Sokhanvar et al., 2021). Thus, AI was positioned as an assistive tool, while students remained responsible for evaluating, applying and communicating ethical knowledge.

Objectives

The innovation aimed to:

- enhance students' ability to develop ethical analyses and recommendations for ethical dilemmas;
- strengthen the application of appropriate ethical principles and the APA Ethical Principles of Psychologists and Code of Conduct to case studies; and
- provide an authentic experiential learning environment for applying and communicating ethical knowledge.

NALI Approach

Novelty

The innovation combines AI-assisted ethical dilemma development, ethical analysis, game-based learning, experiential learning and peer facilitation within one coherent assessment process. It also extends learning beyond the classroom through the Psychological Insight programme, where students share their games with participants from other classes.

Creativity
Students transform ethical dilemmas into interactive board or card games, digital games, role-play activities or simulations. AI may be used to support the development of dialogues, branching scenarios, characters, visual materials and quizzes, allowing students to present ethical concepts in engaging and accessible ways.

Innovativeness
Innovativeness: AI is integrated into the learning process rather than used only to generate assignment content. The innovation applies Kolb's Experiential Learning Cycle through four interconnected components: Concrete Experience – students develop realistic ethical dilemma cases; Reflective Observation – students critically evaluate the AI-generated cases, ethical conflicts and possible actions; Abstract Conceptualisation – students identify and apply relevant APA ethical principles and standards to explain the dilemma; and Active Experimentation – students transform their understanding into interactive games and facilitate them during the *Psychological Insight* programme (Kolb, 1984; Kolb & Kolb, 2018). This integration enables students to move from experiencing and reflecting on ethical situations to conceptualising ethical principles and actively applying them in an authentic learning context.

Applicability:
The innovation can be adapted to other psychology and professional courses involving ethical decision-making, such as counselling ethics, research ethics, organisational ethics, educational psychology and digital ethics. It can also be implemented using different AI and digital platforms according to institutional resources, policies and learning objectives.

Innovation Description, Process and Implementation

The innovation was implemented through three connected assessment components:

Component 1: AI Case Generation and Editing
Students selected a realistic psychological setting, such as clinical, counselling, research, organisational or educational contexts. Using AI, they generated a 300–350-word ethical dilemma case containing the situation, ethical conflict, parties involved and possible actions. Students then critically evaluated and edited the AI-generated case for realism and ethical accuracy, identified relevant ethical principles and explained the complexity of the dilemma. The case was submitted for lecturer approval. A progress report with screenshots of AI prompting and interactions was also required to document the development process and promote transparency in AI use.

Component 2: Game Design and AI Integration
After case approval, students developed an interactive game that required participants to explore the dilemma, make decisions and consider the consequences of their choices. Games could take the form of board/card games, digital interactive games, role-play or simulations. AI could support the development of dialogues, scenarios, characters, visuals, cards and quizzes. Students were responsible for reviewing and modifying AI-generated materials to ensure alignment with the ethical principles and learning objectives.

Component 3: Game Facilitation and Peer Learning
Students facilitated their games with participants from other classes during the Psychological Insight programme. They introduced the objectives and game flow, guided participants during gameplay and facilitated discussion of the ethical issues and lessons learned.

Key Findings

The innovation demonstrated strong achievement of the targeted course learning outcomes.

For CLO 1: "Develop ethical analyses and recommendations in ethical dilemmas that commonly arise in psychology according to Ethical Principles of Psychologists and Code of Conduct," 95% of students achieved the KPI. This indicates strong achievement in analysing ethical dilemmas and developing appropriate recommendations.

For CLO 2: "Apply the appropriate Ethical Principles for Psychologists and Code of Conduct according to APA in case studies," 92% of students achieved the KPI. This demonstrates students' ability to apply ethical principles to case-based situations.

The assessment structure provided evidence across process, product and performance. The progress report and AI prompting screenshots documented the learning process; the final ethical dilemma assessed ethical analysis; and the game design and facilitation assessed the application and communication of ethical knowledge. The high KPI achievement rates of 95% and 92% indicate strong attainment of the intended learning outcomes.

Impact

The innovation created impact at three main levels. At the student level, it provided opportunities to develop ethical reasoning, critical thinking, AI literacy, creativity, collaboration and communication. Students moved from receiving ethical knowledge to becoming case developers, game designers and peer facilitators. At the assessment level, the approach broadened assessment from a final written product to process, product and performance. Evidence of AI use, case development, game design and facilitation allowed students to demonstrate learning in multiple ways.

At the classroom and programme levels, the approach promoted student-centred experiential learning and extended learning beyond the classroom through the Psychological Insight programme. Students also gained experience communicating psychological ethics to a wider audience. Overall, the innovation provides a practical approach for responsible AI integration while maintaining disciplinary knowledge, critical thinking and student accountability (Chan, 2023).

Recommendations for Classroom Practice

AI should be positioned as an assistive tool that requires students to critically evaluate, edit and verify AI-generated content while providing process evidence to promote transparency and responsible use. Progressive assessment combining case development, game design and facilitation can provide students with opportunities to apply ethical knowledge through authentic and experiential learning activities. Future implementation should evaluate learning outcomes through CLO achievement, student feedback and assessment evidence, with pre- and post-intervention measures considered to further examine the effectiveness of the innovation. In SHMY 2093, the innovation demonstrates how AI-assisted learning, experiential learning, game-based learning and authentic assessment can be integrated into Ethics in Psychology. The achievement of 95% for CLO 1 and 92% for CLO 2 provides evidence of strong learning outcome attainment. The approach moves students beyond learning ethical principles towards creating, analysing, applying and communicating ethical knowledge in authentic contexts.

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ID 138: From Prompt to Practice: Human–AI Co-Consultancy through the Halal Integrity Business Model Canvas (HI-BMC)

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Highlights: This teaching innovation embeds Work-Based Learning (WBL) in Islamic Marketing by positioning students as young halal business consultants. Forty-four students in eight teams interacted with managers and entrepreneurs from 23 SME organisations, gathered authentic business intelligence, and used an educator-designed prompt to produce 13-element Halal Integrity Business Model Canvas (HI-BMC) analyses. Drafts were presented to SMEs for validation and refinement. A retrospective pre–post survey showed overall perceived competency increasing from 2.77 to 4.26 (+1.49), with the largest gain in HI-BMC consultancy (+1.59). The approach develops industry-based consultancy and responsible AI competencies while providing participating SMEs with structured insights for strengthening their strategies and growth within the halal industry.

Keywords: Human–AI synergy; Work-Based Learning; Halal Integrity Business Model Canvas; Halal business education; Prompt engineering

Introduction

Higher education increasingly requires graduates who can connect disciplinary knowledge with authentic industry practice and responsible use of artificial intelligence (AI). In Islamic marketing education, this means moving beyond classroom understanding of halal principles toward the ability to analyse real businesses, communicate with entrepreneurs, and formulate strategic recommendations grounded in Shariah values and market realities.

This paper presents a WBL teaching innovation implemented in SBSF 3133 Islamic Marketing at Universiti Teknologi Malaysia (UTM). Through the Young Halal Marketing Lab (YHML), students were positioned as young consultants and engaged directly with managers and entrepreneurs from 23 SME organisations at the Halal Sukses programme organized by Johor Halal Development Corporation. The pedagogy integrates authentic SME interaction, the newly developed Halal Integrity Business Model Canvas (HI-BMC), and structured AI prompt engineering to support halal business analysis and strategy development. After collecting company-specific information on products, customers, operations, halal practices, marketing and sustainability, students used an educator-designed prompt to generate a draft 13-element HI-BMC analysis. The draft was then presented to the relevant SME for attention, validation and refinement.

AI therefore functioned as a co-consultant that synthesised human-gathered intelligence rather than replacing fieldwork (Nawaz et al., 2025). The learning cycle simultaneously supported students' real industry-based learning and provided SMEs with practical insights for strengthening their positioning and growth in the halal industry. This teaching innovation is also consistent with Kolb's Experiential Learning Theory, as students move through concrete experience with SMEs, reflective observation, conceptual analysis using the HI-BMC, and active experimentation through AI-assisted consultancy and stakeholder validation (Kolb, 1984).

Objectives

This innovation achieves four (4) interrelated objectives:

- Develop students' practical halal business analysis and consultancy competency through direct interaction with real SME entrepreneurs and managers.
- Build responsible AI literacy by using a structured, domain-specific prompt to transform authentic industry data into a 13-element HI-BMC analysis.
- Apply Islamic marketing values including *amanah* (trustworthiness), *sidq* (truthfulness), and *ihsan* (excellence) when interpreting, validating and communicating AI-assisted business recommendations.
- Create reciprocal WBL value by providing participating SMEs with structured halal business and marketing insights while enabling educator-researchers to validate the applicability of the newly developed HI-BMC model.

NALI Approach

Novelty

The innovation combines three distinctive elements within an authentic Islamic marketing WBL setting:

- HI-BMC as an Enhanced Halal Business Modelling Tool: The newly developed 13-element HI-BMC enhances the conventional Business Model Canvas (Osterwalder & Pigneur, 2010) by explicitly incorporating halal integrity, Islamic values, governance, sustainability and strategic considerations (Figure 2). Applying it across 23 SME organizations also provided an authentic educational platform for initial validation of its relevance to halal business management and strategy.

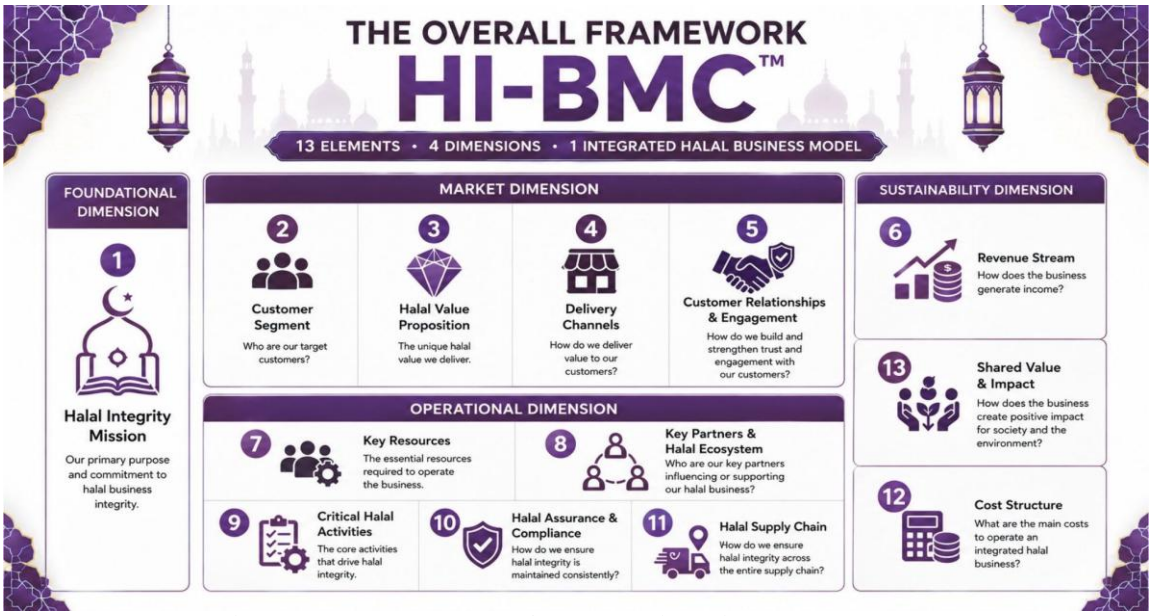


Figure 1: Overall Framework of Halal-Integrity Business Model Canvas

- Domain-Specific Prompt Engineering as a Teaching Scaffold: Rather than permitting unguided AI use, students worked with a structured educator-designed prompt that required authentic SME data. Prompting therefore became a disciplined bridge between field intelligence and systematic business analysis (Figure 3).

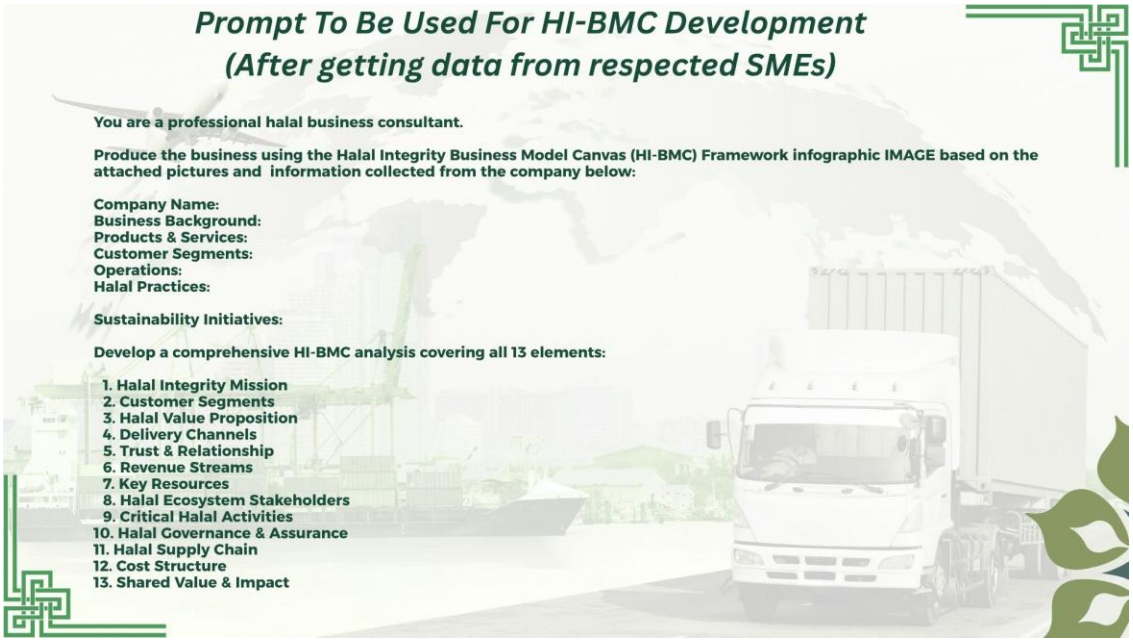


Figure 2: Prompt Engineering as a Teaching Scaffold

- Human–AI Co-Consultancy in WBL: SME knowledge, student observation and consultancy interaction, and AI-supported synthesis converged into a draft HI-BMC that returned to the SME for human validation. The final learning artefact was therefore co-produced through a Human–AI–Human process rather than generated by AI alone.

Creativity

- Canva–WhatsApp Learning Deployment: Canva served as the shared digital workshop platform for the Young Halal Marketing Lab, where all students enrolled in the Islamic Marketing class accessed learning materials and consultancy activities. WhatsApp complemented this environment by enabling rapid distribution of the structured prompt, instructions, reminders and peer communication during the WBL process.
- HI-BMC Infographic as a Consultancy Output: Students translated their analysis into a visually structured HI-BMC that could be presented directly to SME entrepreneurs and managers. The output combined analytical thinking with professional visual communication rather than relying solely on a conventional written assignment.
- Islamic Values Embedded in AI Guidance: The prompt framed the AI as a professional halal business consultant and required analysis to consider halal integrity, responsible marketing, stakeholder value and sustainability, encouraging students to evaluate AI-supported recommendations via an Islamic business lens.
- Young Halal Marketing Lab Consultancy Experience: Students worked as named young consultancy teams within a structured workshop environment, moving from industry interaction to analysis, presentation and reflection. This created a professional identity and sustained experiential learning via the WBL initiative.

Innovativeness

The practice transforms Islamic marketing pedagogy from passive knowledge reception to authentic industry consultation; from generic AI use to structured Human–AI co-analysis; from simulated classroom cases to real SME-based assessment; and from a conventional BMC exercise to an enhanced halal-focused strategic analysis using the HI-BMC. It also creates reciprocal value: students gain real consultancy experience, SMEs receive strategic insights, and educator-researchers obtain practice-based evidence on the applicability of the HI-BMC.

Applicability

- This teaching approach is replicable across entrepreneurship, marketing, supply chain, hospitality and other business courses that use authentic organizational problems as WBL inputs.
- The teaching approach uses accessible platforms already familiar to students namely Canva, WhatsApp and a generative AI tool; alongside direct industry engagement.
- The prompt and HI-BMC can be adapted to different halal-related organisations, including F&B SMEs, manufacturers, service firms, logistics providers and cottage industries.
- The model is scalable for university–industry collaboration because the same Human–AI–Human consultancy cycle can be repeated with different cohorts, sectors and SME partners while preserving stakeholder validation.

Innovation Description, Process and Implementation

The innovation operationalizes NALI 2026 Human–AI Synergy through a three-stage Human–AI–Human learning sequence. Beyond student learning, the WBL setting also served as an authentic validation platform for educator-researchers to examine the applicability of the newly developed HI-BMC, which is an enhanced business modelling tool that extends the conventional Business Model Canvas by zooming into halal business management, integrity and strategy.

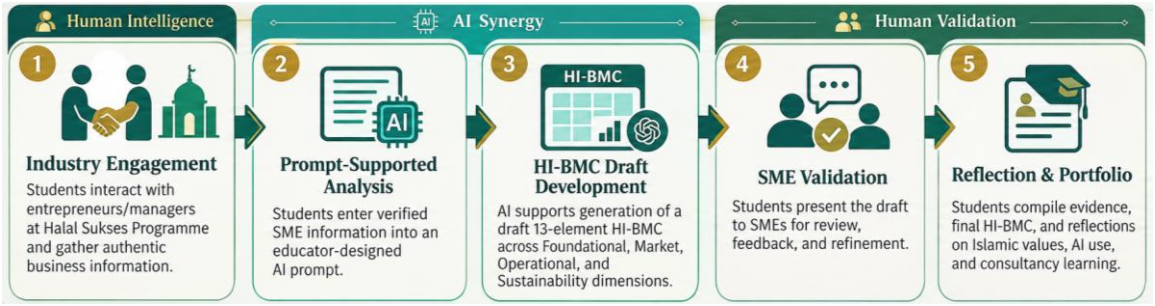


Figure 3: Prompt Engineering as a Teaching Scaffold

Stage 1 — Human Intelligence: Student teams interacted directly with entrepreneurs and managers from 23 SME organizations, using observation and consultation to gather authentic information on the businesses, markets, operations, halal practices and growth challenges (Figure 1). This ensured that subsequent AI outputs were grounded in real industry evidence rather than generic assumptions.




Figure 4: Students interacted directly with entrepreneurs

Stage 2 — AI Synergy: Students inserted the verified SME information into the educator-designed prompt. Generative AI then supported the students, acting as young consultants, in synthesizing the information into a draft 13-element HI-BMC covering four dimensions: Foundational, Market, Operational and Sustainability.

Stage 3 — Human Validation: Students presented the AI-assisted HI-BMC draft to the relevant SME for review and attention, refined it where feedback was received, and documented the process in their WBL portfolio. This returned decision-making to human stakeholders and completed an authentic industry-based learning loop consistent with the spirit of WBL.

The innovation was implemented during Weeks 8–16 of SBSF 3133 Islamic Marketing in Semester 2, 2025/2026, involving 44 students organized into eight Young Halal Marketing Lab consultancy teams. Collectively, the teams approached 23 SME organizations and analyzed their halal business and marketing strategies using the HI-BMC. The WBL process was organized into four structured tasks.

Table 1: Human–AI Co-Consultancy WBL Implementation Tasks

TASK	ACTIVITY	DESCRIPTION
1	Industry Engagement	Teams engage real SME entrepreneurs/managers and collect business intelligence on background, products, customers, marketing, operations, halal practices and sustainability. Across the cohort, 23 SME organisations were approached.
2	Prompt-Supported HI-BMC Analysis	Students enter verified SME information into the educator-designed prompt distributed through WhatsApp. AI supports preparation of a draft 13-element HI-BMC, which students refine and present professionally.
3	Consultancy Validation	Students present the draft HI-BMC to the relevant SME for attention and validation, incorporating feedback where available and documenting the interaction as authentic WBL evidence.
4	Portfolio & Reflection	Students compile engagement evidence, the prompt used, final HI-BMC, industry communication and individual reflection on AI use, Islamic values and consultancy learning.

The structured prompt acts as a pedagogical scaffold rather than a substitute for student thinking. Its effectiveness depends on the quality of field intelligence students collect from SMEs: richer human input produces a more contextualised draft, while SME review exposes students to the professional responsibility of defending, correcting and refining their recommendations. This sequence closely reflects WBL by connecting learning, workplace interaction and application (Raelin, 2008).

Evaluation of Learning Gains: To supplement the implementation evidence, a retrospective pre–post survey was administered after completion of the WBL experience. Thirty-four students provided usable responses. Using a five-point scale (1 = Very Low; 5 = Very High), students rated their perceived competency before and after the WBL experience across six dimensions: WBL application, halal business competency, HI-BMC consultancy, prompt engineering, industry communication, and AI-assisted learning. Because the ratings were paired and ordinal, two-sided Wilcoxon signed-rank tests were used to examine pre–post differences.

Key Findings

- Industry Reach and Authenticity: Forty-four students in eight consultancy teams approached 23 SME organizations and analyzed authentic halal business and marketing strategies, giving students exposure to diverse business contexts rather than a single simulated case.
- HI-BMC Application and Model Validation: Student teams translated field intelligence into complete 13-element HI-BMC analyses. Application across 23 SME organizations also generated practice-based evidence that the enhanced canvas can function as both a teaching tool and a strategic conversation framework for halal-oriented businesses.
- Prompt-to-Practice, SME Validation and Responsible AI: The structured prompt helped students transform field data into an initial professional draft that had to be reviewed critically and presented back to SMEs. This closed the WBL loop through stakeholder validation while reinforcing human verification, professional communication, and Islamic values such as sidq, amanah and Al-'Adl in AI-assisted analysis.
- Retrospective Pre–Post Learning Gains: The survey of 34 students showed improvement across all six learning dimensions, providing direct student-reported evidence of the learning impact of the Human–AI co-consultancy WBL approach.

Table 2: Retrospective Pre–Post Student Learning Gains (n = 34)

LEARNING DIMENSION	PRE-MEAN	POST MEAN	MEAN GAIN
Work-Based Learning application	2.79	4.21	+1.41
Halal business competency	2.62	4.15	+1.53
HI-BMC consultancy competency	2.74	4.32	+1.59
Prompt engineering	3.03	4.50	+1.47
Industry communication	2.59	4.03	+1.44
AI-assisted learning	2.88	4.35	+1.47
Overall Mean	2.77	4.26	+1.49

Note. Scale: 1 = Very Low to 5 = Very High. All six paired differences were statistically significant (two-sided Wilcoxon signed-rank tests, all $p < .001$). HI-BMC consultancy recorded the largest mean gain (+1.59), while prompt engineering achieved the highest post-WBL mean (4.50).

Impact

Students: Developed AI-augmented halal consultancy competency through real entrepreneur engagement, HI-BMC analysis and industry communication. This impact is supported by retrospective survey evidence showing an overall perceived competency increase from 2.77 to 4.26 (+1.49), with significant gains across all six dimensions ($p < .001$). **SMEs:** Received structured insights on halal positioning, marketing, operations and growth opportunities.

Educator-Researchers: Gained an authentic platform to examine and refine the newly developed HI-BMC through application across 23 SME organizations.

Institution and Pedagogy: The practice strengthens university–industry WBL and demonstrates a replicable Human–AI co-consultancy model in which AI augments, rather than replaces, human judgement and stakeholder validation.

Recommendations for Classroom Practice

- Anchor AI use to authentic industry engagement: require students to collect verified workplace information before prompting so that AI extends, rather than replaces, human inquiry.
- Use a structured disciplinary prompt and analytical framework: clearly define the AI role, expected evidence and HI-BMC elements to improve consistency while retaining student judgement.
- Make stakeholder validation part of assessment: require students to present the draft to entrepreneurs or managers, document feedback and revise where appropriate.
- Integrate ethical reflection: students should evaluate AI-supported recommendations for accuracy, halal integrity, Islamic values, potential bias and professional responsibility.

Other relevant information

The HI-BMC is a proprietary pedagogical innovation developed by our team and will be registered through UTM INNOCOM. Its use within this WBL initiative demonstrates its dual potential as an educational analytical tool and a structured framework for halal business strategy discussion with industry stakeholders.

Evaluation Limitation and Next Cycle: The retrospective design captures student-reported perceived competency gains rather than objective performance change and may be influenced by recall or self-assessment bias. Future implementation will triangulate prospective pre–post measures with rubric-based evaluation of HI-BMC outputs and structured SME feedback to compare perception, demonstrated performance and industry validation.

Acknowledgement

The authors acknowledge the 44 students of SBSF 3133 Islamic Marketing (Semester 2, 2025/2026), Faculty of Management, UTM; Johor Halal Development Corporation; and the entrepreneurs and managers representing the 23 SME organisations whose participation enabled the authentic WBL consultancy experience.

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ID 139: Mathematical Thinking Engine with AI Theorem Proving: Human-AI Synergy in Proof for Engineering Mathematics Pedagogy

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Highlights: Engineering students often struggle to integrate physical intuition with mathematical formalism, and formal proof construction remains a major hurdle. This innovation introduces the Mathematical Thinking Engine (MTE), an AI-augmented framework that pairs Generative AI (LLMs) for proof-strategy generation with Formal Proof Assistants (Lean 4, AlphaProof, AlphaGeometry) for rigorous, machine-verified reasoning. Structured through an Engineering Cognition Loop and a Proof Construction Loop, the MTE scaffolds students from intuitive problem framing to machine-checked proof, turning passive equation-followers into critical, verifying problem-solvers. Pilot results show a 47.3% learning gain, 92.5% recommendation accuracy and 87% proof-verification success, embodying human-AI synergy in personalised learning.

Keywords: Mathematical Thinking; Neuro-Symbolic AI; Formal Proof Assistants; Engineering Education; Human-AI Synergy

Introduction

The NALI 2026 theme, "Human-AI Synergy in Pedagogy," calls for new approaches to teaching higher-order cognitive skills. In engineering mathematics, mathematical reasoning and proof construction remain persistent hurdles: students can perform calculations yet struggle to formulate problems, integrate physical intuition with mathematical formalism, or justify why a result is true (Mason et al., 2010; Firouzian et al., 2016). This gap reflects underdeveloped mathematical thinking, the cognitive infrastructure that turns engineers into innovators rather than equation-followers.

The emergence of AI-assisted theorem proving:AlphaProof, AlphaGeometry and Lean 4 paired with AI agents, combines neural networks that propose proof strategies with formal proof assistants that verify every step, giving a hard guarantee that a proof is either fully verified or rejected (Davies et al., 2021; Trinh et al., 2024; de Moura & Ullrich, 2021). This extended abstract presents the Mathematical Thinking Engine (MTE), which operationalises the empirically validated overlap between Mathematical Thinking (MT) and Computational Thinking (CT) , the "Blended Thinking" construct , through an Engineering Cognition Loop extended with a Proof Construction Loop, shifting students from passive recipients of theorems to active architects and critical verifiers of mathematical truth.

Objectives

- To develop an AI-augmented cognitive framework (MTE) that bridges Mathematical Thinking and Computational Thinking using Generative AI, MATLAB and Formal Proof Assistants (e.g., Lean 4, AlphaProof).
- To enhance students' problem-solving and proof-construction skills through a structured Engineering Cognition Loop and Proof Construction Loop that mirror expert engineering reasoning.
- To integrate neuro-symbolic theorem proving, LLMs for strategy generation, formal provers for step-by-step verification, into undergraduate engineering mathematics.
- To provide educators with evidence-based AI-pedagogy strategies, automated machine-checked assessment tools, and an empirical (SEM-AMOS) evaluation of the MTE's impact on mathematical confidence and conceptual understanding.

NALI Approach

Novelty

Unlike AI tutors that supply direct answers, the MTE is grounded in the empirically validated "Blended Thinking" construct: SEM-AMOS analysis of 273 professionals confirms a significant MT–CT overlap (13.1% shared variance, $r = .363$, $p < .001$). The MTE is the first pedagogical framework to embed neuro-symbolic

theorem proving, pairing LLMs that propose proof strategies with formal assistants (Lean 4, AlphaProof, AlphaGeometry, Aristotle, Mathos AI, AxiomProver) that verify every step — into undergraduate engineering mathematics, creating a Human–AI–MATLAB–Formal-Prover collaborative quartet absent from existing engineering-education tools.

Creativity
The MTE creatively fuses Mason's mathematical powers (specialising, generalising, conjecturing, convincing) with GenAI prompt-engineering, MATLAB's computational ecosystem and formal verification. Its four-layer architecture adds a Theorem-Proving Interface linking to Lean 4, AlphaProof, AlphaGeometry, Aristotle, Mathos AI and AxiomProver, enabling progressive disclosure from informal reasoning to fully formal, machine-checked proofs. Adaptive scaffolding sustains a "productive struggle zone" where AI offers hints rather than solutions, while proof-based activities, verifying thermodynamic cycles, structural derivations and control-algorithm correctness, embed formal reasoning directly into engineering practice.

Innovativeness
The MTE reframes assessment from subjective grading to objective, machine-checked logical consistency. Its Engineering Cognition Loop (Observation → Formalisation → Implementation → Theorem Proving → Interpretation) pairs with a four-phase Proof Construction Loop (Framing, Strategy Proposal, Formal Verification, Reflection): a submitted conjecture returns either a machine-verified proof or a counterexample. LLM agents propose tactics that Lean 4 or equivalent provers verify, turning proof debugging into a structured learning activity new to undergraduate engineering pedagogy.

Applicability
The MTE's modular, four-layer architecture adapts across STEM disciplines requiring rigorous logic and can be tuned from informal proof sketches to fully formal Lean 4 proofs depending on course readiness. Its agent catalogue and cloud/LMS-ready deployment support replication across institutions and scaling from a single class to thousands of users. A phased roadmap, free tier, premium, enterprise and professional-development offerings — provides a sustainable pathway for long-term adoption.

Innovation Description, Process and Implementation

The MTE is a cognitive-augmentation framework integrating MATLAB's computational capabilities with Generative AI and neuro-symbolic AI theorem proving across mechanical, civil, electrical, chemical and industrial engineering workflows, via a four-layer architecture: (1) a User Interface with a Proof Editor/Checker; (2) an AI Augmentation layer with a Proof Strategy Agent; (3) an Engineering Computation and Formal Verification layer integrating Lean 4, AlphaProof, AlphaGeometry, Aristotle, Mathos AI and AxiomProver; and (4) the MATLAB Core Platform.

In the Neuro-Symbolic AI Pedagogy Sandbox (NSAPS), an LLM proposes candidate proof steps, a formal assistant verifies each step, and the system returns a machine-checked proof or a counterexample — mirroring how Lean 4 acts as a "compiler for truth." Learning is structured through two interlocking loops (Table 1): the Engineering Cognition Loop, now including a Theorem Proving and Formal Verification phase, and the Proof Construction Loop.

Table 1: The Engineering Cognition Loop and Proof Construction Loop, integrating AI theorem proving.

PHASE	COGNITIVE FOCUS	AI / TOOL INTEGRATION	HUMAN-AI SYNERGY ACTION
1. Observation & Framing	Physical intuition, problem framing	—	Student frames a physical/engineering problem as a formal mathematical conjecture.
2. Formalisation & Strategy Proposal	Abstraction, tactic selection	LLM (neural network)	AI proposes candidate proof strategies (e.g., induction, contradiction).
3. Implementation & Formal Verification	Computational execution, logical deduction	Formal prover (Lean 4 / AlphaProof)	Student codes the proof; the prover verifies or rejects each step.
4. Reflection & Interpretation	Metacognition, generalisation	—	Student reviews the verified proof and generalises it to broader engineering contexts.

Pre-class, students work asynchronously with AI geometry/algebra provers and Socratic AI prompts. In class, pairs alternate as "Intuition Guide" and "Formal Translator," using Lean 4 with AI agents to write and debug proofs collaboratively. Post-class, students submit machine-verified scripts and reflective journals comparing AI-suggested strategies with their own intuition, illustrated by a wind-turbine blade-design case study spanning framing, optimisation and Lean-4-verified structural constraints.

Key Findings

- Learning gains: Achieved a 47.3% learning-gain score, with the strongest gains in Problem Solving (52%) and Representation (49%).
- System performance: Recommendation accuracy of 92.5%; response latency of 3.2 s (simple) to 42.7 s (complex, multi-domain) queries.
- Theorem-proving performance: Among 40 students, the AI Theorem Proving Module verified 87% of submitted derivations, flagged 92% of logical errors, and produced counterexamples for 78% of invalid attempts; theorem-proving users showed 23% greater gains in proof-construction skill than a control group.
- SEM-AMOS validation (N = 273): MT and CT share 13.1% variance ($r = .363$, $p < .001$) and jointly explain 23.9% of variance in Blended Thinking, confirming it as a measurable construct; qualitatively, debugging rejected Lean 4 proofs reduced proof anxiety and deepened conceptual understanding ("the theorem prover showed me exactly where my logic failed").

Impact

For Students: The MTE turns "equation-followers" into "augmented engineers," building resilience, proof-construction competence and transferable skills in representation, connections and communication; 75% of users reported increased mathematical confidence.

For Educators: The framework offers an evidence-based route to integrating GenAI into STEM curricula without sacrificing rigor, redefining the teacher's role from "knowledge-dispenser" to "cognitive architect," while automated proof-checking reduces grading workload and reveals rich data on student reasoning.

For Institutions: The MTE aligns graduate outcomes with Industry 5.0 by producing engineers fluent in both creative and machine-verified formal reasoning — skills central to AI safety and software verification — while its cloud/LMS-ready, modular design supports scaling from a single course to institution-wide adoption and cuts time-to-solution for routine problems by roughly 30%.

Recommendations for Classroom Practice

- Start with visual, geometric proofs (AlphaGeometry, Mathos AI) before moving to abstract algebra or calculus, scaffolding concrete-to-formal reasoning.
- Design for productive struggle: configure AI to give Socratic hints, not answers, and let students work through being "stuck."
- Pair students as "Intuition Guide" and "Formal Translator" to promote collaborative proof construction and peer debugging.
- Use "Proof Debugging" exercises with partially correct, machine-rejected scripts, and keep the human in the loop by requiring students to justify why an AI-suggested tactic is mathematically sound before formalising it.

Other relevant information

Commercialisation potential includes an "Engineering Mathematics through AI-Augmented Thinking" textbook and a "Formal Methods for Engineers" Lean 4 sandbox, educator certification workshops. The MTE's architecture, cognition and proof-construction loops, and theorem-proving integration protocols are the subject of UTM copyright.

Acknowledgement

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ID 140: EduAdapt AI: An AI-Enhanced Assessment and Adaptive Learning Platform

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Highlights: EduAdapt AI addresses the limitations of static lecture materials by transforming lecturer-provided PDFs into content-grounded assessment and adaptive practice. The platform structures lecture content into Knowledge Units (KU) and Knowledge Points (KP), generates and validates multiple-choice questions, and uses students' practice performance to provide targeted revision based on weaker learning areas. A preliminary evaluation by six experienced lecturers found the generated questions suitable for learning or assessment with minor revision. EduAdapt AI supports both classroom assessment and students' independent revision while maintaining lecturer oversight in AI-generated assessment.

Keywords: Automated Question Generation; Artificial Intelligence; Adaptive Learning; Learning Analytics

Introduction

Digital lecture materials such as PDF notes are widely used in higher education because they are easy to distribute and access. However, students may become too dependent on reading static lecture materials without enough opportunities to actively practise and assess their understanding. Personalised and adaptive learning approaches can support students by providing learning activities according to their individual learning needs and performance (du Plooy et al., 2024).

For lecturers, preparing quizzes and assessment questions manually can also be time-consuming. Automated question generation can help reduce part of this workload and support the preparation of learning activities (Al Faraby et al., 2024). Even so, generated questions still need to be relevant to the lecture content and suitable for students to use. Students may also perform differently across topics. Some may understand one chapter well but still struggle with another. Personalised learning can help by adjusting learning activities according to students' needs, weaknesses and progress (Tapalova & Zhiyenbayeva, 2022).

To address these issues, EduAdapt AI was developed as an AI-enhanced learning platform for assessment and adaptive practice. The system processes PDF lecture materials into Knowledge Units (KU) and Knowledge Points (KP) to keep the generated questions grounded in the provided lecture content, generates and checks multiple-choice questions, and records students' personal practice performance. Based on their weaker chapters and KPs, the system can provide more targeted practice. Lecturers can also create quizzes and view class performance separately from students' personal adaptive learning records.

Objectives

- To extract and structure Knowledge Units and Knowledge Points from PDF lecture materials to support content-grounded question generation.
- To generate and validate multiple-choice questions from the identified lecture content using AI techniques.
- To provide targeted adaptive practice based on students' identified learning weaknesses.

NALI Approach

Novelty

EduAdapt AI introduces a structured approach to automated question generation by processing lecture materials slide by slide, where each slide is treated as a Knowledge Unit (KU) and important concepts are identified as Knowledge Points (KP) before question generation. Unlike general-purpose GenAI tools that generate questions directly from uploaded materials, EduAdapt AI uses the identified KUs and KPs to keep questions grounded in the lecture content and validates them before use. The platform further connects students' personal practice performance with learning analytics and adaptive practice, allowing weaker chapters and KPs to determine subsequent exercises.

Creativity
The platform combines several learning functions in one system instead of treating them as separate tools. Lecture materials are first converted into structured content and then used to generate multiple-choice questions. These questions can be used for students' personal practice results or for quizzes created by lecturers. Students' personal exercise results are then used to show performance and guide adaptive practice. This creates a continuous flow from lecture materials to assessment, performance tracking and targeted practice, without requiring students or lecturers to move between different systems.

Innovativeness
EduAdapt AI improves the usual way of preparing and using digital learning materials by connecting lecture content, assessment and adaptive practice in one platform. Instead of requiring lecturers to prepare all quiz questions manually, the system can generate multiple-choice questions from uploaded lecture materials and check the generated questions before they are used. Student practice results are also not only displayed as scores but are used to identify weaker chapters and Knowledge Points for targeted practice. This allows the same lecture materials to support question generation, performance tracking and personalised practice.

Applicability
EduAdapt AI can support different subjects if suitable lecture materials are available in PDF format. Lecturers can use the generated questions for revision, formative assessment or classroom quizzes, while students can use the platform for personal practice. Since questions are generated from the uploaded lecture content, the platform can be adapted and replicated across different courses and faculties. With further development, it could be scaled for institutional use and integrated with existing learning management systems for more sustainable long-term use.

Innovation Description, Process and Implementation

EduAdapt AI is a web-based learning platform designed for both lecturers and students. It connects lecturer-provided learning materials with automated assessment, performance monitoring and adaptive practice. Lecturers can upload lecture notes, generate questions, create quizzes and monitor class performance, while students can complete personal practice, review their performance and receive targeted practice based on weaker learning areas. The overall workflow of the platform is shown in Figure 1.

When a PDF lecture file is uploaded, the system processes the content slide by slide, with each slide treated as a KU. Meaningful KP are identified and validated before being used for question generation. A T5-based model generates candidate questions, which are checked using a question-answering model to determine whether they lead to the intended answers. Distractors are generated from the lecture content, filtered and ranked using semantic similarity, with a language model used as a fallback when insufficient suitable distractors are available. The final multiple-choice questions are stored in the question bank and remain traceable to their source lecture content.

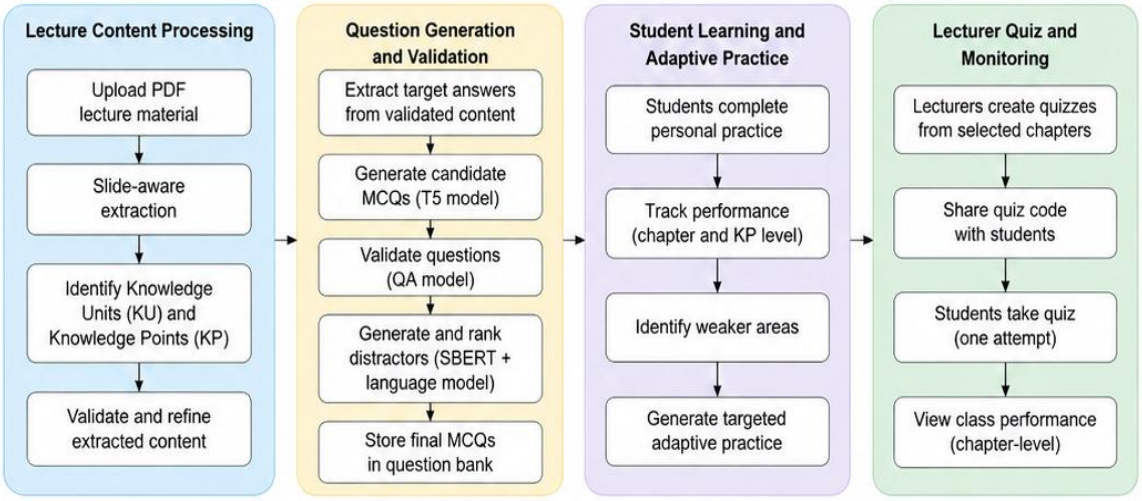


Figure 1: Overall workflow of EduAdapt AI

Students can use the generated questions for personal practice, while their results are recorded to show overall accuracy, performance trends and chapter mastery. As shown in Figure 2, the performance

dashboard allows students to monitor their learning progress across practices and chapters. The adaptive learning process uses these personal practice records to identify weaker chapters and KPs, and prioritises unseen, previously incorrect or less frequently attempted questions for targeted practice.

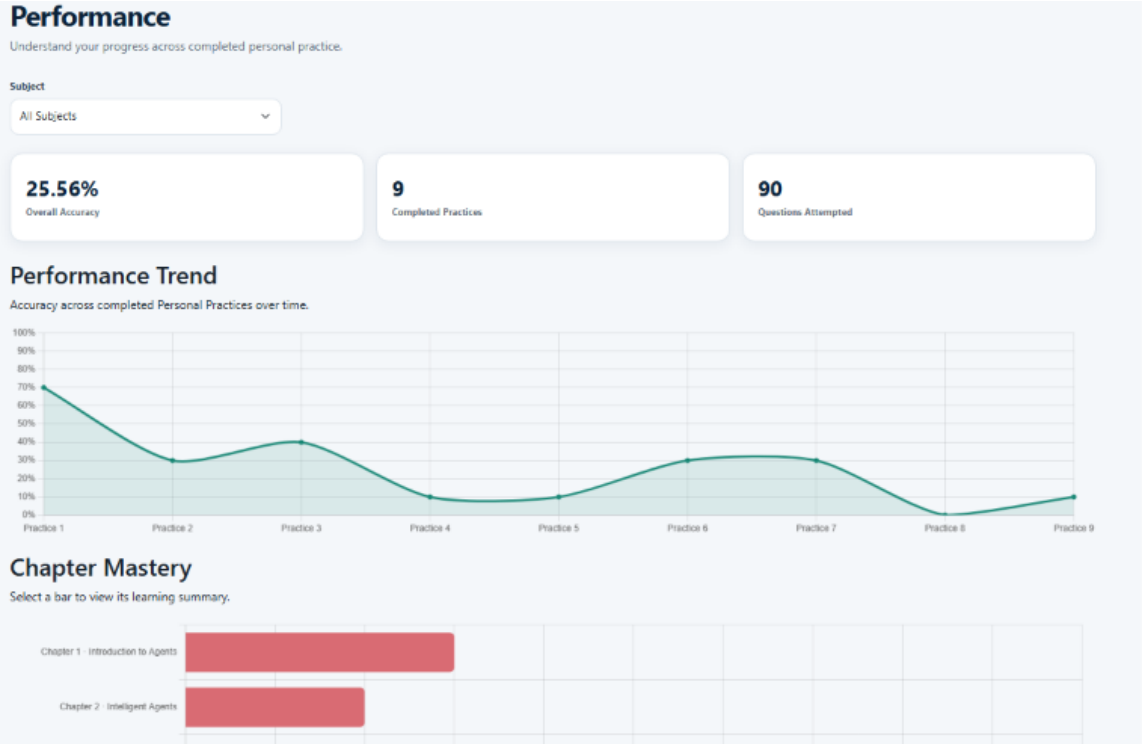


Figure 2: Student performance dashboard showing learning progress and chapter mastery

Lecturers can also create quizzes using questions from selected chapters and monitor quiz and chapter-level class performance. Quiz results are kept separate from students' personal practice records so that formal quiz performance does not affect the individual adaptive-learning process.

Key Findings

EduAdapt AI successfully integrates PDF content processing, validated question generation, performance tracking and adaptive practice within one platform. In a preliminary evaluation, six experienced lecturers assessed ten AI-generated MCQs. Mean scores were 3.92/5 for relevance, 3.73/5 for answer correctness, 3.42/5 for clarity, 3.35/5 for educational usefulness and 2.95/5 for distractor plausibility. All six lecturers considered the questions suitable for learning or assessment with minor revision, although distractor quality requires further improvement.

Impact

EduAdapt AI provides students with opportunities to practise lecture content, monitor their performance and receive targeted practice based on weaker learning areas. For lecturers, automated question generation can reduce the effort required to prepare practice questions and quizzes, while maintaining lecturer oversight before formal use. By combining AI-generated assessment with lecturer review and performance-driven adaptive learning, the platform supports a human-AI approach to teaching and learning.

Recommendations for Classroom Practice

EduAdapt AI can be integrated into classroom activities and students' self-learning. Lecturers can use quizzes during class to assess understanding and identify topics requiring further explanation, while students can use personal practice for independent revision and receive targeted exercises based on their learning weaknesses. The platform can be adapted to different subjects using relevant PDF lecture materials. For effective implementation, lecturers should review generated questions before formal use and encourage regular personal practice so that sufficient performance data are available to support adaptive learning.

Other relevant information

Commercialization Potential - EduAdapt AI has potential for further development as an institutional or commercial learning platform. Its content-based approach allows the platform to be adapted across different subjects using lecturer-provided materials. Future development could include integration with learning management systems and expansion for wider institutional use.

Acknowledgement

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ID 142: PITCH: A Human–AI Accountability Framework for Authentic Group Assessment

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Highlights: PITCH addresses an assessment problem in the AI era: polished group work may conceal uneven individual understanding. The five-stage framework moves students from AI-supported preparation to evidence verification, coordinated professional roles, concise communication and independent human defence. Implemented with 92 enrolled students, PITCH produced collaborative attainment while revealing gaps in spontaneous individual reasoning. Its key contribution is a transferable accountability process that preserves useful AI support while making students' ownership of evidence, judgement and decisions visible.

Keywords: Generative AI; Authentic assessment; Assessment accountability; Pecha Kucha

Introduction

Generative AI can support students in preparing reports, scripts and presentation slides. However, a polished group submission may not accurately reflect each student's understanding, contribution or ability to justify the decisions presented. Assessment must therefore allow useful AI support while preserving human responsibility for evidence and judgement, consistent with human-centred AI principles (Miao & Holmes, 2023).

This challenge was observed in SBSF2133 Pricing Decision at UTM. Pricing decisions require students to connect customer value, costs, competitor responses and commercial priorities (Schindler, 2012). In group assignments, students often prepared separate sections without fully understanding how their decisions affected other functions. Consequently, a strong group presentation could conceal fragmented thinking and uneven individual understanding.

The PITCH Framework addresses this problem through five stages: Prepare with AI (P), Investigate Evidence (I), Take Executive Roles (T), Communicate the Proposal (C) and Human Defence (H). It allows AI to support preparation while requiring students to verify, connect, communicate and independently defend their decisions. Although initially implemented in Pricing Decision, its process-based structure was designed for adaptation to other subjects.

Objectives

- Integrate responsible AI-supported preparation, evidence verification, cross-functional decision-making, concise communication and individual oral defence within one authentic assessment framework.
- strengthen students' ability to connect knowledge, communicate essential information and justify decisions independently.
- Examine initial effectiveness using assessment performance, CLO-PLO attainment, student perception polls and qualitative reflections.

NALI Approach

Novelty

Existing studies examine Pecha Kucha, authentic assessment, oral assessment and human-centred AI for different purposes (Haramba et al., 2024; Vlachopoulos & Makri, 2024; Fenton, 2025; Miao & Holmes, 2023). PITCH's distinctive contribution is their integration into a sequenced accountability framework that progresses from AI assistance to student-verified evidence, coordinated decisions and independent defence.

Creativity

PITCH transforms a group assignment into an executive board challenge. Interdependent roles, image-only timed slides, rapid use of feedback and unexpected questions require students to select, connect, revise and defend one shared recommendation. This reflects authentic assessment principles involving meaningful tasks, agency, collaboration and judgement (Zhan et al., 2025).

Innovativeness
PITCH shifts attention from the polished product to evidence of reasoning throughout the assessment. AI supports preparation, while responsibility for verification, cross-functional judgement and live defence remains human. Oral interaction examines understanding beyond rehearsed responses and mirrors professional practice (Fenton, 2025).

Applicability
The framework is based on a decision process rather than Pricing Decision content. Roles, evidence and scenarios can be adapted for engineering design, healthcare cases, investment appraisal, educational interventions or public policy using common AI and presentation tools, reusable guidelines, rubrics and question banks.

Innovation Description, Process and Implementation

PITCH was implemented in Semester II 2025/2026 with 92 enrolled students across two sections. Teams of six or seven acted as management groups seeking Board approval to proceed with market research and product development.



Figure 1: Progressive transfer of responsibility in the PITCH Framework

Prepare with AI (P) and **Investigate Evidence (I)**. Students could use generative AI to organise information, summarise reviews and improve language. They remained responsible for checking outputs against pricing concepts, original sources and competitor evidence. As the survey stopped at questionnaire design, recommendations were identified as preliminary judgements rather than confirmed customer findings.

Take Executive Roles (T). Members served as CEO and Product, Strategy, Marketing, Pricing and Finance Managers; a Business Development Manager was added for teams of seven. Although responsibilities were divided, the product, market, positioning, price and financial recommendations had to support one coherent proposal.

Communicate the Proposal (C). Teams submitted scripts and slides for feedback on logic, role alignment, clarity and visual relevance. They had 30 minutes to interpret the feedback, coordinate changes and revise, simulating an urgent request. They then delivered 20 automatically advancing slides at 20 seconds each. Every slide contained one relevant image without words or numbers. One restart was permitted, but only the final attempt was assessed.

Human Defence (H). Each student was assessed without AI, slides, notes or a script. Role-aligned C4 questions were randomly presented one at a time, with up to three opportunities. Students had 30 seconds to accept or skip; skipped questions could not be revisited. After acceptance, they received 30 seconds of silent preparation and one minute to recommend an action with three reasons. The five-mark rubric awarded three marks for accurate, relevant reasons and two for analysis and application. This bounded structure preserved an unscripted response while providing consistent cognitive demand (Ward et al., 2024; Fenton, 2025). Board Meeting and peer assessment subsequently examined coordination and contribution.

Initial effectiveness was examined descriptively using 92 assessment records, three perception survey with 86 respondents, and 12 open-ended interview reflections with lecturer follow-up prompts. Results were compared cautiously with a historical 2024/2025 cohort of 76 students. Because cohorts, formats and weights differed, this comparison provides context rather than causal proof.

Key Findings

PITCH generated evidence at collaborative, individual and course-outcome levels. All valid records met the 65% benchmark. The lower individual oral-defence attainment shows that a strong group output did not guarantee independent analysis.

Table 1: Performance and outcome attainment of the PITCH cohort

ASSESSMENT OR OUTCOME	MEAN (%)	≥65% (%)
Peer Assessment	97.89	97.78
Group Proposal Report	90.07	100.00
Pecha Kucha Presentation	79.15	100.00
Individual Board Style Oral Defense	77.00	83.33
CLO-PLO1	77.18	84.44
CLO3-PLO9	89.00	100.00

Student perceptions supported the intended outcomes. The first poll found that 95.65% respondents felt better able to identify and communicate essential information. In the second, 97.78% felt better able to answer unexpected questions and defend decisions without relying only on prepared answers. All 100% selections in the third poll were positive regarding preparedness to defend a real proposal.

Table 2: Perception evidence and illustrative reflections

POLLS EVIDENCE	OUTCOME	ILLUSTRATIVE REFLECTION
Concise communication	95.65% positive	"I just focused on saying what I really had to say and be more direct"
Unscripted decision defence	97.78% positive	"I could not simply rely on memorised answers because I needed to understand the situation and respond quickly"
Professional preparedness	100.00% positive	"I would also prepare evidence and possible alternatives so that I could respond confidently to unexpected questions"

Across 12 reflections, 11 students mentioned timing, key points or direct communication; 11 described using prior learning, experience or logic for unexpected questions; and nine would prepare possible questions in future. Nervousness, strict timing and the need for more practice were also reported, showing that PITCH was demanding rather than merely enjoyable.

Table 3: Contextual comparison with the previous cohort

INDICATOR	2024/2025 (%)	PITCH 2025/2026 (%)	CHANGE (%)
Group proposal Report	81.94	90.07	+8.13
Pecha Kucha Presentation	82.66	79.15	−3.51
Individual Board Style Oral Defense	86.42	77.00	−9.42
CLO1-PLO1 mean	68.47	77.18	+8.71
CLO3-PLO9 mean	87.74	89.00	+1.26
A or A− grades	53.95	67.39	+13.44

Impact

The main impact of PITCH was improved visibility of learning ownership. It showed what students could prepare with AI, verify with evidence, coordinate in a team, communicate under constraints and defend independently. Strong proposal and CLO3-PLO9 results demonstrated collaborative capability, while the lower oral score identified a specific development need in spontaneous analysis and decision justification.

The historical comparison strengthens this interpretation without proving causality. The PITCH cohort achieved higher proposal, CLO1-PLO1 and CLO3-PLO9 means, and A/A− grades increased from 53.95% to 67.39%. Conversely, presentation and oral means declined. These components were deliberately more demanding: automatic timing restricted rehearsed delivery, and unfamiliar oral scenarios removed AI and prepared answers. The declines therefore reveal; not solve-a gap between polished production and performance.

For students, PITCH created practice in concise explanation, coordinated judgement and defending decisions under uncertainty. For lecturers, it produced actionable diagnostic evidence that a final group product alone could not provide. For programmes, it offers a transparent way to retain appropriate AI use while protecting assessment validity and supporting CLO-PLO evidence. The convergence of results,

attainment, polls and reflections supports initial educational value, but matched measures and implementation across disciplines are required before broader effectiveness is claimed.

Recommendations for Classroom Practice

Educators should retain the five-stage sequence but adapt roles and scenarios to their discipline. AI permissions, evidence-verification expectations and no-AI defence conditions must be stated before the task. Question banks should use equivalent cognitive demand and clear rubrics. A short rehearsal can familiarise students with timing without revealing questions. For large classes, brief role-aligned oral questions and structured scoring sheets can keep the assessment manageable. Future cycles should use common baseline and outcome measures to distinguish learning gains from differences in assessment difficulty.

Other relevant information

PITCH is a a reusable assessment package comprising a guide, role templates, presentation guidelines, rubrics, feedback checklist and adaptable oral-question bank. These resources support cross-disciplinary adoption, staff training and future digitalisation. Although not yet been commercialized, appropriate intellectual property protection will be considered.

Acknowledgement

The author gratefully acknowledges the SBSF2133 Pricing Decision students who participated in PITCH and shared honest feedback and reflections. Their effort and learning experiences informed the evaluation and continuing improvement of the framework.

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ID 143: MYFresh Logistics Crisis: A Hybrid Serious Game for Experiential Logistics Learning

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Highlights: University logistics students often struggle to translate textbook supply-chain theory into confident decisions under real-world pressure and uncertainty. MYFresh Logistics Crisis addresses this gap through a hybrid physical-board and digital-dashboard simulation that places student teams inside a Malaysian supply network, requiring warehouse, packaging, unit-load, transport and risk-response decisions against dynamic disruption events. The product combines a Malaysia-centred physical board and 40-card deck, a browser-based online board, crisis events and an automated scoring dashboard. Teams plan routes, select warehousing, packaging, unit-load and transport strategies, then adapt to disruptions while balancing cost, speed, damage, service and sustainability. Formative feedback from students who experienced an earlier logistics-crisis simulation showed strong perceived gains in real-world understanding, decision-making and course alignment. The refined MYFresh design strengthens authentic assessment, structured teamwork, debriefing and measurable feedback. The outcome is an authentic, collaborative and replayable learning environment that makes logistics trade-offs visible, assessable and transferable across face-to-face, hybrid and online classes.

Keywords: Serious game; Logistics education; Experiential learning; Hybrid learning; Authentic assessment; Student-centred learning

Introduction

Logistics is frequently taught as separate topics, namely transportation, warehousing, packaging, material handling and disruption management. Although professional decisions require these elements to be coordinated as one system. Students may recall definitions yet struggle to predict how a low-cost transport choice changes lead time, damage exposure, inventory availability and customer service. Conventional case discussions also provide limited opportunities to experience uncertainty, revise a strategy and observe cumulative consequences. MYFresh Logistics Crisis was developed as a Product-category innovation to close this theory–practice gap through an authentic Malaysian distribution challenge.

The product positions teams as logistics managers delivering fresh products from a Shah Alam factory to Penang, Klang Valley, Sabah and Sarawak. It uses familiar geography, realistic road/sea/air routes and disruptions such as Port Klang congestion, East Coast flooding, Hari Raya demand surges, supplier delays, product recalls and a plastic ban. Its pedagogical design integrates experiential learning, constructive alignment, collaborative problem solving, immediate feedback and structured reflection. Rather than rewarding speed alone, the scoring model exposes trade-offs among revenue, transport and warehouse cost, damage, delay and sustainability. This aligns strongly with NALI 2026 priorities for student-centred, experiential, digitally flexible and authentic learning.

Objectives

The innovation aims to:

- increase students' conceptual understanding of integrated logistics decisions;
- strengthen evidence-based decision-making under uncertainty;
- assess students through authentic evidence comprising strategy justification, gameplay decisions, operational results and reflection;
- increase active participation, teamwork and problem-solving; and
- provide lecturers with a reusable, flexible and transparent learning-and-assessment resource.

NALI Approach

Novelty.
MYFresh is not a content quiz or linear board race. It combines a Malaysian logistics network, configurable strategy cards, stochastic crisis events, constrained switching decisions and an auditable financial-operational score. Physical and browser-based modes use the same decision architecture, allowing

comparable learning in face-to-face, projected and hybrid settings. Its originality lies in connecting concept selection, geographic movement, disruption response, performance consequences and verbal defence within one coherent learning product.

Creativity.
Five colour-coded card families convert abstract content into combinable strategies: warehouse, packaging, unit load, transport and optional strategy boost. Twelve event cards create easy, medium and hard operational conditions. The fresh-product narrative, Malaysian destinations, dice movement, team negotiation and escalating disruptions create an accessible story world while retaining disciplinary rigour. Students may revise one strategy after an event, at the midpoint or by paying a switching cost; therefore, adaptation is possible but carries consequences, as in professional practice.

Innovativeness.
MYFresh changes the lesson from lecturer explanation followed by a conventional exercise into an iterative cycle of decision, consequence, feedback and reflection. The online board supports digital dice, token movement and event prompts, while the auto-scoring workbook calculates revenue, costs, damage and delay penalties, bonuses, final score and rank. These gameplay traces provide immediate formative feedback and an assessment trail. The lecturer remains the pedagogical decision-maker by probing assumptions, challenging unsupported choices and facilitating transfer, while technology performs consistent calculations and visual comparison.

Applicability. T
he product consists of reusable printable files, a browser-based board, a facilitator guide and a scoring workbook. A complete session can be delivered with teams of three to five using ordinary classroom equipment. Difficulty is adjustable through event level, number of turns, destination demand, available cash and scoring weights. The design can be adapted to Logistics Management, Supply Chain Management, Operations Management, executive education, micro-credential and short professional programmes. Its physical mode supports low-connectivity settings, whereas the online mode enables projection, hybrid participation and rapid replay.

Innovation Description, Process and Implementation

Implementation follows a constructively aligned five-phase cycle. First, students receive the learning outcomes, scenario, decision criteria and assessment expectations. Second, teams analyse demand and submit an initial strategy covering warehouse, packaging, unit load, transport and contingency choices. Third, teams move shipments through connected routes over ten turns and record inventory, deliveries, damage, delays and costs. Fourth, an event is drawn after each round; teams interpret the implications, negotiate a response and retain or revise their strategy under the switching rules. Fifth, the dashboard supports a lecturer-led debrief in which teams explain planned versus realised outcomes and apply their learning to a transfer question. Evidence is gathered through decision rationales, game records, lecturer questioning, reflection and student feedback. The feedback also informs continuous improvement of timing, team roles and facilitation. A matched post-test and perception survey complete the evidence cycle.



Figure 1: MYFresh Logistics Crisis integrates Malaysian distribution routes, strategic card decks, crisis events and a performance dashboard.

Table 1: Constructively aligned implementation and evidence cycle.

LEARNING PHASE	STUDENT ACTION	EVIDENCE GENERATED	FEEDBACK
Plan	Analyse demand and justify an integrated strategy	Initial rationale and role allocation	Lecturer probing against decision criteria
Experience and adapt	Move, deliver and respond to crisis events	Decision log and operational results	Immediate consequences and peer dialogue
Analyse	Enter results and compare team performance	Auto-score and dashboard metrics	Transparent calculation and comparison
Explain and reflect	Defend decisions and answer a transfer scenario	Oral verification and individual reflection	Lecturer debrief and feedforward

Key Findings

Formative evaluation was conducted with Logistics Management students who experienced an earlier logistics-crisis simulation that informed the refined MYFresh design. Six five-point items measured understanding, decision-making, real-world relevance, teamwork, engagement and course alignment. Across all 120 ratings, 107 (89.2%) were Agree or Strongly Agree; the overall mean was 4.16 out of 5 (SD across student composite scores = 0.88). The six-item scale showed high internal consistency (Cronbach's α = .965). All responses were retained. One student selected Strongly Disagree for all six ratings despite giving strongly positive written explanations; a sensitivity analysis excluding this internally inconsistent case produced an overall mean of 4.32 and 93.9% positive ratings.

The strongest ratings concerned understanding real-world logistics challenges (M = 4.35; 95% positive), suitability and alignment with the course (M = 4.25; 95% positive), and decision-making under uncertainty (M = 4.20; 95% positive). Students described learning to balance cost, time and risk; plan alternative routes and contingency measures; use insurance and documentation; communicate under pressure; and recognise how one decision affects profit and system stability. The lowest, though still favourable, rating concerned whether gamified learning was more engaging and effective than traditional lectures (M = 3.90; 75% positive). Two written responses identified insufficient time, and one noted uneven team coordination. These findings directly informed the refined MYFresh design through clearer role allocation,

staged instructions, simplified decision recording, more deliberate debriefing and a recommended 90–120-minute session.

Table 2: Formative student feedback informing the MYFresh redesign (n = 20).

STUDENT-FEEDBACK INDICATOR	MEAN / 5	POSITIVE	IMPLICATION FOR CATEGORY 1
Understanding real-world logistics challenges	4.35	95%	Authentic application
Course suitability and learning-outcome alignment	4.25	95%	Curriculum alignment
Decision-making under uncertainty	4.20	95%	Competency development
Understanding the freight-forwarder role	4.15	90%	Professional context
Team communication and problem-solving	4.10	85%	Collaborative learning
More engaging/effective than traditional lectures	3.90	75%	Active engagement

Table 3: Pre and post knowledge gain

INDICATOR	PRE	POST	CHANGE
Knowledge score (0–100)	45.4	82.7	+37.3
Students meeting ≥70% benchmark	0/40	40/40	+100.0
Decision confidence (1–5)	2.53	4.18	+1.65
Cohen's dz for knowledge gain	—	—	3.74

Impact

The evidence indicates that crisis-based gameplay can make logistics learning more applied, memorable and decision-focused. Students reported greater exposure to realistic disruption, stronger decision-making under pressure and improved teamwork and problem-solving. In the refined MYFresh curriculum sequence, engagement is converted into assessable competence: teams must justify choices, document adaptation, interpret score consequences and reflect on transfer to a new context. For educators, the product provides consistent rules, transparent scoring and multiple evidence points rather than relying on enjoyment or winning alone. For the institution, the low-cost, reusable and modality-flexible design supports active learning, authentic assessment and curriculum enrichment. The current evidence is formative and perception-based; future implementation will add a matched knowledge test, analysis of decision-rationale quality and a delayed transfer task to verify learning gain and retention.

Recommendations for Classroom Practice

For classroom implementation, use teams of three to five and allocate 90–120 minutes: briefing and planning (20 minutes), gameplay (45–60 minutes), dashboard comparison (10 minutes), debrief and reflection (15–20 minutes). Assign explicit roles such as strategy lead, operations tracker, finance recorder and spokesperson to address uneven participation. Require an initial rationale and a brief decision log after each crisis. Assess alignment among the chosen strategy, scenario evidence and realised outcome rather than rewarding the highest score alone. Use lecturer questioning to verify individual understanding and strengthen academic integrity. Begin with easy events, then add medium or hard crises, cash constraints or sustainability indicators for advanced learners. End with a transfer scenario so students apply principles beyond the route they played.

Other Relevant Information

MYFresh is a modular educational product comprising: (i) an A3 landscape game board, (ii) a 40-card strategy and crisis deck, (iii) a browser-based online board, (iv) a facilitator guide and (v) an automated scoring workbook. Continuous improvement is driven by student feedback, game records and lecturer

observation. Planned enhancements include bilingual instructions, accessibility features, QR-linked explanations, selectable scenarios and learning analytics. Dissemination can be supported through lecturer training and a standard implementation pack. Authorship, version history, licensing and institutional intellectual-property requirements should be documented before wider commercialisation.

Acknowledgement

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ID 144: Iridescent Grove: Smart Teleprompter with Adaptive Voice-Responsive Text Navigation for Student Presentation Learning

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Highlights: This innovation introduces a speech-synchronised smart teleprompter designed to support students during class presentations. Conventional teleprompters commonly move text according to a preset or manually controlled scrolling speed, which can cause speakers to rush, lose their place, or divide attention between speaking and controlling the screen. The proposed teleprompter follows the speaker's actual delivery: when the speaker pauses or stops reading, the on-screen reading position also pauses and resumes when speech continues. This creates a more natural, learner-controlled presentation experience that can strengthen fluency, confidence, pacing, rehearsal quality, and presentation independence.

Keywords: Smart teleprompter; Speech synchronisation; Presentation skills; Learner-centred technology; Human-AI synergy

Introduction

Oral presentations are essential for developing students' communication, confidence, fluency, pacing, and audience engagement. However, conventional teleprompters rely on fixed or manually controlled scrolling, requiring speakers to follow the text. When a speaker pauses or elaborates, the text may continue moving, disrupting delivery and attention. Iridescent Grove reverses this relationship through AI-supported, speech-responsive synchronisation: the text follows the speaker. It holds position when speech pauses and resumes as the speaker continues, providing adaptive, learner-responsive support (Bin & Ismail, 2025; Li et al., 2025; Merino-Campos, 2025). More than a presentation tool, Iridescent Grove functions as a learning scaffold. By reducing the cognitive effort required to manage scrolling, it allows students to focus on meaning, delivery, pacing, and audience engagement, consistent with Cognitive Load Theory and multimedia learning principles (Sweller et al., 2019; Mayer, 2021). It embodies Human - AI Synergy in Pedagogy: AI listens and adapts, while the learner communicates, engages, and remains in control.

Objectives

- To develop an adaptive voice-responsive teleprompter that synchronises text navigation with the speaker's delivery, automatically holding the reading position during pauses and resuming when speech continues.
- To enhance students' oral presentation experience by supporting natural pacing, presentation continuity, confidence, and learner control.
- To provide a reusable digital learning tool that can be integrated into presentation-based assessments, rehearsals, pitching activities and communication training.
- To evaluate the effectiveness and adoption of the innovation through measurable indicators of perceived usefulness, ease of use, adaptive voice responsiveness, presentation effectiveness, AI–Human synergy, adoption intention, and user feedback.

NALI Approach

Novelty

The key novelty is the shift from speed-driven scrolling to speaker-driven synchronisation. Instead of requiring the learner to continuously match a predetermined scrolling speed, the system responds to the learner's spoken progress. Its defining feature is pause-at-position behaviour: when the speaker stops reading, the visual reading position remains at the relevant point rather than continuing to move. This makes the teleprompter responsive to natural pauses, hesitation, explanation, classroom interaction, and differences in speaking speed. The novelty therefore lies not simply in displaying a script, but in creating a responsive relationship between human speech and the visual prompt.

Creativity

The design reimagines the teleprompter as an adaptive learning companion. Speech input becomes the control mechanism, reducing the need for a remote control, keyboard, mouse, or repeated manual

speed adjustment. The learner can focus on speaking while the interface provides an unobtrusive visual anchor. The concept can also support rehearsal modes in which students practise repeatedly, refine pacing, and progressively reduce reliance on the script. This creates a bridge between presentation technology and active skills development.

Innovativeness

The innovation improves the conventional teleprompter process by changing who controls the pace. The system uses speech responsive logic to align the reading position with the user's delivery. In teaching and learning, this enables a more personalised pace and accommodates differences in fluency, confidence, language proficiency, and presentation style. The intelligent component functions as augmentation where it assists timing and navigation while the learner remains responsible for comprehension, expression and audience engagement.

Applicability

The Iridescent Grove can be applied across disciplines because oral presentation is used in various fields. Potential learning activities include individual presentations, group presentations, pitching, debates, video assignments, microteaching, oral language practice, project demonstrations, and recorded reflections. The concept is scalable because the same interaction model can be adapted for laptops, tablets, mobile phone, classroom displays, or web-based environments. It can also be customised for different script lengths, font sizes, learner needs, and presentation contexts.

Innovation Description, Process and Implementation

The innovation operates through a learner-centred workflow.

- The student prepares or imports a presentation script.
- The script is displayed in a readable teleprompter interface.
- During rehearsal or presentation, the system listens to the speaker's delivery and determines the current progress in the script.
- The displayed reading position advances in response to spoken progress. If the learner pauses or stops, movement is held at the current position. When speech resumes, the teleprompter continues from the aligned position.



Figure 1: Workflow of the Iridescent Grove
(The image was developed by the authors with AI-assisted visualization)

Key Findings

The Iridescent Grove adapts to the speaker, rather than requiring the speaker to follow a fixed scrolling speed. The text pauses when the speaker pauses and resumes automatically when speech continues. This speaker-responsive mechanism is designed to preserve the presenter's natural pacing and control while reducing the need to manually manage text movement. The semi structure interviews were conducted to 31 users, providing encouraging preliminary evidence of its usability and educational value. The preliminary result as Table 1.

Table 1: Data Analysis of Iridescent Grove

Indicator	Results	Font Style
First-time teleprompter users	64.5%	Majority were new users
Overall Evaluation	4.30/5	High overall acceptance
Positive Responses	83.2%	Agree / Strongly Agree
Perceived Usefulness	4.41/5	Highest-rated construct
Presentation Effectiveness	4.35/5	Strong presentation support

Based on Table 1, despite 64.5% being first-time teleprompter users, the system achieved high overall acceptance (M = 4.30/5). The strongest rating for Perceived Usefulness (M = 4.41), together with high Adaptive Voice Responsiveness (M = 4.31), provides promising preliminary evidence for both the educational value and distinctive speaker responsive mechanism of the Iridescent Grove . The user adoption, engagement and key insight results as Figure 2.



Figure 2: The user adoption, engagement and key insight
(The Image was developed by the authors with AI-assisted visualisation)

Based on the Figure 2, User intention to continue using the innovation was similarly strong. 90.3% would use the Iridescent Grove again, 83.9% would recommend it to other students, and 93.5% rated their overall experience as Good or Very Good. Exploratory analysis also revealed a strong association between AI–Human Synergy and Adoption Intention (r = .85), suggesting that users may be more willing to adopt the technology when AI adapts to their presentation behaviour while they remain in control. Overall, the pilot findings provide promising early evidence that the Iridescent Grove is useful, adaptive, presentation-enhancing, and positively accepted by users. Its key contribution lies in reversing the conventional teleprompter relationship: "The speaker does not follow the technology. The technology follows the speaker".

Expected Educational Impact - The Iridescent Grove creates value at three interconnected levels: students, educators, and institutions, while maintaining a clear pedagogical focus on developing independent presentation capability. For students, the Iridescent Grove provides greater control over presentation pace by synchronising text movement with speech, allowing natural pauses without losing position. As a rehearsal scaffold, it supports the development of fluency, confidence, self-regulation, and presentation independence, while offering inclusive support for second-language learners and those requiring additional guidance. Meanwhile, for educators, it provides a practical tool for rehearsals, assessments, pitching, language learning, and communication training while preserving student control. This allows educators to focus on feedback, communication quality, and learning outcomes rather than manually managing scripts. The Iridescent Grove is designed as a progressive learning scaffold, not a tool for dependency. As students develop confidence and presentation competence, script support and teleprompter use are gradually reduced. This progression supports the development of confident, fluent, self-regulated, and independent presenters, while reinforcing rather than replacing essential preparation and communication skills.

Recommendations for Classroom Practice

For effective implementation, the Iridescent Grove should be used as a learning scaffold rather than a substitute for presentation skills. Recommended practices include:

1. Combine with educator feedback on eye contact, vocal delivery, body language, content quality, and audience engagement.
2. Apply progressive fading, gradually reducing script support as students develop confidence,

fluency, and independence.

3. Adapt implementation to learner and subject needs, including language proficiency, presentation type, course context, and required level of support.

Other Relevant Information

The innovation has potential for further development with configurable script segmentation, multilingual speech support, presentation analytics, rehearsal history, and optional lecturer dashboards. Commercialisation potential may include licensing for educational institutions, student presentation support, training providers, public-speaking programmes, content creators, and professional communication training.

Acknowledgement

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ID 145: VeriLearn AI: Verification and Reflective Learning for Trustworthy Academic Writing

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Highlights: VeriLearn AI addresses students' uncritical acceptance of fabricated or weak AI-generated evidence in academic writing. This Human–AI learning intervention integrates AI-supported risk screening, reference verification, risk-based escalation, supervisor judgement, and structured reflection within a six-stage cycle. In a two-cycle pilot with 25 final-year project students, fake citations decreased by 81%, weak or unreliable sources by 77%, evidence-verification rubric scores improved by 45%, and high-risk cases requiring supervisor escalation fell from 13 to 2. Unlike detector-led approaches, VeriLearn AI converts risk alerts into guided learning actions that strengthen source judgement, academic integrity, and learner agency. Findings are preliminary, descriptive, and non-causal.

Keywords: Generative AI; Academic integrity; Feedback literacy; Evidence verification; Self-regulated learning

Introduction

Generative AI can accelerate idea development and drafting, yet fluent outputs may contain fabricated citations, weak sources, or claims that are not supported by the cited evidence. When students accept such outputs without verification, the central educational loss is not only an incorrect reference: it is the missed opportunity to develop source judgement, academic integrity, and independent reasoning. Human-centred guidance therefore emphasizes human agency, ethical validation, and the capacity to evaluate AI outputs rather than simply consume them (Miao & Holmes, 2023; Ng *et al*., 2021).

VeriLearn AI is a Human-AI learning intervention for final-year projects, thesis writing, literature reviews, and research courses. AI is used as a first-line risk scout, not as the final authority. Students verify evidence, supervisors decide genuinely high-risk cases, and every alert becomes a prompt for revision and reflection. This design links feedback literacy with self-regulated learning where students interpret feedback, make an evidence judgement, act on it, and explain what changed (Carless & Boud, 2018; Panadero, 2017). The intervention directly supports NALI 2026 by making Human-AI synergy visible, teachable, and assessable.

Objectives

- Detect risky AI-generated claims, citations, and sources before final submission through an AI-use checklist and evidence-risk screening.
- Strengthen students' ability to verify source existence, source reliability, and claim-evidence alignment using explicit verification questions.
- Route low, medium, and high-risk cases to the appropriate level of student guidance or supervisor review, preserving human judgement for critical decisions.
- Improve evidence quality, rubric performance, reflective engagement and responsible AI use while making supervisor checking more targeted; direct time saving will be measured in a future multi-course study.

NALI Approach

Novelty

VeriLearn AI is distinctive because it is neither an AI detector nor a proofreading tool. Conventional responses often stop at identifying suspected AI use or correcting an error. VeriLearn AI instead treats a risk alert as the beginning of learning. Its pedagogical contribution is the deliberate division of responsibility such as AI flags patterns, automated reference checks gather evidence, students make and justify verification decisions, and supervisors review only critical cases. The result is an auditable Human-AI feedback loop that builds verification competence rather than dependence on a tool.

Creativity

The design translates abstract academic-integrity advice into four memorable questions: (1) Is the citation real? (2) Is the claim supported by the cited evidence? (3) Is the source reliable? (4) What must be

revised? A traffic-light routing metaphor then converts technical risk into a clear learning action. For example, green for student-led revision, amber for guided verification, and red for supervisor judgement. The circular workflow closes only after reflection and resubmission, making improvement visible to both learner and educator.

Innovativeness

The innovation integrates five practices that are usually fragmented such as: (1) AI-use disclosure, (2) AI-supported evidence screening, (3) reference existence and reliability checks, (4) risk-based human escalation, and (5) rubric-linked reflection. This integration changes the teaching process from post-submission correction to pre-submission learning. It also changes the supervisor's role from checking every reference to validating the cases were disciplinary expertise and contextual judgement matter most. The evidence log and reflection create a traceable account of why a source was retained, replaced, or rejected.

Applicability

VeriLearn AI is modular and can be implemented with an institutional or approved generative-AI tool, a DOI/database lookup or reference crawler, a short checklist and an existing course rubric. It can therefore be adopted without replacing the institution's learning-management system. The same cycle is applicable to final-year projects, postgraduate research, literature reviews, laboratory reports, design reports and evidence-based assignments across disciplines. Risk thresholds and source-quality criteria can be configured to disciplinary expectations, while the human-review gate preserves accountability. This combination of low integration overhead, auditable decision points and discipline-configurable criteria support sustainable scale-up.

Innovation Description, Process and Implementation

VeriLearn AI operates through six linked stages (Figure 1). First, the student uploads a draft, attaches the sources, and completes a brief AI-use disclosure checklist. Second, AI-supported screening checks citation patterns and generates feedback prompts for potentially unsupported claims or questionable references. Third, a reference check confirms whether the source exists, whether bibliographic identifiers or database records match, whether the source is credible for the discipline, and whether it supports the associated claim. The system does not label the work as true or false; it organizes evidence for human decision-making.

Fourth, cases are routed by risk such as low-risk cases return directly to the student, medium-risk cases trigger guided verification, and high-risk cases require supervisor review. Fifth, the supervisor validates only the flagged critical cases and guides revision decisions. Sixth, the student revises claims and sources, records a short reflection on the verification decision, and submits an improved draft. The next submission begins a new cycle, creating a feedback loop of checking, judgement, revision, and learning.

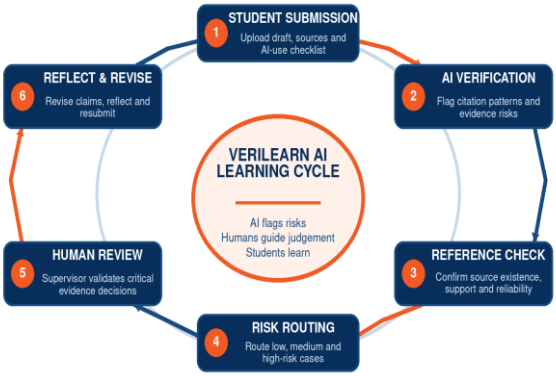


Figure 1: VeriLearn AI six-stage Human-AI verification and reflective learning cycle.

The pilot used a two-cycle pre/post classroom implementation with 25 final-year students in an FYP2 course. Students used the same VeriLearn AI rubric and decision criteria in both cycles. Evidence included citation existence, source reliability/suitability, claim-source alignment, flagged high-risk cases, rubric scores, student reflection submissions and supervisor feedback. Results were analysed descriptively to determine whether the second cycle showed safer evidence use and stronger reflective participation. The repeated use of the same rubric improves comparability across cycles, but the design does not establish causality because it involved one class, two cycles and no comparison group.

Key Findings

The pilot showed consistent improvement across evidence quality, assessment performance and reflective engagement. Table 1 reports relative changes using the same rubric across both cycles. The reduction in high-risk escalations from 13 to 2 represents an 84.6% decrease (reported as 84%), while reflection submissions increased from 2.6 +/- 0.9 to 4.7 +/- 0.8, an 80.8% relative increase (reported as 81%). These results strengthen the student-learning-impact case because they connect the intervention to observable changes in verification behaviour, while the study deliberately avoids causal claims beyond the pilot design.

Table 1: VeriLearn AI pilot findings (*n = 25*).

INDICATOR	PILOT RESULT	LEARNING MEANING
Fake citations	81% reduction	Students checked whether cited items existed before submission.
Weak or unreliable sources	77% reduction	Students made stronger judgements about source authority and suitability.
Evidence-verification rubric	45% increase	Claim-source alignment and documented verification improved.
High-risk cases escalated	13 (52%) to 2 (8%); 84% reduction	Supervisor attention became more targeted as avoidable risks declined.
Reflection submissions	2.6 +/- 0.9 to 4.7 +/- 0.8; 81% increase	Students engaged more actively in explaining and improving their decisions.

Impact

- *Students*: the pilot provides measurable evidence of stronger verification behavior where fake citations decreased 81%, weak or unreliable sources decreased 77%, evidence-verification rubric performance increased 45%, and reflective engagement increased. These indicators directly support source literacy, AI literacy, academic integrity and reflective judgement.
- *Supervisors*: high-risk cases requiring escalation fell from 13 (52%) to 2 (8%), suggesting that expert attention became more targeted as avoidable evidence risks declined. The current pilot did not measure actual supervisor's time saved, so workload reduction remains a future validation outcome rather than a completed claim.
- *Institution*: the intervention offers a scalable and auditable quality-assurance approach for responsible AI guidance, research training and consistent evidence-verification practice across programmes. Its modular checklist, rubric, risk rules, evidence log and reflection prompts can be adopted without dependence on a single AI provider.
- *NALI community*: VeriLearn AI demonstrates a practical Human-AI pedagogy in which AI flags and organizes risk, students verify and justify evidence decisions, and supervisors retain authority over critical cases. Its strongest competition value is the combination of explicit Human-AI role separation with measured student-learning outcomes rather than a detector-only or automation-only model.

Recommendations for Classroom Practice

- Begin with one calibration activity in which the class jointly verifies a fabricated citation, a weak source, and a credible source; make the decision criteria explicit.
- Require students to attach sources and disclose how AI was used so verification focuses on evidence quality rather than suspicion about authorship.
- Keep the human decision gate: AI may flag, retrieve, and prompt, but students and educators remain accountable for accepting or rejecting evidence.
- Use discipline-specific risk thresholds and source criteria, then require a short reflection describing what changed and why.
- Monitor several indicators across cycles, e.g. citation validity, source reliability, rubric performance, escalation rate, and reflection instead of relying on a single detection score.

Other Relevant Information

VeriLearn AI is currently a classroom-validated pedagogical prototype. Its next development stage is a reusable toolkit comprising the AI-use checklist, verification rubric, discipline-configurable risk rules, evidence log, reflection prompts, supervisor dashboard, and learning-management-system (LMS) integration. These modular components support institutional adoption and future software-copyright registration without locking the pedagogy to a single AI provider.

The current evidence is preliminary because the pilot involved one class of 25 students, two cycles, descriptive analysis and no comparison group. Therefore, the reported percentages should be interpreted as within-pilot relative changes rather than causal effect sizes. A planned multi-course study should test transfer across disciplines, inter-rater reliability of risk judgements, learning retention, supervisor time saved and accessibility for students with different levels of AI experience. For future reporting and judging, the underlying raw counts and rubric-score calculations should be retained alongside the percentage changes so that every result can be traced and independently checked. Stating these boundaries protects the credibility of the current gains while providing a clear pathway toward broader validation and sustainable scale-up.

Acknowledgement

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ID 146: ACES 2026 Programme: Internationalisation at Home through Human-AI Exploration and Co-Creation for Sustainable Cultural Innovation

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Highlights: The Asian Culture and Sustainability Engagement Collaborative Community Outreach between Malaysia, Japan and Indonesia (ACES 2026) transformed an inbound mobility programme into internationalisation at home through 6 lecturer-led modules, 2 authentic cultural and business challenges, as well as 26 mixed Malaysia-Japan student teams. Students combined field evidence with generative AI to explore alternatives and create images, visual prototypes and videos that made proposed heritage innovations visible and well understood before real implementation to the market. The resulting ACES Human-AI Heritage Innovation Cycle integrates human inquiry, AI exploration, AI visualisation, human critique and authentic pitching. However, human judgement remained central in this programme through authenticity checks, customer evidence, cross-cultural negotiation, rubric-based assessment and stakeholder feedback. Findings indicate that 96.2% intended to contribute to future heritage preservation and 88.5% connected culture, heritage, innovation and sustainability, demonstrating how Human-AI synergy can develop both innovation capability and youth stewardship.

Keywords: Internationalisation; Human-AI Co-Creation; Experiential Learning; Cultural Heritage; Sustainable Innovation

Introduction

Internationalisation at home deliberately embeds international and intercultural dimensions within formal and informal learning in the domestic campus environment (Beelen & Jones, 2015). Yet short inbound programmes often remain activity-based: students attend cultural visits, exchange information and present ideas, but the learning process may not require them to integrate field evidence, disciplinary knowledge, cultural judgement and actionable innovation. Generative artificial intelligence adds another challenge. It can expand ideation and visualisation, but uncritical use may produce generic, inaccurate or culturally inappropriate outputs. Human-centred pedagogical design must therefore keep learners and educators responsible for purpose, evidence, ethics and final decisions (Miao & Holmes, 2023).

The Asian Culture and Sustainability Engagement Collaborative Community Outreach between Malaysia, Japan and Indonesia (ACES 2026), implemented at UTM from 2 to 7 September 2026, addressed these gaps through a structured Human-AI co-creation model. Twelve UTM Buddies learned alongside nine students from Meijo University and five students from Konan Women's University, supported by lecturers from UTM and Universitas Brawijaya, a Meijo academic, Loaita Corporation, AEON Tebrau City and heritage partners. Six lecturer-led modules supplied a shared knowledge base. Students then applied the modules in an industry case challenge and a Change Maker case study, using AI to combine ideas and visualise cultural innovations through images, product prototypes and videos.

Objectives

- To deliver six integrated modules that connect Malaysian and Nusantara culture, entrepreneurship, sustainability, change making and heritage textiles.
- To develop international and cross-cultural competence among 26 Malaysian and Japanese students through mixed-team inquiry and peer learning at UTM.
- To use generative AI for iterative idea exploration and visual prototyping while requiring human verification of evidence, cultural authenticity, feasibility and ethical fit.
- To assess students' ability to convert field insights into one persuasive cultural or business innovation through two authentic case studies, rubric-based presentations and stakeholder feedback.

NALI Approach

Novelty

ACES introduces the **"5 Stages Human-AI Heritage Innovation Cycle",** a distinctive integration of internationalisation at home, field-based cultural inquiry, generative-AI visualisation and authentic stakeholder assessment. Unlike conventional study tours or classroom AI exercises, students first encounter culture, customers and places; use AI to widen the solution space; and test imagined outcomes against human evidence, cultural authenticity and commercial or social value. The same architecture connected two contrasting problems: reinvention of Malaysian traditional textiles for AEON and intergenerational preservation of Kain Benang Johor through comparison with Japan's Kurume Kasuri.

Creativity

Students became multicultural design teams and used AI as a cultural-imagination partner rather than an answer generator. They combined heritage motifs, consumer needs, sustainability principles and entrepreneurial possibilities, then translated abstract ideas into images, mock-ups, prototypes and videos. These shared visual objects allowed Malaysian and Japanese students to compare meanings, imagine how a future product or experience might be encountered, and revise culturally weak or generic outputs. Lecturer questioning and peer negotiation kept experimentation imaginative while protecting the identity and stories embedded in the heritage assets.

Innovativeness

The five-stage cycle transforms three conventional practices: i) a study visit becomes evidence-led inquiry; ii) AI output becomes object for intercultural critique; and iii) a final slide presentation becomes an iterative, visually prototyped proposal defended before authentic stakeholders. Assessment examines customer evidence, authenticity, cross-cultural insight, feasibility, behaviour-change potential and oral defence, thereby rewarding the reasoning behind an idea rather than polished but unverified AI content. This guided co-intelligence structure is important because repeated AI interaction alone does not guarantee stronger joint creativity (Luan et al., 2025).

Applicability

The implemented package comprises six connected modules, two adaptable case briefs, two analytic rubrics and the five-stage Human-AI cycle. Its consistent application across an industry challenge and a heritage Change Maker case demonstrates practicality beyond a single activity. Educators may substitute another cultural asset or stakeholder problem while retaining field evidence, AI-assisted exploration, human verification, prototype communication and authentic assessment. The package is applicable to marketing, entrepreneurship, sustainability, tourism, design and cultural studies, and to inbound, local or virtual internationalisation-at-home formats.

Innovation Description, Process and Implementation

ACES operationalised experiential learning, project-based learning and social constructivism through a repeatable sequence: shared disciplinary input, field evidence, Human-AI ideation, visual prototyping, critique, authentic presentation and feedback. All students completed six connected modules and applied them across two case challenges. Visits to Yayasan Warisan Johor and related sites supplied primary cultural context that AI could not replace, while common rubrics made implementation and assessment consistent across multicultural teams.

Table 1: Six lecturer-led ACES modules and their learning contribution

MODULE	LECTURER-LED CONTENT	CONTRIBUTION TO THE CASE-BASED LEARNING PROCESS
1	Introduction to Malaysian Culture and Tangible Heritage	Built place-based cultural understanding before observation and ideation.
2	Entrepreneurial and Intangible Cultural Heritage	Connected living heritage, stories and skills with customer value and enterprise.
3	Sustainability Innovation	Required concepts to consider environmental, social and economic value.
4	Change Maker	Framed desired behaviour change, stakeholder impact and implementation.
5	Heritage Textile: Kain Benang Johor	Established the authenticity criteria against which AI-generated concepts were judged.

MODULE	LECTURER-LED CONTENT	CONTRIBUTION TO THE CASE-BASED LEARNING PROCESS
6	Nusantara Culture, Indonesian Language, Arts and Crafts	Extended regional and intercultural comparison across Malaysia, Indonesia and Japan.

AEON Tebrau City Industry Case Challenge. Mixed Meijo-UTM teams investigated how Malaysian traditional textiles could become relevant to younger consumers. From field observation and a customer hypothesis, each team generated AI-assisted alternatives and selected one evidence-based recommendation covering customer value, pricing, market potential, AEON implementation and a 12-month plan. Images, prototypes and videos made the proposed experience visible for comparison and pitching. The rubric equally weighted customer insight, heritage innovation, customer value, business feasibility and presentation.

Change Maker and Innovation Case Study. Students proposed one innovation to keep Kain Benang Johor relevant without losing its identity, tested its transferability to Kurume Kasuri and specified the desired behaviour change and cultural, social or economic impact. AI enabled rapid visual exploration of possible products and experiences, while students remained responsible for authenticity and the final recommendation. Assessment covered heritage understanding, innovation, consumer behaviour, cross-cultural insight, impact and communication.



Figure 1: ACES Human-AI Heritage Innovation Cycle with 5 Stages

Key Findings

The ACES 2026 programme comprised of 26 students aged 20–22: 8 male (30.8%) and 18 female (69.2%). The survey contains 26 valid responses where the students are 9 from Meijo University, Nagoya, Japan; 5 from Konan Women's University, Kobe, Japan; and 12 from Faculty of Management, Universiti Teknologi Malaysia (UTM). All 26 respondents had used AI before ACES 2026. ChatGPT was reported by 18 students and Gemini by 8 students, while Microsoft Copilot, Claude and Canva AI were not selected. Academic AI use was rare for 14.3%, sometimes for 28.6%, often for 50.0% and very often for 7.1%, with no respondent selecting never.

Table 2 reports positive responses (ratings 4–5) and means on a five-point Likert scale. Both pre-survey and post-survey count for n=26 are obtained that show positive rating of 15 AI usage items. Four selected cultural-heritage and innovation indicators are also account for n=26, showing similar positive outcome.

Table 2: AI capability profile and selected cultural-heritage outcomes

DOMAIN AND SURVEY ITEM	PRE SURVEY N/26 (%)	MEAN /5	POST SURVEY N/26 (%)	TARGET GAIN (%)
Current Ability to Use AI				
I understand how AI can support my learning.	22 (84.6)	3.93	25 (96.2)	+11.6
I know how to use AI for academic work.	19 (73.1)	3.86	24 (92.3)	+19.2
I know how to write effective prompts for AI.	17 (65.4)	3.64	24 (92.3)	+26.9
I can evaluate whether AI-generated information is accurate.	13 (50.0)	3.43	23 (88.5)	+38.5
I know how to use AI responsibly in academic work.	17 (65.4)	3.71	24 (92.3)	+26.9
AI and Presentation Development				
I can use AI to generate ideas for my presentation.	15 (57.7)	3.64	24 (92.3)	+34.6
I can use AI to organise my presentation.	13 (50.0)	3.43	23 (88.5)	+38.5
I can use AI to improve my presentation content.	20 (76.9)	4.14	25 (96.2)	+19.3
I can use AI to create or improve presentation visuals.	17 (65.4)	3.79	25 (96.2)	+30.8
I feel confident using AI to develop a presentation.	15 (57.7)	3.50	24 (92.3)	+34.6
AI and Academic Work				

DOMAIN AND SURVEY ITEM	PRE SURVEY N/26 (%)	MEAN /5	POST SURVEY N/26 (%)	TARGET GAIN (%)
AI helps me generate ideas for my academic work.	19 (73.1)	3.86	24 (92.3)	+19.2
AI helps me understand difficult topics.	20 (76.9)	4.07	25 (96.2)	+19.3
AI helps me improve the quality of my work.	20 (76.9)	4.14	25 (96.2)	+19.3
AI helps me complete academic tasks more efficiently.	19 (73.1)	3.86	24 (92.3)	+19.2
I believe AI can improve my learning.	17 (65.4)	3.86	24 (92.3)	+26.9
Post-program heritage and innovation impact (n=26)				
Selected indicator	Estimated positive n/26 (%)	Evidence of youth heritage succession		
I intend to contribute to cultural heritage preservation and sustainable development.in the future.	25 (96.2)	Commitment to future preservation Motivation for sustainability stewardship		
ACES increased my awareness of links among culture, heritage, innovation and sustainability.	23 (88.5)	Integrated heritage understanding		
I can generate innovative ideas to solve community challenges.	23 (88.5)	Innovation for community value		

The results show that students already recognised AI's learning value, but needed greater capability in evaluating AI accuracy and organising presentations (both 50.0%). ACES 2026 therefore used AI for iterative visualisation while retaining human verification, cultural judgement and oral defence. Post-survey outcomes extended beyond technical AI use: 96.2% intended to contribute to future heritage preservation, while 88.5% recognised the culture-heritage-innovation-sustainability relationship, felt inspired to support heritage and sustainable development, and could generate innovative ideas for community challenges. Within the combined modules, fieldwork and multicultural teamwork, AI-supported visualisation helped young people imagine contemporary futures for heritage and translate cultural understanding into innovation and stewardship. These self-reported outcomes demonstrate perceived programme impact but do not isolate AI as the sole causal factor.

Impact

Impact evidence was triangulated through survey indicators, completed case artefacts, rubric-based presentations and stakeholder feedback. Students demonstrated critical AI literacy by visualising alternatives while defending evidence, authenticity and feasibility; they also linked cultural understanding with marketing, entrepreneurship, sustainability and professional pitching. The strong intention to preserve heritage indicates empowerment beyond short-term participation and supports ACES as a sustainable youth-stewardship model. UTM students gained international learning without overseas travel, AEON received youth-informed concepts, and heritage partners gained proposals balancing contemporary relevance with cultural identity. Shared modules and rubrics also created reusable institutional capacity across UTM, Meijo University, Konan Women's University, Universitas Brawijaya, Loaita Corporation and community and industry partners.

Recommendations for Classroom Practice

Educators should begin with first-hand evidence before opening AI exploration. Students should document observations, stakeholder information and cultural constraints, then use AI to generate and visualise several alternatives. Assessment should reward prompt refinement only when it improves reasoning; marks should focus on evidence, authenticity, feasibility and oral defence. Facilitators should require students to label facts, assumptions and AI-generated material, compare outputs across cultural perspectives and explain what they rejected or changed. A final industry or community pitch provides an authentic test of whether the AI-assisted concept remains understandable, responsible and useful.

Other relevant information

ACES 2026 was implemented under a formal appointment by Loaita Corporation with a project value of RM7,500, demonstrating external commitment and operational feasibility. It can be delivered as an inbound summer school, an internationalisation-at-home package or a shorter industry challenge. Replication requires only a local cultural asset, an authentic stakeholder problem, a mixed student cohort, guided generative-AI access, a field-evidence protocol and assessment that protects human

accountability. The modular resources and rubrics provide a scalable base for repeated implementation, educator adaptation and longitudinal evaluation.

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Recognition

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