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Scaffolding Active Learning with AI Tools: An instructional Design Approach in Teaching and Learning

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ABSTRACT

The integration of digital tools into education continues to reshape how teaching and learning are delivered, yet many educators struggle to adopt effective approaches that balance technology and pedagogy. This paper presents the design and evaluation of a micro-module to strengthen active learning practices among teachers and lecturers. The module was structured using instructional design frameworks, including SOLO taxonomy, the Zone of Proximal Development (ZPD), and cognitive alignment theory, to ensure clear learning objectives, scaffolded activities, and appropriate assessment methods. Training sessions introduced participants to tools such as Canva and ChatGPT, as well as ready-to-use templates to support lesson preparation. A mixed-methods approach was used, combining survey data with interviews to capture both outcomes and participants' experiences. Quantitative results showed high ratings for content suitability, instructional strategies, and delivery format, with mean scores above 4.5 on a five-point scale. Interview findings indicated that participants gained confidence in applying active learning techniques and valued the practicality of the resources provided. However, limited prior exposure to certain tools and challenges related to time and infrastructure was noted. The findings suggest that a structured instructional design approach, when combined with accessible e-learning resources, can provide educators with both the confidence and the practical means to apply active learning in their classrooms. This study presents a replicable model for professional development and highlights best practices to support educators in adopting technology-enhanced active learning.

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1. INTRODUCTION

The adoption and adaptation of digital technologies have created new possibilities for teaching and learning in diverse educational contexts. In Malaysia, the Ministry of Education has emphasised the importance of digital transformation to support more engaging and student-centred practices. Despite these initiatives, many educators continue to face challenges in effectively adopting technology. Limited training, lack of confidence, and uneven access to resources have contributed to a gap between the availability of digital tools and their meaningful application in the classroom.

Active learning has been widely recognised as a key approach to foster deeper engagement, collaboration, and critical thinking among students. However, implementing active learning requires careful preparation, clear instructional design, and appropriate use of learning resources. For many teachers, designing and delivering active learning strategies can be time-consuming and difficult to sustain without structured support. Technology offers potential solutions through interactive platforms, ready-to-use templates, and flexible resources that reduce the preparation burden and enhance pedagogical effectiveness. To address these challenges, a micro-module was developed to scaffold educators in designing and applying active learning strategies using digital tools. The module was designed with reference to established instructional frameworks, including SOLO taxonomy, the Zone of Proximal Development (ZPD), and cognitive alignment theory, to ensure that learning objectives, activities, and assessments were properly aligned. At the same time, the inclusion of tools such as Canva and ChatGPT provided practical examples of how technology could support lesson preparation and classroom engagement.

This project aims to evaluate the effectiveness of the micro-module in strengthening teachers' capacity to integrate technology into active learning. This paper reports on the design, implementation, and outcomes of training sessions conducted with selected educators, and it analyses survey and interview data to identify strengths, challenges, and implications for professional development. By situating technology within a structured instructional design, this study contributes to best practices in leveraging digital tools for active learning in teaching and learning contexts.

2. ACTIVE LEARNING IN AN EDUCATIONAL CONTEXT

Active learning is widely recognised as an instructional approach that shifts the focus of teaching from knowledge transmission to learner engagement. Bonwell and Eison (1991) first popularised the concept as an alternative to traditional lecture-based teaching, emphasising activities that promote analysis, synthesis, and evaluation. Since then, numerous studies have established the benefits of active learning in enhancing student participation, critical thinking, and long-term knowledge retention. Prince (2004), in a comprehensive review, concluded that active learning improves learning outcomes across multiple disciplines. Similarly, Freeman et al. (2014), in a meta-analysis of STEM courses, found that students in active-learning environments achieved higher performance and lower failure rates than those in conventional settings.

2.1 Challenges in Active Learning

Despite the advantages of active learning reported in prior literature, its adoption has not been universal. Instructors often cite time constraints, the complexity of preparing suitable materials, and uncertainty about classroom management as key barriers. For many educators, active learning requires not only pedagogical knowledge but also access to resources and practical tools that reduce the burden of preparation. These challenges are especially relevant in contexts where educators juggle heavy teaching loads and limited institutional support. Such barriers highlight the importance of designing support mechanisms that scaffold educators' ability to adopt active learning strategies sustainably.

2.2 Technology as a Driver of Active Learning

Technology offers new opportunities to address the challenges of implementing active learning. Digital platforms can provide interactive environments where students collaborate, visualise concepts, and receive real-time feedback. Recent developments in artificial intelligence and user-friendly design tools have expanded these possibilities even further. For instance, applications such as Canva allow teachers to design visually appealing learning resources with minimal technical skill, while platforms like ChatGPT can assist in generating prompts, questions, and formative assessments.

The literature has consistently shown that digital tools can enhance both engagement and accessibility. Holmes et al. (2021) argue that AI-powered applications have the potential to individualise learning experiences and support teachers in adapting materials to diverse student needs. Luckin et al. (2016) similarly highlight the role of AI in reducing teacher workload by automating routine tasks, thereby freeing up time for more interactive and student-centred teaching. In Malaysia, the Digital Education Policy (DPD), launched in 2023, reinforced this direction by calling for the integration of digital technologies to promote 21st-century skills and active participation in learning.

However, the benefits of technology integration are unevenly distributed. Research in both local and international contexts has documented challenges such as the digital divide, limited infrastructure, and uneven digital competencies among teachers. In Malaysia, for example, many educators, particularly in rural schools, still lack sufficient access to reliable internet connections or advanced devices. In addition, senior teachers often report lower confidence in using digital tools, which further limits uptake. These findings suggest that while technology has the potential to drive active learning, its success depends heavily on scaffolding support and professional development opportunities tailored to educators' needs.

2.3 Instructional Design Frameworks for Technology Integration

The effective use of technology in education requires more than access to digital tools; it demands careful instructional design to align objectives, activities, and assessments. The Structure of Observed Learning Outcomes (SOLO) taxonomy, developed by Biggs and Collis (1982), provides a framework for understanding how learners, including teacher trainees, progress through increasingly complex levels of understanding. In the context of teacher professional development, the SOLO taxonomy can be applied to describe educators' growth from basic exposure to digital tools to the ability to integrate them meaningfully into teaching practice, and ultimately to innovate and guide others.

The Zone of Proximal Development (ZPD), introduced by Vygotsky (1978), provides another useful framework. ZPD refers to the gap between what learners can achieve independently and what they can accomplish with support. Scaffolding through micro-modules and guided activities allows teachers to gradually develop digital competencies, moving from initial uncertainty to confident and autonomous use of technology.

Cognitive Alignment Theory (Anderson & Krathwohl, 2001) further emphasises that learning is most effective when objectives, activities, and assessments are tightly aligned. When educators are introduced to new technologies, such alignment ensures that digital tools are not used for their novelty alone, but rather to achieve specific pedagogical goals. For example, using Canva to design interactive templates or ChatGPT to generate higher-order thinking questions must be directly linked to targeted learning outcomes. Literature in this area underscores that without instructional design frameworks, technology integration risks remaining superficial and disconnected from meaningful learning.

2.4 Professional Development for Educators in Technology Integration

The literature also highlights the importance of continuous professional development (CPD) in enabling educators to adopt and sustain technology-supported practices. Desimone (2009) outlined core features of effective PD, including content focus, active learning, coherence with practice, sustained duration, and collective participation. Darling-Hammond et al. (2017) further emphasised that effective PD is job-embedded, collaborative, and provides opportunities for reflection and application.

Recent scholarship has highlighted microlearning and modular approaches as particularly suitable for technology integration training. Short, focused modules can reduce the cognitive and time burden on teachers while allowing immediate application to classroom contexts. Studies on microlearning indicate that bite-sized training with practical examples improves retention and supports incremental skill development. In addition, professional development is most effective when combined with communities of practice where educators share experiences, reflect on challenges, and co-create solutions.

Within the Malaysian context, research has shown that many professional development initiatives still emphasise theory over practice, leaving teachers uncertain about how to translate knowledge into classroom strategies. The integration of technology into PD programs must therefore prioritise hands-on activities, practical tools, and scaffolding that bridge the gap between training and practice. The micro-module approach responds directly to these needs by providing ready-to-use templates, guided activities, and opportunities for reflection, thus lowering barriers to adoption.

Table 1
Instructional design frameworks applied in the study

Framework	Purpose	Key Principles	Application in This Study
SOLO Taxonomy (Biggs & Collis, 1982)	To describe progressive levels of learning outcomes and complexity.	- Pre-structural: limited or no understanding. - Uni-structural: understanding one aspect. - Multi-structural: understanding several aspects independently. - Relational: integrating ideas meaningfully. - Extended Abstract: applying learning in new contexts.	Used to map teachers' progression in adopting digital tools: from basic Canva/ChatGPT use to integrating them meaningfully in lesson design and innovating new practices.
Zone of Proximal Development (ZPD) (Vygotsky, 1978)	To scaffold learning by bridging the gap between what learners can do alone and what they can do with guidance.	- Actual development: current skills. - Potential development: achievable with support. - Scaffolding: guided practice and gradual release.	Guided training sessions and micro-modules served as scaffolds, helping teachers move from limited use of technology to confident adoption of active learning strategies.
Cognitive Alignment Theory (Anderson & Krathwohl, 2001)	To ensure coherence between learning objectives, instructional activities, and assessment.	- Clear objectives. - Activities that directly support objectives. - Assessment that measures intended outcomes.	Micro-module activities were aligned with the objectives of promoting active learning. Templates included both design tasks and reflection tasks to ensure outcomes could be measured.
Instructional Design for Technology Integration (TPACK model – Mishra & Koehler, 2006)	To combine technological, pedagogical, and content knowledge for effective teaching.	- Balance between content, pedagogy, and technology. - Teachers must integrate, not separate, these dimensions.	Though not the primary framework, elements of TPACK informed the design by ensuring that the use of Canva and ChatGPT was meaningful to the subject content and pedagogy.

Source: Biggs & Collis, 1982; Vygotsky, 1978; Anderson & Krathwohl, 2001; Mishra & Koehler, 2006

3. METHODOLOGY

This study employed a mixed-methods design to capture both the breadth and depth of educators' experiences with the micro-module. The quantitative component focused on measuring perceptions of suitability, content relevance, delivery strategies, and overall usability, while the qualitative component explored participants' reflections, challenges, and perceived impact. The combination of both approaches provided a more comprehensive understanding of how technology-supported scaffolding could strengthen active learning practices.

Participants were selected using purposive sampling to ensure diversity in teaching contexts. The sample included school teachers, lecturers, and educators from various institutions across Malaysia, representing a range of teaching experience and subject backgrounds. In total,

A total of 51 respondents contributed to the survey, with additional participants engaged in follow-up interviews. This variation allowed the study to capture perspectives from educators with different levels of digital competency and familiarity with technology in teaching.

The intervention was delivered through a series of structured training sessions in which participants were introduced to the micro-module. Fig. 1 shows the micro-module used in this study. The module contained ready-to-use templates, short guides, and activities designed to scaffold active learning with digital tools such as Canva and ChatGPT. Sessions were delivered online and blended with hands-on exercises, enabling participants to apply the templates directly to their lesson planning.

Data collection involved three stages. First, an online survey using a five-point Likert scale captured quantitative data on participants' perceptions of the micro-module. Second, semi-structured interviews were conducted to gather in-depth reflections on the benefits and challenges of using the module. Third, teaching artefacts and outputs produced by participants were analysed to assess the integration of technology into their instructional design. Quantitative data were analysed descriptively using mean scores and standard deviations, while qualitative data were thematically coded to identify recurring patterns and insights.

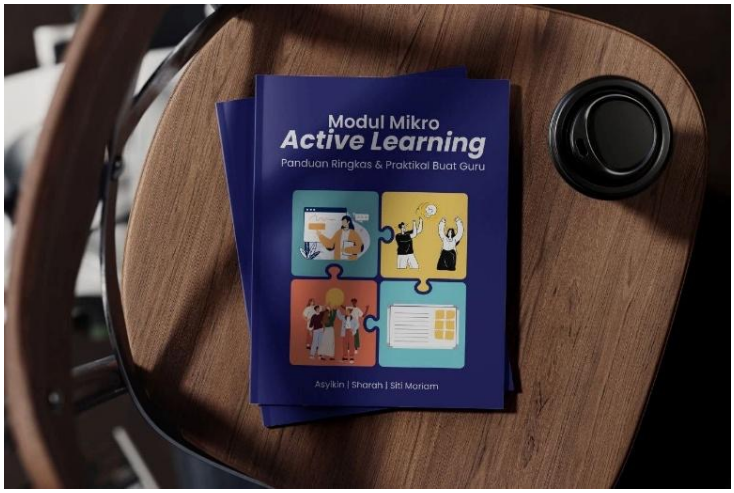

Fig. 1 *Active Learning micro-module used in this study*

4. RESULTS AND DISCUSSION

The results are categorised into three phases: quantitative findings, qualitative findings, and artefact analysis.

4.1 Quantitative Findings

Survey results provided clear evidence of the perceived suitability and effectiveness of the micro-module. Fig. 2 shows the mean scores of the constructs measuring relevance, content, and instructional strategies.

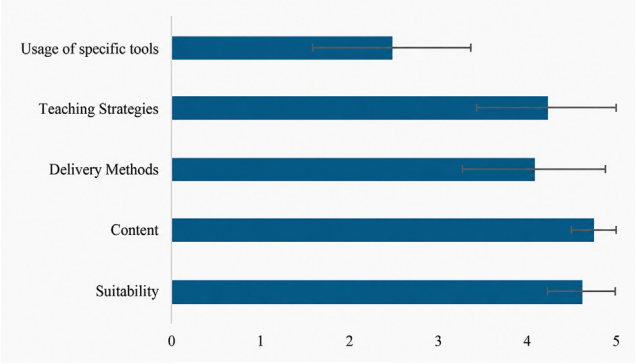

Fig. 2 *Perceived suitability and effectiveness of the micro-module*

Overall, the mean scores were consistently high across constructs measuring relevance, content, and instructional strategies. The construct on suitability recorded a mean score of 4.61±0.37, placing it within the "very high" category on the five-point Likert scale. Respondents unanimously indicated that the module was appropriate for use in their teaching context, with no ratings falling in the "low" or "very low" categories. The construct on content achieved the highest rating, with a mean of 4.74±0.24. Participants strongly agreed that the content was aligned with syllabus topics, addressed multiple student levels (low, medium, high), and contained varied resources such as activities, infographics, and short videos. This suggests that the design of the micro-module successfully addressed teachers' need for structured yet flexible materials.

Delivery methods were rated slightly lower but still high, with a mean of 4.05±0.82. Respondents indicated a preference for digital delivery (mean 4.35) and blended formats (mean 4.18), while printed resources were rated lower (mean 3.61). This reflects teachers' increasing comfort with digital platforms. Teaching strategies such as problem-based learning, cooperative learning, think-pair-share, gamification, and student-centred approaches were also rated highly, with a mean of 4.19±0.79. The lowest ratings were reported for the construct related to the use of specific tools. Canva (mean 2.88) and ChatGPT (mean 2.76) were used moderately, while other applications, such as Mentimeter (1.80) and Zep Quiz (1.55), were used at low levels. This indicates a gap between positive perceptions of the module and the actual integration of digital tools in practice.

4.2 Qualitative Findings

Interviews and open-ended feedback highlighted several recurring themes. Participants reported that the micro-module:

1. Enhanced confidence – Teachers felt more capable of designing and delivering active learning activities after receiving structured guidance.
2. Improved creativity – Ready-to-use templates in Canva and prompts from ChatGPT were seen as helpful starting points for lesson design.
3. Increased engagement – Teachers noted that students responded positively to more interactive and visually rich materials created with digital tools.

At the same time, challenges were also identified. Many participants highlighted time constraints in preparing lessons, even with the provided templates. Others mentioned limited prior exposure to AI tools, leading to hesitation in classroom application. Infrastructure issues, particularly internet connectivity, were also cited as barriers in certain teaching contexts.

4.3 Artefact Analysis

An examination of teaching artefacts produced by participants, as shown in Fig. 3, further reinforced the survey and interview findings. Educators adapted the micro-module templates into lesson plans, worksheets, and interactive activities. While some artefacts showed advanced integration of Canva and ChatGPT, others reflected more basic adaptations, indicating varying levels of digital competence. This variability suggests that while the module lowered barriers to adoption, continued scaffolding and follow-up support are necessary to ensure deeper, more consistent application across educator groups.

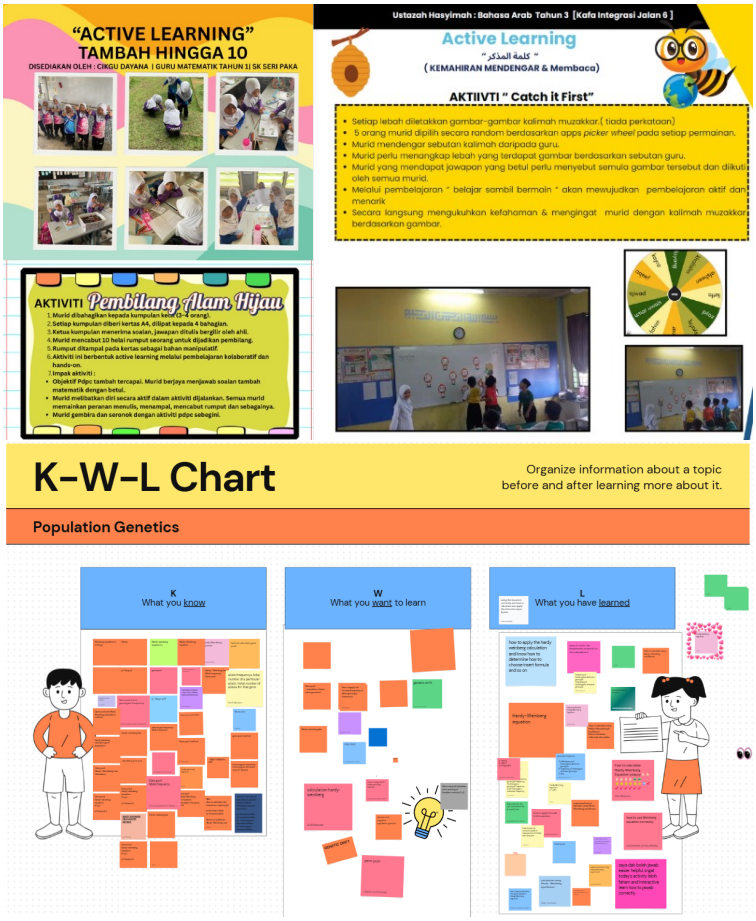

Fig. 3 *Teaching artefacts by participants: (a) Mathematics, Year 1, (b) Arabic Language, Year 3, (c) Population Genetics, Matriculation College*

4.4 Discussion

The findings of this study demonstrate the value of scaffolding educators with a structured micro-module to promote active learning through technology. The high ratings for content suitability and relevance (M = 4.74, SD = 0.43) confirm that the module addressed teachers' need for practical, ready-to-use materials. This aligns with previous studies, which emphasise that active learning is most effective when educators are supported with resources that reduce preparation barriers (Prince, 2004; Freeman et al., 2014). By offering templates, infographics, and short videos, the micro-module directly addressed one of the most-cited challenges in active learning implementation: the time burden on teachers.

The strong preference for digital and blended delivery formats also reflects a broader shift towards technology integration in professional practice. Holmes et al. (2021) noted that digital platforms enhance accessibility and interactivity, and the present results indicate that educators in Malaysia are receptive to such approaches. Nevertheless, the lower scores on tool usage (e.g., Canva M = 2.88; ChatGPT M = 2.76) suggest that while teachers value the idea of technology integration, their actual adoption remains limited. This echoes findings by Luckin et al. (2016), who observed that confidence and familiarity are key determinants of technology uptake in teaching.

Qualitative findings further illuminate this gap. Teachers reported increased confidence and creativity after engaging with the micro-module, consistent with Desimone's (2009) assertion that effective professional development must include active, hands-on learning. However, challenges such as time constraints, limited prior exposure, and infrastructural barriers were frequently mentioned. These are consistent with the "digital divide" highlighted in Malaysian contexts. Such constraints point to the need for systemic support, including reliable internet access, sustained training opportunities, and follow-up mentoring to consolidate skills.

From an instructional design perspective, the results reinforce the importance of applying frameworks such as the SOLO taxonomy and the Zone of Proximal Development. Teachers in this study exhibited a range of competencies: some were at early stages of tool exploration, while others integrated multiple digital resources into their lessons. The scaffolding provided by the module allowed teachers to progress along this continuum, confirming Vygotsky's view that learning occurs most effectively when learners are supported within their ZPD. The variability observed in teaching artefacts suggests that continued scaffolding and iterative training cycles may help more educators advance towards higher levels of integration and innovation.

5. CONCLUSION AND RECOMMENDATION

This study examined the design, implementation, and evaluation of a micro-module intended to scaffold educators in adopting active learning through digital tools. The findings demonstrate that the module was well received, with very high ratings for content suitability and relevance. Teachers reported increased confidence and creativity in lesson preparation, showing that structured scaffolding can lower barriers to technology integration. At the same time, the relatively low usage scores for specific tools such as Canva and ChatGPT indicate that familiarity and adoption remain uneven, underscoring the need for sustained support. The study contributes both theoretically and practically. It reinforces the literature that stresses the importance of aligning instructional design frameworks with technology integration and provides empirical evidence from the Malaysian context that such an approach can positively impact teacher readiness. More broadly, it offers a replicable model of professional development that blends microlearning, scaffolding, and accessible digital tools.

Several recommendations arise from these findings. First, professional development initiatives should continue to emphasise scaffolded, modular training that is practical and directly applicable to classroom contexts. Second, institutions should invest in ongoing mentoring and communities of practice, enabling teachers to share strategies and support one another in adopting technology. Third, addressing systemic challenges, such as infrastructure and time allocation, is essential to enable the sustainable integration of digital tools. Finally, future research should explore the longitudinal impact of such interventions, examining not only teacher confidence but also long-term student learning outcomes. By embedding technology within a structured instructional design, this study illustrates a pathway for bridging the gap between digital innovation and meaningful classroom practice.

6. ACKNOWLEDGEMENT

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7. AUTHORS' CONTRIBUTIONS

Nurul Asyikin Md Zaki : Investigation, field work, and writing original draft and review;
Siti Sharah Rajab : Conceptualisation, methodology, field work, formal analysis, and validation;
Siti Mariam Khairuddin : Conceptualisation, methodology, field work, investigation, and formal analysis.

8. CONFLICT OF INTEREST DECLARATION

We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We attest that all Authors have contributed significantly to the work, the validity and legitimacy of the data, and its interpretation for submission to IJELHE.

9. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this work, the authors used ChatGPT to improve the manuscript's readability and language quality. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the publication's content.

10. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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