INTELLIGENT TECHNOLOGIES IN EDUCATION

Rethinking the Integration of AI in Higher Education Teaching and Learning

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Abstract

The rapid evolution of Generative Artificial Intelligence (GenAI) presents both transformative opportunities and complex challenges within teaching and learning in higher education, with opportunities that have led to the proliferation of AI frameworks to support educators in integrating GenAI tools into teaching and learning, and challenges necessitating the upskilling of educators to effectively integrate GenAI at a module-level. This conceptual paper addresses identified challenges associated with integrating AI literacy into higher education curricula, particularly within non-computer science disciplines and at the module level. The paper proposes a five-step GenAI Curriculum Alignment Model (AI-CAM) that enables educators in non-computer science disciplines to systematically integrate AI literacy into curriculum design at the module level, drawing on the principles of constructive alignment. An example from the BSc Business Management Data Analysis module is presented to illustrate how the five-step AI-CAM was implemented at the module level. The research question is: How can educators integrate AI literacy at the module level to enhance students' AI skills? This paper contributes to the growing discourse on AI in education by offering practical guidance to module organisers at the module level.

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Introduction

The discourse on AI in education has evolved over the years, shifting from concerns about academic integrity to embracing the opportunities the technology provides for teaching and learning (Chan, 2023; Rasul et al., 2023). Generative AI (GenAI) is considered a subset of Artificial Intelligence (AI) and refers to AI systems capable of creating new content such as text, images, or code (Celik et al., 2022; Kasneci et al., 2023; O'Dea, 2024). Rasul et al. (2023) argue that GenAI tools, such as ChatGPT, an OpenAI-developed conversational AI tool that generates human-like text responses based on the input it receives, can facilitate the active construction of students' knowledge as they are continuously engaged with the task and encouraged to find patterns through a scaffolded approach. This enables learning through experimentation and experience, which is integral to knowledge generation. Authors such as Alqahtani et al. (2024) and Bayaga (2024) provide insight into how GenAI can support educators; however, their pedagogical strategies, while valuable, do not offer a structured process that enables educators to systematically align AI tools with AI literacy, linking the literacy process to learning objectives, class activities and assessment methods.

This shift towards a more responsible integration of GenAI tools into teaching and learning reflects a broader educational mandate to prepare students for an AI-enabled economy, with educators, international organisations, such as the World Economic Forum (2024), and industry leaders including McKinsey (2023), advocating the importance of AI literate graduates and skills. The emergence of AI frameworks, such as those developed by UNESCO (2024a, b), Ng et al. (2023), and Zhou and Schofield (2024b), reflects a shift toward supporting educators in integrating AI into their curriculum. Although these frameworks are innovative and provide practical guidance, they do not offer a comprehensive approach to integrating them at the module level.

Building on this groundwork, the research objectives are twofold: (1) To elaborate a structured five-step process, grounded in constructive alignment, for effectively integrating AI literacy at the module-level within non-computer science disciplines; and (2) to demonstrate through examples how this five-step approach can be implemented at the module level. Therefore, this paper introduces a five-step GenAI Curriculum Alignment model for integrating GenAI into the curriculum, grounded in the principles of constructive alignment (Biggs & Tang, 2003). It presents a case study illustrating how this approach was implemented in an undergraduate business management module.

This conceptual paper is structured into four parts. First, it provides a literature review with an overview of GenAI in education, identifying various AI frameworks in teaching and learning. Second, it discusses learning theories and GenAI Integration, as well as the theoretical grounding and rationale for the model. The third part introduces the five-step approach for incorporating AI into teaching and learning. The final part concludes the paper and reflects on the study's limitations. The following section examines the literature on AI in Education and provides the theoretical foundation and rationale for the model.

Literature review

AI in Education

Generative AI (GenAI), a subset of artificial intelligence specifically designed to create new data or content, has advanced significantly in the last few years and gained popularity in higher education (Chan, 2023; Ng et al., 2023). GenAI models are characterised by their ability to generate diverse forms of data, including text, images, and audio, using learned statistical patterns (Perkins et al., 2024). Several GenAI tools, such as ChatGPT, Copilot, Elicit, Consensus, and Connected Papers, are now used in teaching and learning, even though there remains contestation over the use of GenAI in education due to academic misconduct and equal access. Staff also face challenges in detecting GenAI generated content (Chan, 2023; Schofield, 2024). However, some educators argue that these tools can be used as active stakeholders in the learning process (Zhou & Schofield, 2024a).

In terms of supporting educators, international organisations, such as UNESCO (2024), have developed guidelines for teachers and students on the ethical use of AI technologies, emphasising the key idea of human-centredness. Writers such as Ng et al. (2023) have contributed significant insights into AI literacy, developing four dimensions: 'know and understand,' 'use and apply, ' 'create and evaluate, ' and 'AI ethics. ' Building on this foundation, Zhou and Schofield (2024b) introduced an AI in teaching and learning framework, providing teaching activities and suggested tools educators could use to integrate AI into teaching. Chan (2023) developed an AI policy education framework for university teaching and learning, organised into three critical dimensions: pedagogical, governance, and operational. These frameworks offer an understanding of AI literacy and pedagogical activities that support students and educators in utilising the tools.

However, Celik (2023) and Ng et al. (2023) highlight the challenges educators face in technological pedagogical knowledge (TPK). That is, whilst educators are knowledgeable about the content of their subjects, they may lack the technological pedagogical knowledge to integrate AI into their pedagogies. Similarly, Southworth et al. (2023) highlight the inconsistent integration of AI literacy across disciplines, with AI skills often limited to specialised STEM subjects. Consequently, educators outside these areas lack clarity on how to integrate AI into their teaching. Though literature on GenAI in education has provided insights through scholarly works and frameworks into how educators can use AI tools in their practice (Zhou & Schofield, 2024b), this analysis reveals a crucial gap: the lack of simplified, practical guidance that shows educators how to integrate AI literacy holistically in the full cycle of curriculum design, aligning AI literacy with learning outcomes, class activities, and assessment.

Theoretical Grounding and Rationale for the Model

AI literacy has become a critical competency in higher education, particularly as GenAI technologies become increasingly used in academic and professional contexts (Becker et al., 2024; Ng et al., 20221). Southworth et al. (2023) posit that AI literacy is multifaceted, encompassing an understanding of AI systems' capabilities, limitations, and ethical considerations. Laupichler et al. (2022) argue that basic AI literacy encompasses understanding AI, critically evaluating its outputs, recognising potential biases, and making informed decisions about when and how to use AI tools effectively. At the same time, many AI users find themselves inadequately equipped to understand, use and critically engage with the tools, resulting in widespread illiteracy (Pinski & Benlian, 2024).

Addressing this literacy demand necessitates pedagogical approaches grounded in learning theories. Social constructivist theories espouse collaborative learning and the active construction of knowledge through social interactions and meaningful engagement with educational tools (Adams, 2006; Keaton & Bodie, 2011; Saleem et al., 2021). The theory advocates that learners develop deeper understanding and critical thinking skills by actively participating in knowledge creation alongside peers and educators. Lea and Street's (2006) academic literacies framework further highlights the contextual and socially embedded nature of literacy practices, stressing that effective education should address diverse literacy demands across disciplinary contexts. These theoretical perspectives underline the importance of adaptability, context-specific learning, and dynamic interactions within educational environments. However, educators frequently encounter challenges in practically applying these dynamic theoretical perspectives, especially when incorporating emerging technologies such as GenAI (Celik, 2023; Ng et al., 2023). Existing pedagogical frameworks often fail to provide structured yet flexible guidance for educators with limited technological pedagogical knowledge (TPK), thereby creating gaps in the holistic integration of AI literacy into the curriculum.

AI , such as GenAI, have diverse capabilities that can be used within different learning approaches and learning activities; however, enhancing students' AI literacy depends on how well the understanding of ethical and responsible use of these tools aligns with specific learning outcomes (Zhou & Schofield, 2024b). Lodge et al. (2023) advocate for a holistic approach to enhancing students' AI literacy, suggesting that AI literacy should extend beyond operational use to encompass a nuanced understanding of AI's capabilities, limitations, ethical considerations, and broader societal impacts. Southworth et al. (2023) emphasise the need for structured models to integrate AI literacy into curricula, ensuring that AI literacy is aligned with learning outcomes and pedagogical strategies. Applying Biggs's constructive alignment theory ensures that AI literacy is incorporated into the curriculum to achieve specific learning objectives (Biggs et al., 2022).

Constructive alignment

Constructive alignment is rooted in constructivist learning theories (Mascolo et al., 1998; Piaget, 1954; Vygotsky, 1978), which posit that learners actively construct knowledge through engagement with learning activities. Constructive alignment, developed by Biggs, is an outcomes-based approach to teaching and learning that explicitly aligns intended learning outcomes (ILOs), teaching and learning activities (TLAs), and assessment tasks (ATs) (Biggs & Tang, 2003; Biggs & Tang, 2010). Its purpose is to ensure that students actively construct their understanding through engaging in learning activities directly connected to clear learning goals. Unlike traditional teaching, which focuses primarily on content delivery, constructive alignment stresses clearly defined learning outcomes, encouraging students to apply, analyse, and generate knowledge in authentic contexts such as learning by doing.

According to Biggs and Tang (2003), elements of constructive alignment include:

1. **Description of the learning outcomes**, specifying what students are expected to learn regarding knowledge, skills, and attitudes. The intended learning outcome should be described using a verb (learning activity), its object (the content) and the standards the students are to attain. The outcomes should be explicitly stated so that both the educator and the students understand the goals of the module. According to Biggs et al. (2022), "It is important to stipulate the kind of knowledge to be learned… and use a verb and a context that indicates clearly the level at which it is to be learned and how the performance is to be displayed" (2022, p. 64).
2. **Teaching and learning activities** aligned with the verbs in the intended learning outcomes, ensuring that they allow students to practice the skills and knowledge they are expected to learn.
3. **Assessment tasks and methods** aligned with both the learning outcomes and teaching activities. The purpose of assessment in this framework is to check if students have achieved the learning outcomes; therefore, the assessments should be authentic and provide evidence of student understanding. Assessments are not only for grading but are integral to the learning process,

providing feedback to students and instructors about the effectiveness of teaching and the depth of student understanding.

Although constructive alignment has been widely applied across various higher education institutions, there are limitations, particularly in the context of integrating GenAI into the curriculum (Biggs et al., 2022). One of these challenges is the lack of clarity about what constitutes AI literacy, which makes it difficult for educators to structure meaningful AI-integrated learning experiences into their curriculum (Sperling et al., 2023). Additionally, educators face apprehension and resistance to AI integration due to concerns about existing academic misconduct, ethical considerations, as well as the assumption that AI subverts learning (Schofield & Zhang, 2024).

Moreover, the literature highlights the importance of ongoing assessment, monitoring, and evaluation, considering evolving technological advancements, particularly in the era of AI. Roe et al. (2024) highlight several issues with assessment, including the increasing prevalence of AI in assessments and the difficulty in accurately detecting AI output, and argue for reform in higher education assessment. Without structured mechanisms for regular review and refinement, educators may struggle to adapt assessments to evolving technological capabilities and issues or address unforeseen challenges posed by AI integration or technological advancement.

Given these challenges, there is a clear rationale for developing a simplified, structured, practical approach for module organisers to incorporate GenAI into the curriculum at the module level, ensuring that students receive sufficient opportunities to develop the multidimensional aspects of AI literacy and AI skills. To address these limitations, the five-step GenAI Curriculum Alignment Model proposed in this conceptual paper is designed to support educators, particularly those in non-computer science disciplines, in integrating AI into their curriculum. Its simplicity and flexibility enable module organisers to identify suitable GenAI tools, incorporate AI literacy within learning outcomes and activities, and design relevant assessment strategies, including monitoring and evaluation.

Introduction to the five-step approach for incorporating GenAI into teaching and learning

The five-step GenAI Curriculum Alignment Model presented in this paper was developed by the authors, informed by literature and practical experience, embedding AI literacy within higher education curricula. It emerged as a direct response to evolving AI discourse in education and the growing recognition among educators, particularly those in non-computer science disciplines in higher education, who aim to embed AI literacy into their curricula. The initial concept was shaped by insights from funded projects focused on embedding AI into academic curricula, following case study collections with students and educators exploring approaches to AI integration. Prompted by the literature on educators facing challenges and apprehension towards using GenAI, this model was conceptualised to provide educators with a structured yet familiar approach to effectively embed GenAI in their teaching and assessment practices (Schofield & Zhang, 2024).

The well-established curriculum design principles of Biggs' Constructive Alignment were the starting point for developing the five-step GenAI Curriculum Alignment Model. This approach provided a simplified but familiar approach for systematically integrating AI literacy holistically within the curriculum, not as an add-on or stand-alone application, but as a core component of AI literacy. The resulting AI-CAM simplifies the complexity of AI integration, structuring it into five essential steps familiar to educators:

1. Define intended learning outcomes
2. Design assessments that measure student achievement of these outcomes
3. Select appropriate AI tools
4. Develop teaching activities that enable students to meet the learning outcomes
5. Continuously monitor and evaluate AI integration to refine educational practices.

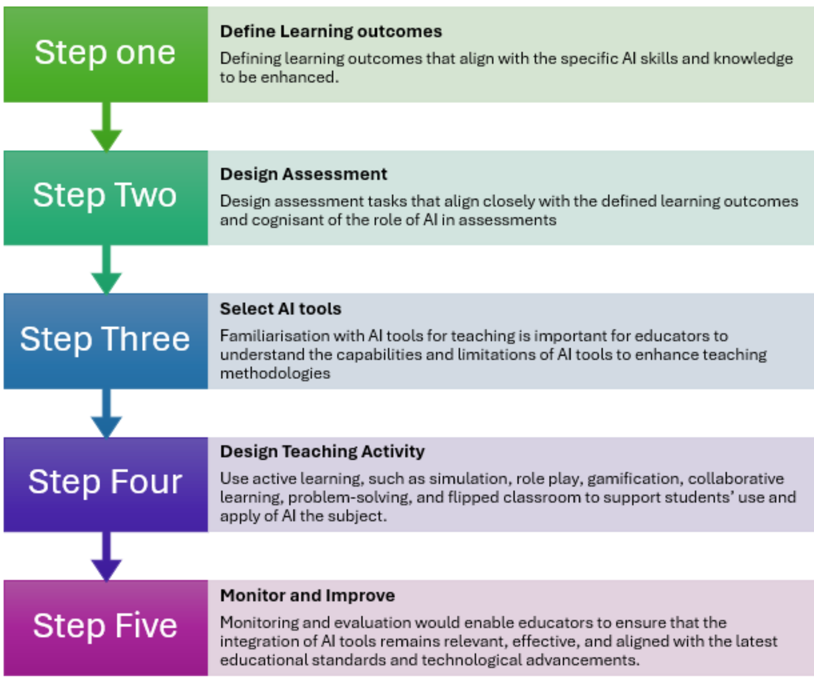

Figure 1

Five-step GenAI Curriculum Alignment Model. Figure derived from authors' conceptualisation

The illustrative case study is situated within a business school context, demonstrating our approach's practical application and effectiveness in a discipline where educators have varying degrees of prior exposure to AI technologies. While this structured approach offers simplicity and coherence, it is important to recognise that educators may choose not to follow these steps linearly, provided all elements are addressed. Further, the framework remains flexible, allowing educators from different disciplines to adapt or amend it according to their specific curricular needs and disciplinary contexts. This adaptability ensures that the model remains practically relevant and widely applicable.

Step 1: Define learning outcomes

The defining the learning outcomes stage involves module organisers clearly defining how GenAI will be integrated into the intended learning outcomes and articulating specific skills and knowledge that students are expected to acquire using GenAI. This ensures that GenAI is not just an add-on but a fundamental component of the learning objectives. If the goal is to enhance student's ability to use and apply GenAI in their subject area, the learning outcomes should be explicitly stated to reflect this focus. These outcomes should be designed to ensure that the teaching activities are specifically designed to meet these competencies.

> **Example**: In the BSc Business Management Year 2 Data Analysis module, the aim of the module was to enhance students' data analysis, visualisation, and interpretation. The gap in the module was a lack of students' understanding of ethically and responsibly using AI for data analysis and interpretation. The module organiser wanted students, by the end of the module, to be able to 'visualise, interpret, and analyse' data using GenAI tools ethically and responsibly and demonstrate an understanding of GenAI tools in data analysis and data limitations. This was clearly stated in the learning outcomes, and the class activities were designed to enable students to use GenAI tools like Microsoft Copilot for data analysis.

The intended learning outcomes were stated that by the end of this module, students will be able to:

- **ILO 1**: Utilise Generative AI tools to effectively visualise data.
- **ILO 2**: Apply Generative AI tools for data interpretation and analysis.
- **ILO 3**: Demonstrate an understanding of the ethical considerations in using Generative AI for data analysis and interpretation.

It is important to note that the BSc Business Management module learning outcomes were aligned with the programme-level learning outcomes; therefore, module organisers must ensure that they align with the programme when designing the module learning outcomes. Where there is a gap, the programme director needs to update the programme learning outcomes.

Step 2: Design Assessment

Once the learning outcomes are established, module organisers design assessments that effectively measure students' achievement of these outcomes. Assessments should align with the AI-integrated learning objectives and evaluate students' understanding and application of AI literacy in the intended learning outcomes (Biggs et al., 2023; Roe et al., 2024). The assessments could include project-based assessments, quizzes, or reflective essays that demonstrate students' engagement with AI tools and their impact on learning. This approach ensures that assessments are not only a measure of learning but also an integral part of the learning process (JISC, 2023).

> **Example**: In the Year 2 BSc Business Management data analysis class, the assessment approach was carefully designed to evaluate students' understanding and application of AI in business management. Students were required to use GenAI tools to analyse data and make decisions based on the generated information. The assessment process involved students presenting their findings and justifying their analytical choices, focusing on how they applied GenAI tools to solve specific problems. This not only tested their technical skills but also their ability to think critically about the ethical, social, and technical aspects of GenAI use. The assessments were structured to ensure that students could demonstrate an understanding of using GenAI for data analysis. There was a reflective aspect to the assessment, where students were to write reflections on their experiences with using GenAI for data analysis and interpretation.

Step 3: Select AI tools

This stage focuses on module organisers familiarising themselves with diverse AI tools to support class activities and enhance learning outcomes. In this phase, module organisers learn the fundamentals of GenAI, including an overview of their capabilities and limitations, as well as an understanding of how to select tools that align with the learning outcomes. This approach involves not only knowing which GenAI tools to teach but also understanding how these tools can enable students to meet the intended learning outcomes, as well as ensuring accessibility and ease of use for both educators and students. Additionally, it entails verifying the tools' adherence to data privacy standards and their ability to accommodate different class sizes and the number of prompts. For instance, some GenAI tools are available for free, while others are offered with limitations, and some are only accessible through a paid subscription. An example is Gamma, which users can use for free up to a certain credit limit, after which they must subscribe. Some institutions have licences where students can use the tools for free. For inclusivity, module organisers should familiarise themselves with various tools that can develop the same competencies and select one that all students can use to achieve the intended learning outcomes. Module organisers should begin by developing a pedagogical strategy for incorporating GenAI into teaching activities. For example, if the aim is to promote deep thinking about GenAI-generated information, the module organiser could use GenAI tools such as ChatGPT, Copilot, Deepseek, Grok or Claude for such activities, depending on the subject. Table 1 illustrates various AI tools and their respective capabilities.

> **Example**: In the case of the BSc Business Management Data Analysis class, consideration was given to selecting AI tools that would enhance both teaching and learning experiences. GenAI tools such as Bricks and PowerBI for visualisation for data visualisation, enabling students to create, analyse and visualise data insights. Copilot, Gemini, and ChatGPT were introduced to students to enable them to perform data analysis and interpretation tasks. The teaching and learning activities involved students working in groups and working with the prompts provided by the module organiser, analysing the data and critically evaluating the generated responses. The intention is for students, through this task, to develop critical thinking, scepticism about generated information and the ability to analyse and interpret the data and develop the graduate attributes of a data analyst.

The tools listed in Table 1 were selected based on our practical experience in integrating GenAI into teaching and research, as well as those we tested and evaluated in our work (Zhou & Schofield, 2024). The criteria used to select the tools in Table 1 include their relevance to AI integration in pedagogy, ensuring that students can utilise them as additional stakeholders in constructing knowledge. Additionally, we prioritised tools that are user-friendly and accessible to enable all students to participate in class activities and develop their AI literacy. Finally, scalability requires the tools to be adaptable across different pedagogical approaches and class sizes. While the list is not exhaustive, it provides a curated starting point for educators new to GenAI, offering a range of accessible and practical tools that align with the principles of our Five-step GenAI Curriculum Alignment Model. These tools have been chosen for their usability, relevance to academic contexts, and potential to support functional and critical engagement with GenAI.

Table 1

AI tools for active learning

Capability	AI tools for teaching	Description
Presentation	Gamma	Can be used for presentations, profiles and sites
	Canva	Canva helps students create visually appealing projects, presentations, and social media content using customisable templates and an easy drag-and-drop interface.
	Beautiful.ai	Helps create presentations on requested topics.
Mind mapping	Miro	Helps in brainstorming and creating interactive presentations
Record and transcribe	Otter	Record audio and transcribe
Exploration, brainstorming ideas	Chat GPT	Assists with assignments, explanations, and study support.
	Claude AI	Generating summaries, and explanations. It can be used to explore different topics.
	Poe AI	Provides students with access to various AI models, including GPT-4 and Claude, facilitating interactive learning and research assistance
	Perplexity	An AI-powered search engine that provides students with accurate, real-time answers to their questions, enhancing research efficiency and understanding
	Gemini	Assists with study and Google tools.
	Copilot	Suggests code to speed learning.
	Monica	Can be used to explore, chat, search, write, translation, and create multimedia content
Research query, explore articles and organise literature	Consensus	Summarises research papers quickly.
	Connected papers	Maps related research papers visually.
	Litmaps	Maps and tracks academic citations
	Research rabbit	Visualises and tracks research papers.
	Elicit	Finds and summarises research papers.
	Explainpaper	Clarifies academic paper text.
	Scholarcy	Extracts and summarises key information from a research paper
Grammar check and paraphrasing	Grammarly	Improves grammar, clarity, and tone.
	Quillbot	Paraphrases check grammar and summarise.
Systematic review	Rayyan	Free web tool designed to speed up the process of screening and selecting studies
Note-taking for students	Notion AI	Assists with writing, brainstorming, and summaries.
	NoteAI	Summarises and generates notes from content.
	Notebooklm	Summarises and explains uploaded documents.

	Intellecs AI	Intellecs AI helps students learn efficiently by providing personalised resources, summaries, and real-time study support.
Reference manager	Mendeley	Manages references and generates citations.
	Zotero	Organises and cites research sources.
	Cite This For Me	Simple tool for generating citations in multiple styles.

Source: Schofield & Zhou

Step 4: Design Teaching Activities. The teaching activity component of constructive alignment emphasises designing learning experiences that enable students to meet the intended learning outcomes through meaningful interaction with content and tools. Module organisers can leverage their existing, proven pedagogies and do not need to design entirely new ones for AI literacy. Instead, they can incorporate AI-related content into established teaching approaches such as simulations, flipped classrooms, problem-based learning, case studies, experiential learning, and project-based assignments. For example, in a flipped classroom, pre-class materials might introduce core concepts of AI, while in-class sessions focus on applying these concepts through guided use of generative AI.

> **Example**: For example, in the Business Management Data Analysis class, the case study method was used. Students were first asked to analyse and solve cases using their own human-centred reasoning. Next, they used generative AI tools to produce alternative solutions. They then critically evaluated the AI-generated responses, comparing them to their own, and explored why the GenAI arrived at particular outputs. This process helped students understand the underlying logic of generative AI output. An iterative approach was adopted, allowing students to continuously reflect on both human and machine reasoning, deepening their learning through comparison and critique.

Step 5: Monitor and evaluate: The final step highlights the importance of continuous monitoring and evaluation of GenAI integration in educational practices. Module organisers should regularly assess the effectiveness of GenAI tools and their impact on student learning. Student feedback and assessment data can inform necessary adjustments and refinements to teaching strategies, ensuring that AI remains a valuable learning resource. This ongoing process involves regularly evaluating the extent to which students achieve the defined learning outcomes. Insights from these evaluations should inform the effectiveness of the teaching methods and the use of GenAI tools. Based on these insights, continuous efforts should be considered to refine and enhance the teaching and learning strategies. This may involve introducing new assessment methods that better capture students' competency in using AI tools or addressing new issues that emerge from the evolving nature of AI technology and its application in teaching and learning.

> **Example**: In the Business Management Data Analysis class, students were invited to complete a survey, and the module organiser reflected on students' coursework performance. The module organiser also gathered feedback on what aspects of using GenAI in the module students enjoyed and what areas could be improved. For instance, students mentioned that Copilot was not always reliable, particularly during daytime hours, as it sometimes failed to generate data visualisations as expected. Consequently, in the upcoming year, the module organiser plans to explore alternative GenAI tools, particularly those that are licensed or free of charge, to ensure that all students have equitable access and benefit from this module.

The five-step GenAI Curriculum Alignment model provides a simple, accessible approach that supports educators new to GenAI integration. It is designed to allow educators to explore various GenAI tools, familiarise themselves with them, and integrate them into the curriculum. The rationale is that AI literacy should involve more than understanding GenAI applications; students should critically engage with the tools and reflect on their implications in various contexts (Lodge et al., 2023). Integrating AI literacy into curricula thus links to the principles of academic literacies by emphasising context, critical engagement, and situated learning (Lea & Street, 2006). Building on this, module organisers not only teach students the application of GenAI tools but also explicitly connect AI literacy to clearly defined learning outcomes, relevant teaching activities, and suitable assessments (Biggs & Tang, 2011). This five-step GenAI Curriculum Alignment ensures that AI literacy development is coherent, intentional, and embedded within authentic learning experiences.

Conclusion

This conceptual paper examined existing learning theories and approaches to integrating GenAI in teaching and learning, providing a simplified model for module organisers to integrate AI literacy into their curriculum at the module level. This paper presented and discussed a five-step framework that includes defining learning outcomes, designing assessments, selecting GenAI tools and developing teaching activities, and finally, implementing a robust system for monitoring and improvement. The paper drew on the principle of constructive alignment and emphasised ensuring that learning outcomes are aligned with teaching activities and assessments.

The paper advocates for a holistic integration that ensures module organisers develop teaching activities and AI tools for learning activities based on the learning outcomes and evaluates students to ensure they meet these outcomes. The learning activities should incorporate active learning approaches, including hands-on and experiential learning activities that prompt students to engage actively with AI tools, ensuring they are not passive recipients of information but active participants in the learning process.

Limitations and Directions for Future Research

While the five-step AI Curriculum Alignment Model (AI-CAM) provides a structured and practical approach to integrating Generative AI (GenAI) at the module level, it is important to acknowledge its limitations. First, this approach has primarily been developed as a conceptual framework intended to support educators at the module level within higher education, particularly focusing on module leaders who may have limited technological pedagogical knowledge (TPK). As such, there is a need for empirical studies to determine its effectiveness and adaptability across diverse educational contexts.

Second, the framework has been explicitly based on Biggs' constructive alignment theory, which, while valuable for its clarity and structure, may not fully capture the complexity or flexibility required at the curriculum or programme levels. Constructive alignment emphasises a structured and linear alignment of learning outcomes, teaching activities, and assessment methods, potentially limiting the adaptability required by rapidly evolving AI technologies. Future research could explore alternative or complementary learning theories, such as social constructivism, which could offer more dynamic and flexible strategies for embedding AI into diverse educational contexts.

Another limitation is the module-level focus, which may not sufficiently address institutional-level barriers, such as resource constraints, policy limitations, and infrastructure challenges that significantly influence AI integration. Moreover, the conceptual model and examples are primarily drawn from business disciplines, which may limit their perceived applicability in other fields. Further research should examine the framework's applicability and adaptability across various disciplinary and institutional contexts, exploring practical examples and conducting case studies in interdisciplinary or non-business domains.

Finally, the list of GenAI tools in Table 1 is intended to assist module organisers in identifying tools that align with their learning outcomes. This list is not exhaustive, as tools continue to evolve rapidly. Rather than requiring students to master specific tools, the goal is to develop students' broader AI literacy, equipping them with the critical thinking and ethical awareness necessary to effectively engage with AI technologies as they emerge.

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References

Adams, P. (2006). Exploring social constructivism: theories and practicalities. *Education*, 34:3, 243-257, DOI: 10.1080/03004270600898893.

Alqahtani, Naifa, & Wafula, Zarina (2024). Artificial Intelligence Integration: Pedagogical Strategies and Policies at Leading Universities. Innovative Higher Education. https://doi.org/10.1007/s10755-024-09749-x

Bayaga, Anass (2024). Leveraging AI-enhanced and emerging technologies for pedagogical innovations in higher education. Education and Information Technologies. https://doi.org/10.1007/s10639-024-13122-y

Becker, P. K., Parker, L. J., Ritcher, D. (2024). Framework for the Future: Building AI Literacy in Higher Education White Paper. https://www.researchgate.net/publication/381660503_Framework_for_the_Future_Building_AI_Literacy_in_Higher_Education_White_Paper Accessed on 09/03/2025

Biggs, J., & Tang, C. (2010, February). Applying constructive alignment to outcomes-based teaching and learning. In Training material for "quality teaching for learning in higher education" workshop for master trainers, Ministry of Higher Education, Kuala Lumpur (Vol. 53, No. 9, pp. 23-25).

Biggs, J. and Tang, C. (2003) Teaching for Quality Learning at University – What the Student Does 2nd Edition SRHE / Open University Press, Buckingham.

Biggs, J., Tang, C., & Kennedy, G. (2022). Teaching for quality learning at university. McGraw-hill Education (UK).

Celik, I. (2023). Towards Intelligent-TPACK: An empirical study on teachers' professional knowledge to ethically integrate artificial intelligence (AI)-based tools into education. *Computers in Human Behavior*, 138, 107468. https://doi.org/10.1016/j.chb.2022.107468

Chan, C.K.Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *Int J Educ Technol High Educ*, 20, 38. https://doi.org/10.1186/s41239-023-00408-3

JISC (2023). Embracing Generative AI in Assessments: A Guided Approach. https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Frepository.jisc.ac.uk%2F9234%2F1%2Fassessment-ideas-for-an-ai-enabled-world.pptx&wdOrigin=BROWSELINK Accessed 23/03/2025

Kasneci, E., Sessler, K. , Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U. , Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T.,Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., Stadler, M., andKasneci, G. (2023) 'ChatGPT for good? On opportunities and challenges of large language models for education', *Learning and Individual Differences*,103, 102274. https://doi.org/10.1016/j.lindif.2023.102274

Keaton, S. A., & Bodie, G. D. (2011). Explaining Social Constructivism. *Communication Teacher*, 25(4), 192–196. https://doi.org/10.1080/17404622.2011.601725

Laupichler, M. C., Aster, A., Schirch, J., & Raupach, T. (2022). Artificial intelligence literacy in higher and adult education: A scoping literature review. *Computers and Education: Artificial Intelligence*, 3, 100101. https://doi.org/10.1016/j.caeai.2022.100101

Lea, M. R., & Street, B. V. (2006). The "academic literacies" model: Theory and applications. *Theory into practice*, 45(4), 368-377. https://doi.org/10.1207/s15430421tip4504_11

Lodge, J. M., de Barba, P., & Broadbent, J. (2023). Learning with Generative Artificial Intelligence Within a Network of Co-Regulation. *Journal of University Teaching & Learning Practice*, 20(7). https://doi.org/10.53761/1.20.7.02

Mascolo, M. F., Kanner, B. G., & Griffin, S. (1998). Neo-Piagetian Systems Theory and the Education of Young Children. *Early Child Development and Care*, 140(1), 31-52. DOI: 10.1080/0300443981400104

McKinsey (2023). Economic potential of generative AI. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier. Accessed 10/03/2025

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023a). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational technology research and development*, 71(1), 137-161. https://doi.org/10.1007/s11423-023-10203-6

Ng, D. T. K., Leung, J. K. L., Chu, S. K. W., & Qiao, M. S. (2021). Conceptualizing AI literacy: An exploratory review. *Computers and Education: Artificial Intelligence*, https://doi.org/10.1016/j.caeai.2021.100041

O'Dea, X. (2024). Generative AI: is it a paradigm shift for higher education? *Studies in Higher Education*, *49*(5), 811-816. https://doi.org/10.1080/03075079.2024.2332944

Perkins, M., Furze, L., Roe, J., & MacVaugh, J. (2024). The Artificial Intelligence Assessment Scale (AIAS): A framework for ethical integration of generative AI in educational assessment. *Journal of University Teaching and Learning Practice*, *21*(6), 49-66. DOI: https://doi.org/10.53761/q3azde36

Piaget, J. (1954). The construction of reality in the child (M. Cook, trans.). New York: Basic Books.

Pinski, M., & Benlian, A. (2024). AI literacy for users–A comprehensive review and future research directions of learning methods, components, and effects. *Computers in Human Behavior: Artificial Humans*, 100062. https://doi.org/10.1016/j.chbah.2024.100062

Rasul, T., Nair, S., Kalendra, D., Robin, M., de Oliveira Santini, F., Ladeira, W.J., Sun, M., Day, I., Rather, R.A. and Heathcote, L. (2023). The role of ChatGPT in higher education: Benefits, challenges, and future research directions. *Journal of Applied Learning and Teaching*, 6(1), pp.41-56. DOI: https://doi.org/10.37074/jalt.2023.6.1.29

Roe, J., Perkins, M., & Ruelle, D. (2024). Is GenAI the Future of Feedback? Understanding Student and Academic Staff Perceptions of AI Use in Assessment and Feedback. *Intelligent Technologies in Education*, Advanced Online Publication. DOI: https://doi.org/10.70770/rzzz6y35

Saleem, A., Kausar, H., & Deeba, F. (2021). Social constructivism: A new paradigm in teaching and learning environment. Perennial journal of history, 2(2), 403-421. https://doi.org/10.52700/pjh.v2i2.86

Schofield, L. & Zhou, X. (2024). Policing AI use by counting 'telltale' words is flawed and damaging. https://www.timeshighereducation.com/blog/policing-ai-use-counting-telltale-words-flawed-and-damaging accessed 08/03/2025

Schofield, L. & Zhang, J.J. (2024). Spotlight on the inclusion process in developing AI guidance and policy. Available: https://srheblog.com/?p=4921&preview=1&_ppp=8db0186ba3

Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. *Computers and Education: Artificial Intelligence*, 4, 100127. https://doi.org/10.1016/j.caeai.2023.100127

Sperling, K., Stenberg, C. J., McGrath, C., Åkerfeldt, A., Heintz, F., & Stenliden, L. (2024). In search of artificial intelligence (AI) literacy in teacher education: A scoping review. *Computers and Education Open*, 100169. https://doi.org/10.1016/j.caeo.2024.100169

The United Nations Educational, Scientific and Cultural Organization (UNESCO) (2024a). AI Competency framework for teachers. 391104eng.pdf (unesco.org). Accessed 26/09/2024.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) (2024b). AI Competency framework for students. https://doi.org/10.54675/JKJB9835 Accessed on 20/10/2024.

Vygotsky, L.S. (1978). Mind in society Cambridge, NM: Harvard.

World Economic Forum (2024). Reskilling Revolution: Preparing 1 billion people for tomorrow's economy. https://www.weforum.org/impact/reskilling-revolution-reaching-600-million-people-by-2030/. Accessed 09/05/2024.

Zhou, X. and Schofield, L. (2024a). Using social learning theories to explore the role of generative Artificial Intelligence (AI) in collaborative learning. *Journal of Learning Development in Higher Education*. DOI: https://doi.org/10.47408/jldhe.vi30.1031

Zhou, X. and Schofield, L. (2024b). "Developing a conceptual framework for Artificial Intelligence (AI) literacy in higher education", *Journal of Learning Development in Higher Education*, (31). DOI: https://doi.org/10.47408/jldhe.vi31.1354