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AI-Enabled Learning Support and Student Learning Performance in Malaysian Higher Education: The Mediating Roles of Self-Regulated Learning and Academic Engagement

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Abstract

Objective: To develop a conceptual model examining the relationships between AI learning support, digital competence, teacher AI guidance, and learning performance among students in Malaysian higher education institutions. **Methods:** The proposed study adopts a quantitative cross-sectional design. Data will be collected through a survey of Malaysian university students, and the hypothesised relationships will be tested using structural equation modelling. The model includes academic engagement and self-regulated learning as sequential mediators and academic integrity concern as a moderator of the relationship between academic engagement and learning performance. **Results:** Drawing on self-regulated learning theory, student engagement theory, social cognitive theory, AI literacy, digital competence, and academic integrity literature, the proposed model suggests that AI learning support does not automatically improve students' learning performance. Its effectiveness depends on students' ability to use AI strategically, critically, and ethically, together with appropriate guidance from lecturers. **Conclusion:** The proposed model contributes to the AI education literature by shifting attention from students' intention to adopt AI towards the learning mechanisms through which AI use may influence academic outcomes. It also provides a framework for understanding the roles of academic engagement, self-regulated learning, teacher guidance, digital competence, and academic integrity in AI-supported learning.

Keywords: Artificial intelligence, AI learning support, digital competence, self-regulated learning, academic engagement, academic integrity

Introduction

AI is a significant player in reshaping the higher education landscape. AI is being researched in universities globally for its potential in teaching and learning, assessment and

feedback, student advising, research and academic administration (Bond et al., 2024; Holmes et al., 2019; Luckin, 2017). The education sector in Malaysia is also witnessing a fast-paced digital transformation, following the increased demand for flexible, tech-enabled and future-oriented learning. The importance of AI readiness, education through technology, and AI in education cannot be overstated, as it is increasingly focus of Malaysia's national agenda in relation to AI-enabled learning in higher education (Jamaluddin, 2025; UNESCO, 2023).

AI-powered learning tools offer a number of educational advantages. They can be used to aid students in comprehending challenging concepts, creating examples, getting prompt explanation, enhancing writing, arranging learning material and preparing for examinations, etc. (Chan & Hu, 2023; Kasneci et al., 2023; Zawacki-Richter et al., 2019). AI technologies can serve as personal assistants for students needing extra learning support, available outside of class time. This is particularly important in higher education in Malaysia, where students have a varied academic, linguistic, cultural and technological background.

But using AI tools does not equal better learning. Technology powered by artificial intelligence can be used actively and responsibly by students, or passively and unethically by students. Some students may seek to clarify concepts and enhance learning strategies by using AI (Cotton et al., 2024; Eaton, 2023; Perkins, 2023) while others use AI tools to copy content without understanding or acknowledging the work (Cotton et al., 2024; Eaton, 2023; Perkins, 2023). The question is not just whether students employ AI tools, but how they employ them and when—under what learning conditions—is the use of AI tools contributing to true learning?

In the past, there were many studies that specifically concentrated on acceptance of technology, perceived usefulness, ease of use, and behavioural intention (Davis, 1989; Venkatesh et al., 2003; Venkatesh et al., 2012). While this is true, it is not all of the factors that account for

how AI tools affect academic outcomes. A student can use AI and accept it in more ways than one, but that doesn't necessarily mean that this is having an impactful effect on learning. Hence, the present paper suggests a learning mechanism–based model instead of a mere technology adoption.

Specifically, the proposed model investigates the effects of AI learning support, digital competence, and teacher AI guidance on students' learning performance by way of self-regulated learning and academic engagement. Self-regulated learning also is crucial because the learning behaviour needs to be planned, monitored, evaluated and controlled by the learners (Pintrich, 2000; Zimmerman, 2002). Academic engagement also is critical as students need to be actively involved in learning activities in order for AI support to lead to positive academic outcomes (Fredricks et al., 2004; Kahu, 2013; Kuh, 2009).

Academic Integrity Concern is also included as a moderating variable in this paper. Ethical awareness is key in the context of AI in education, as students can employ AI for learning support or as a tool to expedite academic work. Academic integrity concern is linked to greater likelihood to confirm AI-generated information, not plagiarize, and recognize AI assistance as required (Bretag, 2016; Eaton, 2023; McCabe et al., 2012). So academic integrity issue can boost the connection between academic involvement and real academic outcomes.

Literature Review

Artificial Intelligence in Malaysian Higher Education

AI in education is the application of intelligent systems to assist in learning, teaching, feedback, prediction, assessment, and academic decision making (Holmes et al., 2019; Luckin, 2017). Some tools that make use of AI can encompass intelligent tutoring systems, automated

writing support, adaptive learning platforms, learning analytics systems, and generative AI applications. They can facilitate students' flexible and independent learning and assist teachers in creating more responsive learning settings (Ifenthaler & Yau, 2020; Zawacki-Richter et al., 2019).

In Malaysia, the relevance of AI comes in the wake of the digital transformation of universities in higher education. The use of online learning, blended learning, digital platforms and data-driven academic support have increased. AI tools can help with these changes by providing students with academic support outside of the classroom. The effective application of AI requires digital competence of students, guidance from lecturers, institutional preparedness, and ethical awareness (Bond et al., 2024; Jamaluddin, 2025; UNESCO, 2023).

AI must not be perceived as a replacement for teachers and students' work. Instead, it should be seen as a learning support mechanism. Holmes et al. (2019) proposed that in education the use of AI must be to assist human learning and human judgement, not to replace them. UNESCO (2023) also highlighted the importance of using generative AI in education in ways that are shaped by human-centered principles and values, inclusion, transparency and ethical protection. These viewpoints are particularly crucial for integration of AI into Malaysian universities, as it should contribute to enhancing the educational experience while simultaneously promoting academic integrity.

AI Learning Support

AI learning support is students' perception of how they use AI to support their academic learning activities. Such support can encompass aiding students in comprehending complex ideas, offering illustrative examples, guiding writing, offering feedback, creating practice questions, organizing ideas, and guiding the revision process. AI learning support is different from general digital technology use, as it specifically addresses the learning support that is offered by AI-

based systems (Kasneci et al., 2023; Ng et al., 2021).

Students might be able to overcome learning obstacles with AI learning support. If they have difficulty understanding the academic language, students can ask AI to explain it in simpler terms; if they have difficulty with a topic, students can ask AI to give examples or explain it in other ways. These functions can be especially beneficial in multilingual and heterogeneous contexts like Malaysia in higher education. Learning support, on the other hand, can only be useful if students apply it critically with the help of AI support. When students copy the AI-generated responses, learning quality can be decreased by AI. When they use AI to brainstorm ideas, track their comprehension, and edit their work, AI can enhance their learning journey (Chan & Hu, 2023; Kasneci et al., 2023).

Digital Competence

Digital competence is the complex ability of students to use digital tools effectively, critically, creatively and responsibly. It contains skills like information searching, digital communication, online collaboration, problem solving, privacy awareness and evaluation of digital information (Carretero et al., 2017; Ferrari, 2013). Digital competence in the age of AI also encompasses how to interact with AI systems, how to evaluate AI-generated content, and how to understand the ethical issues that arise from the use of AI (Long & Magerko, 2020; Ng et al., 2021).

Higher levels of digital competence are correlated with greater strategic use of AI tools by students. They can refine their prompts, compare AI-generated content to academic texts, recognize incorrect information, and leverage AI to help achieve specific learning objectives. However, learners with less digital competence might be misled or misinterpret digital responses, accept information that is not accurate, or rely too heavily on generated content. This is

especially so for digital competence in Malaysian Higher Education as universities are expected to produce graduates who can function in digital and AI driven environments.

Teacher AI Guidance

Teacher AI guidance involves lecturers giving direction, support and instruction on how to use the AI tools appropriately for learning. This guidance might involve the communication of acceptable uses of AI, the creation of exemplar prompts, prompting students to reflect on the outputs of AI, and the rules concerning plagiarism and academic integrity (Boud & Molloy, 2013; McDonald et al., 2024).

Lecturers have a pivotal role in influencing students' learning behaviour in relation to AI. Students might be more inclined to utilize artificial intelligence tools as learning aids when they receive clear and constructive guidance from lecturers. When lecturers give clear and constructive guidance, students are more likely to use AI tools as learning supports. But when lecturers do not take any action on AI usage or only ban it without any justification, students may resort to using AI surreptitiously without comprehending the ethics. Teacher guidance can lower the uncertainty and help students to be more responsible regarding learning strategies (Dotan et al., 2024; UNESCO, 2023).

Self-Regulated Learning

Self-regulated learning is the ability of students to plan, monitor, control and evaluate their own learning. It involves goal setting, time management, learning strategy use, self-monitoring, reflection, and help seeking (Boekaerts, 1999; Pintrich, 2000; Zimmerman, 2002). Self-regulated learning is particularly significant in the setting of an AI-supported learning environment. Students can have access to powerful tools that may give them answers that will immediately

appear.

A self-regulated student can leverage AI to verify comprehension, create practice questions, share explanations, and identify knowledge gaps. A student who is not supervised may use AI to simply hand in work without learning. In this regard, self-regulated learning, which is one of the mechanisms that influence academic engagement, is proposed here as an important pathway by which AI learning support and digital competence, as well as the teacher's guidance on the use of AI, exert their effects.

Academic Engagement

Academic engagement is defined as students' active participation in the academic learning process. It consists of behavioural engagement, emotional engagement, and cognitive engagement (Fredricks et al., 2004). Behavioural engagement is manifested in participation, effort, and task completion. Emotional engagement consists of interest, motivation and positive learning feelings. Cognitive engagement is characterized by complex learning strategies, persistence and deep thinking (Kahu, 2013; Kuh, 2009).

AI tools can enhance engagement through interactive and personalized learning experiences. Students will be better able to have instant explanations. Additionally, they can be more cognitively involved when utilizing AI to investigate concepts and contrast point of views. Furthermore, they can be more intellectually engaged when moving on the ideas and contrasting points of view with AI. But AI doesn't mean engagement. Cognitive passivity means that learners may engage with the AI on a regular basis without questioning or judging the content created by the AI, as this would require additional cognitive effort and skills (Bond et al., 2024; Selwyn, 2022).

Learning Performance

Learning performance are defined as the students' learning results, such as learning improvements as perceived by students, academic task performance, learning achievement of the course, students' grades, and students' satisfaction with learning. The model doesn't make the assumption that AI will directly enhance performance. Instead, it suggests that AI can enhance performance when used to facilitation SRL and academic engagement. Because student behaviour, motivation, and effort, as well as ethical use, will influence learning outcomes, this is important, not only technology (Kuh, 2009; Pintrich, 2000; Zimmerman, 2002).

Academic Integrity Concern

Academic integrity concern is the student's concern and awareness for academic honesty, originality, responsibility, fairness and appropriate acknowledgment in academic work. This is a critical concern in AI-supported learning as generative AI can generate text that may be submitted as student work. Cotton et al. (2024), Eaton (2023), and Perkins (2023) stated that AI poses new academic integrity challenges due to the difficulties in distinguishing between assistance and academic dishonesty.

Students who have high academic integrity concern are more likely to use AI responsibly. They can confirm AI-generated content, refrain from copying AI-generated content, note when AI has been used and as required, follow institutional guidelines. Based on this, academic integrity concern is thus proposed as a moderator between academic engagement and learning performance.

Theoretical Foundation

This study is based on the integrated theoretical framework of self-regulated learning theory,

student engagement theory, social cognitive theory, AI literacy theory, digital competence literature, teacher scaffolding and academic integrity scholarship. The proposed model presents the claim that the adoption of AI-based LSU in Malaysian Higher Education institutions does not necessarily lead to improved learning outcomes. Rather, AI supports students' learning when they have adequate digital competence, are guided by their teacher in a meaningful way, take charge of their own learning, are actively involved in learning-related tasks, and are mindful of what is expected with respect to academic integrity.

Self-Regulated Learning Theory

The concept of SRL theory is a conceptual model that describes how students plan, monitor, use strategies and reflect on their learning process. According to Zimmerman (2002), SRLs are students who are metacognitively, motivationally, and behaviourally engaged in learning. In the same way, Pintrich (2000) stated that self-regulation is consisting of goal-setting, self-monitoring, control of learning strategies, and reflection on learning progress. The other important research that was mentioned was Boekaerts' (1999) formulation that SRL is a function of student motivation, cognitive strategies, and learning context.

Self-regulated learning is an important concept in AI-enabled learning because while AI tools can offer students the necessary support, they must learn to use this support in the right manner. Students can use AI to gain a deeper understanding of complex topics, create examples, proofread grammar, summarise information, and get instant explanations. However, if students are not self-regulated, they might passively or dependently use AI tools (Kasneci et al., 2023; Selwyn, 2022).

Self-regulated students are better able to strategic use AI. They can ask AI to present the concept in other ways, compare the answers from the AI with academic sources, adjust their

understanding and track their own learning. Based on this view, AI learning support does not contribute to learning unless it enhances the students' capacity to self-manage their learning. The authors Schunk and Greene (2018) pointed out that self-regulation is not a personal attribute but a learning ability that can be developed through learning environments, feedback and instructional support.

Student Engagement Theory

The proposed model also draws on the theory of student engagement. Academic engagement is the level of students' emotional, cognitive and behavioral participation in learning. Fredricks et al. (2004) found three key aspects of engagement: behavioural engagement, emotional engagement, and cognitive engagement. There is extensive research on how engagement relates to learning success in higher education. Kuh (2009) asserted that student engagement is a measure of "time and effort spent on educationally purposeful activity". Kahu (2013) went on to explain that engagement is the link between student motivation, institutional conditions, learning behaviour, and outcomes.

Engagement is even more crucial in AI-supported learning environments as the presence of AI tools could foster engagement but can also lead to shallow tasks. By making learning more interactive, responsive, and personalised, AI tools can help boost engagement. But AI use is not always a sure thing for engagement. If students use generated answers without reflection, they might have frequent opportunities to talk with AI, but lack the opportunity for cognitive engagement (Bond et al., 2024; Selwyn, 2022).

Social Cognitive Theory

According to social cognitive theory, learning is influenced by the interplay between

personal characteristics, behaviour and environment. Bandura (1986) stated that human learning is a result of reciprocal determinism, which is an interaction between personal cognition, behaviour, and environment. From the perspective of the usage of AI in education, students' digital competency is a personal competency, teacher AI guidance is an environmental support, and self-regulated learning is a learning behaviour.

This is especially helpful to consider when talking about the adoption of AI in Malaysian higher education as students are not using AI alone. They are shaped by their own confidence and competence, digital learning environment, lecturer expectations, the norms of peers and institutional policies. A student who has good digital competence might feel more confident in being able to leverage AI tools properly. Providing clear guidance on the proper use of AI by a lecturer can foster a responsible environment for using AI. These can influence students' SRL behaviour and thereby student engagement and learning performance.

AI Literacy and Digital Competence Perspective

AI literacy is defined as the awareness and proficiency needed to understand, utilize, assess and engage with AI systems in a responsible manner. AI literacy is a collection of abilities that enable people to critically analyze AI technologies and effectively interact with them, according to Long and Magerko (2020). Ng et al. (2021) also added the four components of AI literacy, which are concept of AI, application of AI, assessment of AI output and ethical consideration related to AI. More recent debates on AI literacy also highlight the importance of understanding of AI systems at a functional, critical, and sociocultural level (Gu & Ericson, 2025).

Digital competence is closely related to AI literacy. In the proposed model, digital competence becomes a predictor of SRL due to its ability to effectively utilize AI tools by students for academic purposes. They can ask more precise questions, evaluate the pertinence of

the AI-generated answers, confirm the information, and prevent inappropriate usage. This is particularly relevant for the Malaysian educational sector as the students are required to be able to function in a learning environment that is rich in technology.

Teacher Guidance and Scaffolding Perspective

The other critical theoretical factor in this research is the teacher's AI guidance. AI tools can be directly used by students, but lecturers play a crucial role in how these tools are applied. The teacher guidance can be explained with the term scaffolding, which is a support given by the teacher so that the learner can do something that he or she cannot do alone (Boud & Molloy, 2013).

Scaffolding can involve clarifying ethical and responsible use of AI, providing models of good prompting, teaching students how to recognize the use of AI, or summarizing academic integrity guidelines. Uncertainty can also be minimized through teacher AI guidance. Students might not know if they're permitted to use AI or if they can use too much, or whether they have to cite AI-generated ideas. Good lecturer guidance can support students in their safe and responsible use of AI (Dotan et al., 2024; McDonald et al., 2024).

Academic Integrity and Ethical AI Use

Academic integrity is defined as honesty, responsibility, fairness, trust and respect in academic work (Bretag, 2016; McCabe et al., 2012). AI in education brings academic integrity into focus as students might be tempted to complete assignments using generative AI-generated content as their own. Cotton et al. (2024) stated that ChatGPT and other AI tools present significant ethical and academic integrity concerns that must be addressed, as they offer a range of possibilities for academic cheating that are hard to distinguish from academic support and

collaboration. Bittle et al. (2025) also noted the positive and negative implications generative AI has had for academic integrity in higher education.

In this model, academic integrity concern is considered as a moderator between academic engagement and performance in learning. The answer is that engagement can't always ensure that learning is authentic. Even if a student is very active in using AI tools, they could still be misusing them if they are not aware of academic integrity. On the other hand, students of high academic integrity worry more about using AI tools to enhance their real learning. However, students with high academic integrity are more likely to be concerned about using AI for authentic learning. It aligns with the recent calls for a multi-layered approach to assessment, encompassing not just the use of AI detection tools but also the creation of assessment designs, policies, and learning cultures that foster responsible use of AI (Eaton, 2023; Perkins, 2023; UNESCO, 2023).

Hypotheses Development

AI Learning Support and Self-Regulated Learning

AI learning support is the perception that the student has about the usefulness of the use of AI tools to support their academic learning. This can involve clarifying complex ideas, generating examples, offering guidance with writing, offering feedback, supporting revision and independent study. The idea that self-regulated learning works best when students can plan, monitor and assess their learning activities (Pintrich 2000; Zimmerman, 2002) is supported by research. AI tools can assist this process by enabling pupils to ask questions, identify gaps in knowledge and be given instant answers.

But AI learning support does not necessarily lead to self-regulation. Students will be

required to intentionally and critically use AI tools. The use of AI for rapid answers could undermine SRL. However, if AI is used as a learning aid, it can motivate students to establish learning goals, practice their learning, and refine their learning products. AI in education research indicates that when used correctly, AI tools can contribute significantly to personalised learning and feedback (Holmes et al., 2019; Kasneci et al., 2023; Luckin, 2017).

H1: AI learning support positively influences self-regulated learning among Malaysian higher education students.

Digital Competence and Self-Regulated Learning

Digital competence is defined as student's ability to utilize digital technologies effectively, critically and responsibly. It covers aspects of information search, assessing online resources, solving digital problems, using e-learning platforms, as well as the ethical implications of digital tools (Carretero et al., 2017; Ferrari, 2013). Digital competence is particularly relevant in AI-supported education as it involves students engaging with intricate systems, assessing suggestions created by AI, and defending academic integrity.

There is a positive correlation between students' digital competence and the strategic use of AI tools. They can develop more effective prompts, detect misleading information, compare AI-generated answers to academic resources, and use digital tools to assist learning objectives. Such behaviours are highly similar to the SRL behaviors. Ng et al. (2021) suggested that AI literacy is required so that the learners can be aware of applications of AI and use them responsibly. The importance of being able to critically assess AI systems is also highlighted by Long and Magerko (2020), who call for AI literacy.

H2: Digital competence positively influences self-regulated learning among Malaysian higher education students.

Teacher AI Guidance and Self-Regulated Learning

The concept of teacher AI guidance is how much direction, explanation and support teachers give their students with the proper use of AI tools. Lecturers can guide students from the use of unstructured AI tools to meaningful AI-assisted learning from a scaffolding point of view. Boud and Molloy (2013) proposed that students' feedback should contribute to the development of evaluative judgement. With AI-assisted learning, lecturers can assist students in evaluating the accuracy and relevance of AI-generated answers and decide whether they are academically suitable.

AI policies for higher education institutions could vary from university to faculty, making teacher guidance especially critical in the Malaysian context. Lecturers can guide students to control their use of AI according to academic standards when they give clear guidance. In the absence of guidance, students can turn to peer norms or personal judgement which may lead to increased risk of misuse (Dotan et al., 2024; McDonald et al., 2024).

H3: Teacher AI guidance positively influences self-regulated learning among Malaysian higher education students.

Self-Regulated Learning and Academic Engagement

Self-regulated learning is expected to positively influence academic engagement as students who manage their learning positively are expected to be active in academic tasks. The 4 components of SRL are setting goals, monitoring progress, adjusting strategies, and reflecting on outcomes (Boekaerts, 1999; Schunk & Greene, 2018; Zimmerman, 2002). These behaviours are closely related to behavioural and cognitive engagement.

Student engagement theory proposes that student engagement is a three-part process that includes behavioral, emotional and cognitive engagement in learning (Fredricks et al., 2004). All

three dimensions are nurtured by SFL. Self-regulation may be even more critical in an AI-supported learning environment, as students are presented with vast quantities of information generated by AI. If they aren't self-regulated, students can get distracted or rely too heavily on AI. Self-regulation enables students to utilize AI resources to promote active learning.

H4: Self-regulated learning positively influences academic engagement among Malaysian higher education students.

Academic Engagement and Learning Performance

Academic involvement is known to be one of the factors that predicts learning performance. Engaged students are more likely to invest in learning activities by spending time, effort and attention. In the case of engagement, Kuh (2009) said that it means students are involved in educationally relevant activities, which helps to achieve learning success. Kahu (2013) also highlighted that engagement is the link between institutional support, student motivation, student learning behaviour and outcomes.

Engagement is the key to whether students leverage AI tools meaningfully in AI-supported education. For engaged students, AI can help them brainstorm ideas, refine their writing, practice their comprehension and critically analyze feedback. These activities can enhance learning performance as they are active cognitive processes. On the other hand, students who are just using AI to get the work done might finish tasks swiftly, but they might not grasp the content thoroughly (Selwyn, 2022).

H5: Academic engagement positively influences learning performance among Malaysian higher education students.

Sequential Mediation of Self-Regulated Learning and Academic Engagement

The model proposed in this study suggests that the impact of factors related to AI on learning performance is mediated by self-regulated learning and academic engagement. This implies that the initial effects of AI learning support, digital competence and teacher AI guidance are to enhance the ability of students to regulate their learning. Increased academic engagement results in increased learning performance, while increased self-regulated learning increases academic engagement.

This sequence of mediation logic is in line with the concept of learning outcome being generated through learning processes, and not just through technology access. AI tools can be used as resources, and students should be able to control how they utilize the assistance. Engagement in academic activities is more likely when students have a successful regulation of their learning. Engagement is then linked to enhanced performances (Fredricks et al., 2004; Kahu, 2013; Pintrich, 2000).

H6: Self-regulated learning and academic engagement sequentially mediate the relationship between AI learning support and learning performance.

H7: Self-regulated learning and academic engagement sequentially mediate the relationship between digital competence and learning performance.

H8: Self-regulated learning and academic engagement sequentially mediate the relationship between teacher AI guidance and learning performance.

Moderating Role of Academic Integrity Concern

Academic Integrity Concern indicates students' understanding and interest in academic integrity, including the use of AI responsibly, avoiding plagiarism, and giving proper credit. Academic integrity concern plays a crucial role in AI-powered learning, as students can choose

to employ AI either as a learning aid or to avoid effort. Cotton et al. (2024), Eaton (2023) and Perkins (2023) emphasized that generative AI presents problems for academic integrity due to the potential for students to generate content that could be considered theirs, but may not be.

Based on this idea, this study argues that academic integrity concern is a moderator between academic engagement and learning performance. With high academic integrity concerns, engaged students are more apt to make responsible use of AI. They can confirm AI-generated work, refrain from plagiarizing AI-generated content, cite the use of AI if necessary, and ensure that their work is their own. In such a situation, students' engagement in an academic activity will increase the likelihood of achieving actual academic performance.

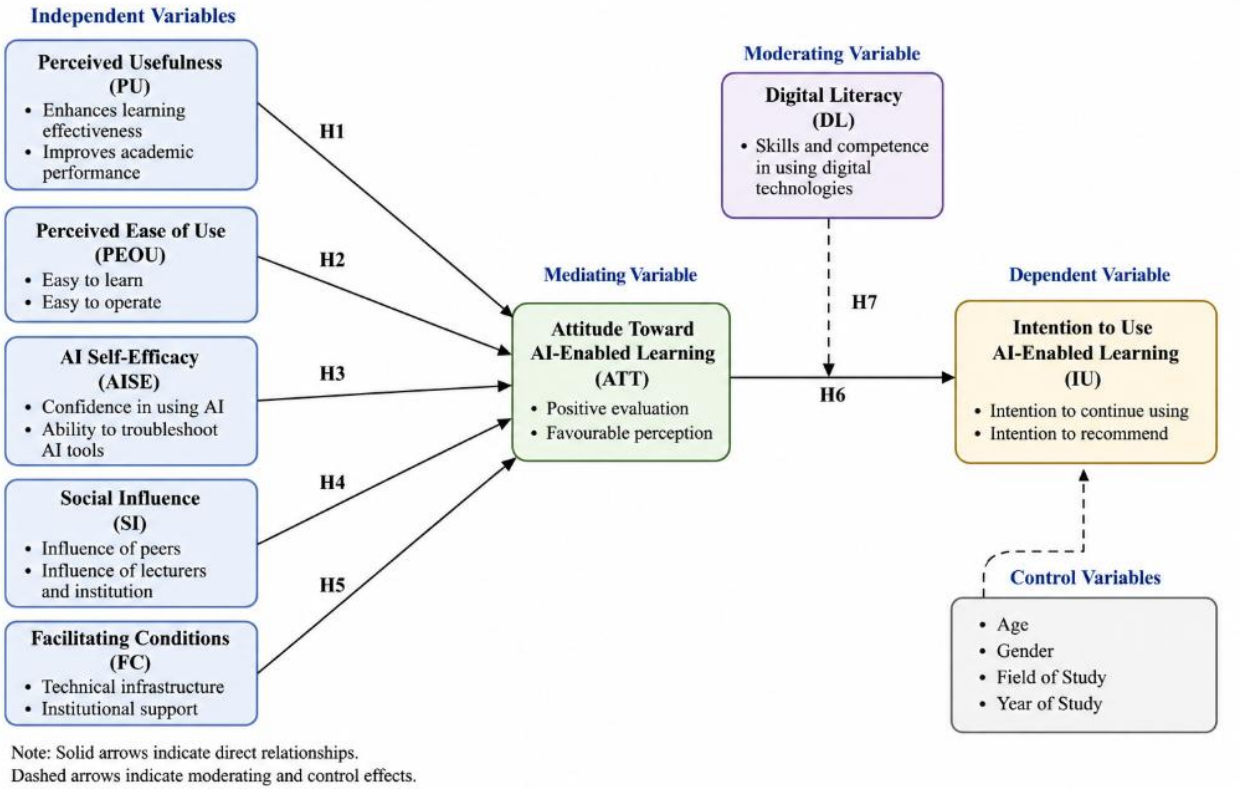
H9: Academic integrity concern moderates the relationship between academic engagement and learning performance, such that the relationship is stronger when academic integrity concern is high.

Proposed Conceptual Framework

The proposed conceptual framework comprises of three independent variables, namely AI learning support, digital competence, and teacher AI guidance. These variables are hypothesized to have an effect on self-regulated learning. The roles of self-regulated learning in influencing academic engagement and learning performance are expected. It is suggested that self-regulated learning and academic engagement are sequential mediators. Academic integrity concern is suggested as a mediating factor between academic engagement and academic performance.

The proposed model can be summarized in figure 1:

Figure 1. Research Model



Proposed Methodology

Research Design

The research design in this study is quantitative research with a cross-sectional survey type. The study seeks to test hypothesized relationships between measurable constructs; a quantitative design is appropriate. The cross-sectional study method is suitable for asking answers from a large number of students from universities for a certain period of time. The study of educational technology and AI adoption often relies on quantitative survey designs, as they enable researchers to analyze the relationship among perceptions, learning processes and learning outcomes (Hair et al., 2022; Zawacki-Richter et al., 2019).

Research Context

The study will be focusing the Malaysian higher education sector. The study setting can be public or private universities in Malaysia. The context of this Malaysia is appropriate as various higher education institutions are also implementing digital and AI-based learning tools with concurrent challenges of digital readiness, lecturer readiness, and academic integrity (Jamaluddin, 2025; UNESCO, 2023).

Population and Sample

The target population will be the undergraduate students who are studying in Malaysia higher education institutions. The selection of undergraduate students is driven by the increasingly common use of digital learning platforms by students and the possibility that they may be more dependent on AI tools for academic support. For structural equation modelling, it is recommended to have 400-500 students. The sample size is appropriate for testing a model with multiple predictors, mediators and a moderator (Hair et al., 2022; Kline, 2023).

Sampling Technique

Purposive sampling and convenience sampling may be used for the study. Purposive sampling involves a sampling of university students that have awareness/experience using AI-enabled learning tools. The researcher can use convenience sampling to make the questionnaire available on university networks, on-line student groups, learning management systems and email invitations. To increase the variety of the samples, the researcher should consider collecting data from both public and private universities with students from a range of year level.

Data Collection Procedure

Data will be collected using a structured online questionnaire. Ethical approval must be

granted by the appropriate University ethics committee prior to data collection. Participants will be told the purpose of the study, the voluntary nature of participation, the conditions of confidentiality, anonymity and right to withdraw. The questionnaire will start with screening questions to make sure that the respondents are current university students and have some knowledge about AI learning tools.

Measurement of Constructs

Multi-item scales adapted from previous literature will be used to measure all constructs. This will be measured on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The learning support items used in AI can be modified based on AI-supported learning and educational technology studies (Holmes et al., 2019; Kasneci et al., 2023). Digital competence items can be chosen from various digital competence or AI literacy frameworks (Carretero et al., 2017; Ng et al., 2021; Ferrari, 2013). Some self-regulated learning items are adapted from Pintrich (2000), Schunk and Greene (2018), and Zimmerman (2002). Academic engagement items can be adapted from Fredricks et al. (2004), Kahu (2013) and Kuh (2009). Items for concern regarding academic integrity may be modified from Breitg and Eaton (2016), Eaton (2023), and McCabe et al. (2012).

Data Analysis

The data will be analysed by SPSS and SmartPLS or AMOS. Firstly, a data screening will be performed to look out for missing data, outliers, incomplete answers and careless answers. The profiles and patterns of usage of the AI will be summarized using descriptive statistics. Secondly, reliability and validity will be measured. Cronbach's alpha and composite reliability will be used to assess internal consistency. Convergent validity will be tested by using Average

Variance Extracted (AVE). The Fornell-Larcker criterion and heterotrait-monotrait ratio will be used to test the discriminant validity (Hair et al., 2022). Thirdly, the hypotheses will be tested using structural equation modelling. Mediation and moderation will be tested using a bootstrapping procedure.

Ethical Considerations

Ethical research principles will be adhered to in the study. Participation will be voluntary and informed consent will be obtained prior to answering the questionnaire. The survey will not request personal information that would not be useful to the researcher. Responses will be anonymous and confidential. The study will require academic integrity and use of AI, which might cause some participants to be hesitant to report their true behaviour. The purpose of the questionnaire should therefore be clearly specified to exclude investigation of individual misconduct. The intent is to gain a general idea of learning experiences and perceptions.

Research Implications

This study offers several important research implications for the field of AI-enabled education, particularly within the Malaysian higher education context. First, the proposed model extends existing research by shifting the focus from students' general intention to use AI tools toward the learning processes through which AI may influence academic outcomes. While many previous studies have examined technology acceptance and AI adoption, this study highlights that AI learning support contributes to learning performance mainly through self-regulated learning and academic engagement. This provides a more learning-centred explanation of AI's role in higher education.

Second, the study contributes to self-regulated learning literature by positioning AI learning

support, digital competence, and teacher AI guidance as important antecedents of students' self-regulated learning. This suggests that self-regulated learning in AI-supported environments is not only an individual ability but also a process shaped by technological support, students' digital capability, and lecturer guidance. Future researchers may further examine how different forms of AI tools influence students' planning, monitoring, reflection, and learning strategy use.

Third, this study strengthens the connection between student engagement theory and AI-enabled learning. By proposing academic engagement as a mediator between self-regulated learning and learning performance, the model explains how AI-supported learning may become meaningful only when students are behaviourally, emotionally, and cognitively involved in academic tasks. This provides a useful direction for future studies to explore whether AI tools promote deep engagement or merely increase surface-level task completion.

Fourth, the inclusion of academic integrity concern as a moderating variable adds an ethical dimension to AI education research. The model suggests that the positive effect of academic engagement on learning performance may depend on students' awareness of responsible AI use, plagiarism, originality, and proper acknowledgement. This implication is important because AI-related learning performance should not be assessed only in terms of grades or productivity, but also in terms of authentic and ethical learning.

Finally, this study provides a foundation for future empirical research in Malaysian higher education. Researchers may test the proposed model across public and private universities, different academic disciplines, and different student groups. Future studies may also compare AI usage patterns between undergraduate and postgraduate students or examine whether institutional AI policies influence the relationships proposed in this model. Overall, the study contributes to the development of a more comprehensive research agenda on responsible,

student-centred, and performance-oriented AI integration in higher education.

Practical Implications

The proposed model offers several practical implications for Malaysian higher education institutions. First, universities should move beyond simple access to AI tools and focus on meaningful learning support. Students need to understand how AI can be used to support explanation, revision, feedback, and reflection. Second, universities should strengthen digital competence. AI literacy should be included in student development programmes. Students should learn how to write effective prompts, verify AI-generated information, protect privacy, and avoid academic misconduct.

Third, lecturers should receive training on AI-supported teaching. Lecturer guidance is important because students need clear expectations about acceptable and unacceptable AI use. Lecturers should also redesign assessments to encourage reflection, application, originality, and critical thinking. Fourth, academic integrity policies should be updated. Universities should clarify whether students may use AI for brainstorming, grammar checking, translation, coding, or drafting. Students should also be taught how to disclose AI assistance when required. Finally, Malaysian higher education institutions should promote a culture of responsible innovation. AI should be used to enhance human learning, not replace student effort or lecturer judgement.

Conclusion

This paper proposed a new conceptual model for examining AI-enabled learning in Malaysian higher education. Unlike technology acceptance models that focus mainly on intention to use, this model focuses on learning mechanisms. It proposes that AI learning support, digital competence, and teacher AI guidance influence learning performance through self-

regulated learning and academic engagement. Academic integrity concern is proposed as a moderator that strengthens the relationship between engagement and genuine learning performance.

The proposed study is important because AI tools are becoming increasingly common in higher education. However, their educational value depends on how students use them. AI can support learning when students are digitally competent, self-regulated, engaged, and ethically aware. For Malaysian universities, the challenge is not only to adopt AI but also to guide its responsible and meaningful use.

Declarations

Ethical Considerations

The present article develops a conceptual framework and proposes an empirical research design for examining AI-enabled learning in Malaysian higher education. No participant data were collected for the present paper. Prior to the implementation of the proposed empirical study, ethical approval will be obtained from the appropriate institutional ethics committee. Participation will be voluntary, and informed consent will be obtained from all participants. The proposed survey will also ensure anonymity, confidentiality, and participants' right to withdraw.

Data Availability

No empirical dataset was generated or analysed for this article. The study presents a conceptual model and proposed methodology intended to guide subsequent empirical investigation.

Competing Interests

The authors declare that they have no competing interests.

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Author Contributions

All authors contributed to the conceptual development of the study, review and synthesis of the relevant literature, development of the proposed research framework, and preparation and revision of the manuscript. All authors reviewed and approved the final manuscript.

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