European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available online at: www.oapub.org/edu

DOI: 10.46827/ejes.v12i12.6356 Volume 12 | Issue 12 | 2025

OPTIMIZING LEARNING WITH ARTIFICIAL INTELLIGENCE IN THE CLASSROOM: THE MEDIATING ROLE OF TIME MANAGEMENT SKILLS IN ENHANCING ACADEMIC ACHIEVEMENT AMONG UNIVERSITY STUDENTS IN KLANG VALLEY, MALAYSIA

Kumaran Kanapathipillai[i],
Wan Rahafiz Bin Wan Abdul Rahim,
Muhamad Khairul Anwar Bin Mat Azidin,
Norhafizah Binti Hambali
UNITAR International University,
Tierra Crest, Jalan SS6/3,
Kelana Jaya, 47301 Petaling Jaya,
Selangor, Malaysia

Abstract:
This study investigated how Artificial Intelligence (AI) influences academic achievement among university students in Klang Valley, Malaysia, with time management skills as a mediating factor. Grounded in Zimmerman's Self-Regulated Learning (SRL) model, it explored the relationships between the frequency, familiarity, and duration of AI use and students' academic performance. A quantitative design was employed using 313 valid responses from three private universities. Data were collected through a structured questionnaire and analysed using SPSS version 30 with multiple regression and Hayes PROCESS MACRO mediation tests. The findings revealed that frequent, familiar, and prolonged AI use enhanced academic performance. Time management skill mediated the relationships between AI familiarity and duration with academic performance, but not between frequency and academic performance. The study bridges theoretical and practical gaps by showing that self-regulatory behaviours strengthen the educational value of AI. It recommends integrating AI literacy with structured time management skills to optimize learning outcomes.

Keywords: artificial intelligence, frequency, familiarity, duration, academic performance

[i] Correspondence: email kumar.erapintar@gmail.com

1. Introduction

The higher education sector in Klang Valley is rapidly embracing artificial intelligence (AI) across teaching, assessment, and student support systems. This transformation raises important questions about how AI engagement influences academic performance within Malaysian universities. Existing studies demonstrate that AI enhances educational outcomes through adaptive feedback, intelligent tutoring, and personalized analytics (Bond, 2024; Dong *et al.*, 2025; Vieriu *et al.*, 2025).

Students increasingly integrate AI into their study habits and time-management skills, reshaping how learning is organized (Kelly, 2024). National initiatives such as AI governance frameworks and dedicated learning centres further promote responsible technological adoption (Ministry of Finance Malaysia, 2023; UNESCO, 2024).

However, realizing these benefits depends on institutional readiness, ethical awareness, and resource adequacy (Bond, 2024; UNESCO, 2024). Given Malaysia's diverse academic landscape, localized evidence is essential. This study, therefore, investigates how AI use affects academic performance among university students in Klang Valley within Malaysia's evolving digital education context.

1.1 Research Problem Statement

Artificial Intelligence (AI) has become integral to higher education but the mechanisms through which it shapes students' academic performance remain insufficiently explored. Studies by (Abbas *et al.*, 2023; Abubakar *et al.*, 2024; Ahmad *et al.*, 2022; Hu *et al.*, 2024) have highlighted that frequent and duration of AI use improves learning efficiency, motivation, and adaptability. Likewise, familiarity with AI enhances students' ability to plan, monitor, and regulate their learning behaviours (Chan & Hu, 2023; Xie, 2023). However, contrasting evidence by (Abuzaid *et al.*, 2022; Zhang, S. *et al.*, 2024; Klímová *et al.*, 2023) shows that excessive dependence on AI may undermine self-regulated learning, reduce creativity, and weaken time-control skills. These inconsistencies reveal a crucial research gap concerning how AI engagement transforms into tangible academic performance.

Grounded through the Self-Regulated Learning (SRL) model (Zimmerman, 1989), this study addresses that gap by examining the mediating influence of time management skills on the relationship between AI use (frequency, familiarity, and duration) and students' academic performance. Past studies by (Al-Yami *et al.*, 2021; Hidayat & Hasim, 2023; Woods *et al.*, 2024) have indicated that time management skills facilitate cognitive organization, task prioritization, and academic persistence, but few have investigated their mediating role within AI-based learning environments.

In Malaysia's Klang Valley, where online and AI-assisted learning has become widespread (Huang *et al.*, 2021; Namjoo *et al.*, 2023; Xia *et al.*, 2023), understanding this interaction is significant. Without such evidence, educational institutions risk emphasizing technological adoption over behavioral regulation. Conversely, confirming

this mediation could guide universities in designing curricula that integrate AI use with self-regulatory training, promoting responsible technology use and sustainable academic achievement.

1.2 Research Questions

RQ1: Is there a significant relationship between frequency of AI use and students' academic performance?
RQ2: Is there a significant relationship between familiarity with AI and students' academic performance?
RQ3: Is there a significant relationship between duration of AI use and students' academic performance?
RQ4: Is there a significant relationship between frequency of AI use and time management skills?
RQ5: Is there a significant relationship between familiarity with AI and time management skills?
RQ6: Is there a significant relationship between duration of AI use and time management skills?
RQ7: Is there a significant relationship between time management skills and students' academic performance?
RQ8: Is there a significant mediating role of time management skills in the relationship between frequency of AI use and students' academic performance?
RQ9: Is there a significant mediating role of time management skills in the relationship between familiarity with AI and students' academic performance?
RQ10: Is there a significant mediating role of time management skills in the relationship between duration of AI use and students' academic performance?

1.3 Research Objectives

RO1: To examine the relationship between frequency of AI use and students' academic performance.
RO2: To examine the relationship between familiarity with AI and students' academic performance.
RO3: To examine the relationship between duration of AI use and students' academic performance.
RO4: To examine the relationship between frequency of AI use and time management skills.
RO5: To examine the relationship between familiarity with AI and time management skills.
RO6: To examine the relationship between duration of AI use and time management skills.
RO7: To examine the relationship between time management skills and students' academic performance.

RO8: To examine if time management skills mediate the relationship between frequency of AI use and students' academic performance.
RO9: To examine if time management skills mediate the relationship between familiarity with AI and students' academic performance.
RO10: To examine if time management skills mediate the relationship between duration of AI use and students' academic performance.

2. Literature Review

The following sections provide the underpinning theory, literature review and hypothesis development.

2.1 Underpinning Theory

This study is grounded in the Self-Regulated Learning (SRL) Model developed by (Zimmerman, 1989), which outlines how learners manage their study processes to achieve academic success. The SRL model is increasingly relevant as students incorporate Artificial Intelligence (AI) tools to enhance their learning effectiveness.

The SRL model consists of three phases: the forethought phase, performance phase, and self-reflection phase. In the forethought phase, students prepare for learning by setting goals and planning strategies. This phase is critical as it guides subsequent learning activities. AI tools like Grammarly and ChatGPT support students in this phase by helping them evaluate academic requirements and structure their assignments, thereby improving their academic outcomes (Huang *et al.*, 2021).

During the performance phase, students monitor their progress and adjust their strategies in real-time. AI tools provide essential feedback, enabling students to enhance their writing and problem-solving skills (Namjoo *et al.*, 2023). Continuous assessment with AI assistance helps students stay focused and manage their time effectively, preventing procrastination (Youn, 2025).

The self-reflection phase involves students evaluating their performance and learning experiences to identify areas for improvement. AI chatbots facilitate this evaluation process, allowing students to analyse their goal attainment and the effectiveness of their strategies (Xia *et al.*, 2023). This phase fosters lifelong learning as students learn from both successes and setbacks, ultimately enhancing their ability to manage their learning independently (Almusaed *et al.*, 2023).

Overall, the SRL model's phases align with this study in terms of usage of AI tools, which enhance students' self-regulation and improve learning outcomes (Huang *et al.*, 2021; Namjoo, 2023). The study highlights the importance of integrating AI into educational practices to support self-regulated learning.

2.2 Academic Performance of Students

Artificial Intelligence (AI) possesses significant potential to enhance student performance in educational environments. Based on the studies by (Almusaed *et al.*, 2023; Liu *et al.*, 2022) AI can revolutionise teaching and learning methodologies by providing personalised and adaptive educational experiences tailored to individual learning requirements. Nonetheless, achieving these advantages necessitates tackling implementation hurdles, including integration difficulties and sufficient teacher preparation. The expanding framework, adaptability, and availability of digital education have significantly improved overall student involvement and success, especially among female students in IT and computer science.

The integration of AI in educational systems has significantly impacted teaching methodology, mentorship strategies, and curriculum development (Gao, 2022). Moreover, according to (Tanjga, 2023) the integration of AI with contemporary e-learning systems can provide all educational stakeholders with intelligent, adaptable, and customised services. Additionally, (Kuleto *et al.*, 2021) emphasised that AI, previously limited to data processing, has developed into revolutionary technologies that are reshaping the education industry via personalised learning applications tailored to specific student requirements. On the other hand, (Huang *et al.*, 2021) warned that the full integration of AI in education is constrained, since institutions, educators, and students encounter considerable problems in adjusting to AI-driven settings.

In both developing and developed countries, investigations into AI's impact on higher education have proliferated, demonstrating its capacity to enhance learning engagement, customise instruction, and optimise academic administration (Youn, 2025). Nonetheless, this trend is less evident in poorer regions, where significant research deficiencies endure. Rectifying these gaps is crucial to guarantee equitable educational progress across various situations. The potential of AI technologies is in their ability to improve academic achievement by increasing learning efficiency, fostering cooperation, and broadening access to educational resources (Huang *et al.*, 2021). As AI applications proliferate, their role in enhancing learning outcomes becomes increasingly apparent. Integrating AI into academic settings offers chances to improve student performance via more dynamic, responsive, and data-driven learning systems (Xia *et al.*, 2023).

2.3 The Relationship Between Frequency of AI Use and Students' Academic Performance

The frequency of artificial intelligence (AI) use has been increasingly recognized as a contributing factor to improved academic performance, although its impact depends on the depth of integration and the learning context. Studies by (Abbas *et al.*, 2023; Ezeoguine & Eteng-Uket, 2024) have shown that consistent engagement with AI tools enhances student performance by promoting personalized learning, increasing motivation, and improving engagement with course materials. Moreover, according to (Abubakar *et al.*, 2024; Ahmad *et al.*, 2022), frequent interaction with AI applications can also foster

adaptive learning, where systems adjust to students' individual progress and provide timely feedback, leading to measurable academic gains. Furthermore, AI-driven innovations in education management have been found to enhance both teaching quality and student training, demonstrating significant improvement in higher education outcomes (Zhang, 2024). In recent research by (Amer *et al.*, 2025) also indicates that frequent use of AI chatbots positively influences students' academic achievement, particularly when supported by positive attitudes toward technology, suggesting that technophilia strengthens while technophobia weakens academic outcomes. This aligns with the automation–augmentation perspective that argues AI use can enhance, rather than replace, human cognition, helping students process information more effectively and perform better academically (Raisch & Krakowski, 2021). Similarly, (Ahmad *et al.*, 2022) mentions that AI applications that support efficient grading and assessment reduce teacher workload and create more time for active learning, indirectly improving students' performance through better instructional quality. In addition, (Hu *et al.*, 2024) discovered that AI-facilitated smart learning techniques have been shown to encourage curiosity and a desire for knowledge, which together drive students toward higher academic achievement.

However, the relationship between frequency of AI use and academic performance is not universally positive, as several studies have identified potential drawbacks. Excessive dependence on AI may lead to a decline in students' critical thinking and engagement, especially when the technology is used without adequate guidance or understanding (Abuzaid *et al.*, 2022). Moreover, overreliance on AI can interfere with social interactions and emotional development, as frequent use of AI technologies has been linked to reduced interpersonal skills and weaker peer relationships (Puteri *et al.*, 2024; Lai *et al.*, 2023). Moreover, ethical and psychological challenges have also emerged, including concerns about data privacy, algorithmic bias, and emotional disconnection between learners and instructors, which can hinder meaningful learning experiences (Klímová *et al.*, 2023). Additionally, (Zhang, 2021) mentions that ineffective implementation of AI systems and a lack of data protection mechanisms have been reported to compromise both educational quality and student trust in technology. These findings suggest that while frequent AI use can support academic success when appropriately structured, it can also undermine learning if not balanced with human-centered approaches and proper oversight.

Therefore, the frequency of AI use contributes positively to academic performance when combined with adequate training, ethical practices, and a supportive educational environment. When applied effectively, frequent AI engagement can enhance personalized learning, efficiency, and motivation. On the other hand, when AI is overused or poorly implemented, it may weaken social, emotional, and ethical dimensions of education. Therefore, effective integration requires not only technological proficiency but also strong pedagogical strategies that allow students to use AI

purposefully rather than dependently. These dissimilarities in findings reveal a gap in the literature, which led to the formation of hypothesis H1.

H1: There is a significant relationship between the frequency of AI use and students' academic performance.

2.4 The Relationship Between Familiarity with AI and Students' Academic Performance

Familiarity with artificial intelligence (AI) has increasingly been recognized as a key determinant of students' academic performance, as it shapes their capacity to navigate modern learning environments with confidence and adaptability. Research consistently suggests that students who are more familiar with AI tools display greater engagement, motivation, and learning efficiency. Studies by (Chan & Hu, 2023; Wu & Yu, 2023) mention that exposure to adaptive platforms, intelligent tutoring systems, and chatbots, students benefit from personalized feedback and real-time support that strengthen comprehension and retention. Moreover, (Kwak *et al.*, 2022; Al-Roomi *et al.*, 2024) found that in medical and professional education, higher familiarity with AI has been associated with improved self-efficacy and readiness to integrate technology into practice, reflecting a deeper understanding of its role in enhancing both theoretical knowledge and applied skills. Similarly, (Akavova *et al.*, 2023; Xie, 2023) elucidated that AI-driven inquiry and adaptive learning models have been shown to foster autonomy and self-regulated learning by tailoring educational content to individual needs.

Despite these advantages, contrasting findings reveal that familiarity alone does not guarantee improved academic outcomes. Study by (AlZaabi *et al.*, 2023) indicate that inadequate training, inconsistent exposure, or shallow understanding of AI can hinder students from effectively applying these tools in academic settings. Moreover, excessive reliance on AI may reduce critical thinking and creativity, leading to academic dependency, misinformation, and diminished self-efficacy (Zhang, S. *et al.*, 2024). Moreover, (Zhang, Y. *et al.*, 2021) mentions that variations in AI's impact across disciplines also suggest that its benefits depend on the quality of implementation and pedagogical context.

Therefore, familiarity with AI enhances academic performance when accompanied by structured training, reflective learning, and ethical integration. Without these, it risks fostering dependence rather than empowerment, emphasizing the importance of balanced AI literacy that nurtures both technological competence and independent intellectual growth. These difference reveals a gap in the literature which led to the formation of hypothesis H2.

H2: There is a significant relationship between familiarity with AI and students' academic performance.

2.5 The Relationship Between Duration of AI Use and Students' Academic Performance

The duration of artificial intelligence (AI) use has emerged as a critical determinant of academic performance, reflecting how sustained interaction with technology can shape students' cognitive and behavioral learning outcomes. Evidence from recent studies by (Deng & Yu, 2023; Khan & Irfan, 2025; Mishra, 2025) suggests that extended exposure to AI tools contributes to improved academic performance through cumulative engagement, personalized feedback, and adaptive learning experiences. In line with this (Abdullahi, 2025; Lai *et al.*, 2025) discovered that students who consistently utilize AI-enhanced platforms over longer periods develop stronger problem-solving abilities, improved analytical reasoning, and higher motivation, as continuous feedback mechanisms reinforce self-regulated learning behaviors. Moreover, (Drouet *et al.*, 2024; Kawatra, 2024) mention that sustained AI use is also shown to increase satisfaction and cognitive development, as learners benefit from iterative interaction with intelligent tutoring systems that adapt to their evolving academic needs. In higher education contexts, such prolonged engagement not only fosters greater academic persistence but also enables educators to allocate more time to interactive instruction, thereby enhancing both student participation and overall achievement (Faridoon *et al.*, 2025).

Despite these positive indications, contrasting evidence underscores that extended use of AI does not always guarantee improved learning outcomes. Meta-analytic studies report inconsistent findings, with some showing stronger effects for short interventions rather than long-term exposure (Sun & Zhou, 2024; Shah *et al.*, 2025). Additionally, (Aproda *et al.*, 2024; Rienties *et al.*, 2024) found that excessive or unguided use can lead to reduced creativity, ethical complacency, and overreliance on automated assistance, undermining critical thinking and academic integrity. Moreover, research by (Kharis *et al.*, 2024; Umaiba, 2025; Amal *et al.*, 2024) highlights concern about data privacy, inadequate user training, and disparities in technological access that may limit the educational value of sustained AI interaction.

Thus, while prolonged AI use enhances academic performance when guided by structured pedagogical strategies, its success depends on balance and reflective practice. Meaningful integration must emphasize ethical awareness, human oversight, and continuous evaluation to ensure that extended use strengthens learning rather than fostering dependence. These disparities in previous findings reveal a gap in the literature, which led to the formation of hypothesis H3.

H3: There is a significant relationship between duration of AI use and students' academic performance.

2.6 The Relationship Between Frequency of AI Use and Time Management Skills

Frequent use of AI applications has been consistently linked with better time-management skills among students and educators. According to (Meron & Araci, 2023; Dhulipala, 2025) regular engagement with AI tools helps users save time, reduce workload, and complete academic tasks more efficiently by automating routine processes and structuring learning schedules. In higher education settings, students who frequently interact with AI systems report improvements in organizing study sessions, setting priorities, and adhering to academic deadlines. These benefits arise from intelligent scheduling functions, adaptive feedback, and personalized learning recommendations that guide students in distributing study time effectively (Bhatnagar & Raja, 2025; Fauzi, *et al.*, 2023). Moreover, (Addae & Brown, 2025) found that frequent AI use also contributes to lower stress levels and greater academic confidence, suggesting that the technology supports cognitive efficiency and self-regulation when used appropriately. Additionally, (Ullah *et al.*, 2024; Onal *et al.*, 2025) studies demonstrate that both students and teachers benefit from AI-based systems that optimize planning and administrative workload, leading to more structured and productive learning environments, enabling them to manage time effectively.

However, not all findings converge on this positive pattern. A parallel line of research reveals that excessive or uncontrolled use of AI and digital technologies can erode time-management abilities by fostering dependency and distraction (Han *et al.*, 2023; Yas *et al.*, 2021). Furthermore, according to (Chen *et al.*, 2021) high-frequency AI users often experience increased procrastination, fragmented attention, and lower persistence in completing tasks, particularly when AI usage becomes habitual rather than goal-driven. Similarly, (Alotaibi *et al.*, 2022) suggests that AI overuse undermines productivity, organization, and mental well-being, especially among university students. Hence, frequency of AI use enhances time-management when applied strategically within guided academic frameworks. Conversely, when unmonitored or excessive, frequent interaction can impair self-discipline and scheduling habits. Therefore, balancing AI engagement with intentional planning and digital literacy remains essential for sustaining productive time-management practices. These differences in previous findings reveal a gap in the literature, which led to the development of hypothesis H4.

H4: There is a significant relationship between frequency of AI use and time management skills.

2.7 The Relationship Between Familiarity with AI and Time Management Skills

Familiarity with artificial intelligence is increasingly recognized as an important factor in developing students' time-management abilities. Studies by (AL-Tkhayneh *et al.*, 2023; Dacholfany *et al.*, 2023) suggest that when learners understand how AI tools function, they can integrate them effectively into their learning routines. This enables them to experience measurable improvements in planning, monitoring, and task organization.

Additionally, (Trisnawati *et al.*, 2023) found that familiarity with AI systems enhances self-regulation and allows students to schedule their studies more efficiently, manage workloads, and sustain attention on complex assignments. Moreover, according to (Xing, 2023; Guo *et al.*, 2023) this relationship is often mediated by educational management efficiency, as students who are more adept at using AI tools report higher engagement, improved learning outcomes, and greater control over time management skills. Beyond individual performance, AI literacy also strengthens collaborative learning and classroom organization, where familiarity with intelligent systems supports both students and educators in optimizing time through automated scheduling, feedback loops, and adaptive learning environments (Zhang *et al.*, 2024). Additionally, further studies by (Ranieri *et al.*, 2025; Jingyu *et al.*, 2024; Kostas & Manousou, 2025) confirm that AI literacy contributes to better academic well-being and time management skills, as familiarity encourages the effective use of digital tools for information management and self-directed learning.

Nonetheless, contrasting evidence indicates that familiarity alone may not guarantee improved time-management. Studies by (Sulton, 2024; Tartuk, 2023) discovered that students' knowledge of AI concepts does not significantly translate into better organization or task prioritization, especially in early or secondary education contexts. Moreover, (Beig & Qasim, 2023; González-Rico & Sintes, 2024) reported that while familiarity enhances technological awareness, it does not strongly influence behavioral outcomes related to time management skills. Research on cognitive offloading further warns that growing comfort with AI may foster overreliance on external prompts, weakening metacognitive control and independent planning without improving time management skills (Sun *et al.*, 2024).

Thus, familiarity with AI tends to improve students' time management when coupled with guided application, reflective practice, and institutional support. However, without pedagogical frameworks that link AI literacy to practical self-management strategies, its potential impact on students' organization and efficiency may remain underrealized. These dissimilarities in previous outcomes reveal a gap in the literature, which led to the creation of hypothesis H5.

H5: There is a significant relationship between familiarity with AI and time management skills.

2.8 The Relationship Between Duration of AI Use and Time Management Skills

The length of exposure to AI in learning environments is frequently linked with stronger time-management capabilities because repeated use allows students to routinize planning, monitoring, and task execution. According to (Bahroun *et al.*, 2023; Tapalova & Zhiyenbayeva, 2022) studies across higher education shows that when AI tools are used over sustained periods, learners receive ongoing feedback, automated supports, and adaptive prompts that streamline study routines, which in turn supports scheduling

discipline and efficient allocation of effort. Furthermore, (Strzelecki, 2023; Xu *et al.*, 2024) suggest that continued interaction strengthens intention to use and normalizes AI within daily study practices can translate into better organization and follow-through. Institutional and policy perspectives converge on a similar point. When universities integrate AI across courses and assessments, the accumulated use facilitates personalized feedback loops, faster progress tracking, and leaner administrative processes, all of which can free time for higher-order work and reduce coordination costs (Chan, 2023; Onesi-Ozigagun *et al.*, 2024; Kuleto *et al.*, 2021). Likewise, reviews and field studies by (Fitria, 2023; Ebrahimi, 2023; Nikolopoulou, 2024; Herath, Ode, & Herath, 2025) add that longer AI use within intelligent tutoring and self-directed settings helps students align tasks with learning needs, refine self-designed plans, and complete assignments more efficiently. Similarly, (George & Wooden, 2023; Calatayud, Espinosa, & Roig-Vila, 2021) report that extended AI adoption can improve operational efficiency while supporting students' time-management through tailored pathways and just-in-time support.

On the other hand, the relationship between duration of AI use and time management skills is not uniformly positive. Studies by (Wang *et al.*, 2025; Delcker *et al.*, 2024) do not find a direct link between duration of use and time-management. They argue that time management skills depend on complementary skills, motivation, and targeted training. Moreover, (Hua, 2023; Yim & Wegerif, 2024) emphasize that duration alone may not shift behavioral outcomes when implementation barriers persist or when ethical and infrastructural supports are weak. Broader organizational research also cautions that longer adoption cycles demand significant change management and that outcomes can vary when the surrounding work ecosystem is not aligned (Einola & Khoreva, 2022).

Therefore, the literature suggests that extended AI use most reliably improves time-management when it is embedded within coherent pedagogy, transparent policies, and user training that convert repeated exposure into deliberate, self-regulatory routines. Hence, these dissimilar views reveal a gap in the literature, which led to the development of hypothesis H6.

H6: There is a significant relationship between duration of AI use and time management skills.

2.9 The Relationship Between Time Management Skills and Students' Academic Performance

Time management has long been regarded as a crucial academic competency that strengthens learning and achievement. Research by (Al-Yami *et al.*, 2021; Abass & Shalaby, 2021) demonstrates that students who master the ability to plan, prioritize, and regulate their study schedules tend to perform significantly better in academic settings. Moreover, studies by (Mariano *et al.*, 2022; Muslim & Wahyuni, 2023) consistently reveal that learners who manage their time efficiently achieve higher grade point averages, meet deadlines more effectively, and experience lower stress levels compared to those who

lack structured time-use strategies. Additionally, according to (Elmahdy & Anwer, 2023; Hidayat & Hasim, 2023) state that improved time-management skills not only enhance productivity but also reduces procrastination and cognitive overload, thereby promoting consistent engagement and performance quality across diverse disciplines. Furthermore, research by (Woods *et al.*, 2024) highlights that effective time-management skills contribute to the development of broader academic dispositions, such as self-discipline and perseverance, which lead to academic performance. Empirical evidence also supports that students who balance organizational responsibilities and academic commitments tend to maintain stronger performance outcomes, suggesting that time-management skills serve as a transferable skill applicable across both academic and professional contexts (Syofyan, 2023; Ghafar, 2023).

Nevertheless, past literature also presents contrasting findings that moderate the strength of this relationship. Studies by (Aeon *et al.*, 2021; Ariarta *et al.*, 2024) indicate that time-management skills do not consistently predict academic outcomes, particularly when confounding factors such as self-regulation, social support, and learning quality are inadequately addressed. According to (Ngo, 2024; Aryal, 2024; Suan, 2023) students acknowledge the importance of managing time but perceive its impact on performance as secondary to motivation, reflection, or emotional well-being. Evidence from discipline-specific analyses even suggests that time-management skills may have limited predictive power in certain subjects, such as mathematics, where conceptual mastery and cognitive aptitude exert stronger influences (Ganzon & Edig, 2022).

Therefore, while effective time-management remains a foundational academic skill, its influence on performance appears contingent upon contextual, motivational, and disciplinary variables that either amplify or attenuate its impact. These disparities reveal a gap in the literature, which led to the realisation of hypothesis H7.

H7: There is a significant relationship between time management skills and students' academic performance.

2.10 Time Management Skills Mediate the Relationship between Frequency of AI Use and Students' Academic Performance

Studies suggest that time-management skills help mediate frequent AI use into tangible academic gains because they shape how students plan, prioritize, and follow through. Evidence from higher education contexts indicates that students who organize their study time while using AI report clearer progress monitoring, better assignment completion, and stronger outcomes. This points to the mediating effect of time management skills between AI use frequency and academic performance elucidated by (Capinding & Dumayas, 2024; Akavova *et al.*, 2023). Moreover, (Abbas *et al.*, 2023; Tiwari, 2023; Onesi-Ozigagun *et al.*, 2024) found that personalization and timely feedback improve workflow discipline, so students who adopt structured routines benefit more from their regular AI engagement. Related work on learner–instructor interaction with

AI systems by (Seo *et al.*, 2021) noted that careful design helps students coordinate tasks and communications, which reinforces the time-management skills pathway to academic achievement. Studies of motivation and attitudes around AI tools by (Ali *et al.*, 2023; Amer *et al.*, 2025) offer a complementary view, since positive orientations appear to channel frequent AI use into productive behaviours that include planning and pacing. This strengthens the indirect route from AI use frequency to academic performance. Scoping and predictive reviews by (Buchanan *et al.*, 2021; Fazil *et al.*, 2024) in professional programs likewise anticipate that structured time management skills will condition the academic benefits of AI adoption across courses and competencies.

Contrarily, not all studies observe this mediating role. Some researchers argue that AI affects performance directly through engagement or content support, without passing through time-management improvements (Ezeoguine & Eteng-Uket, 2024; Crompton & Song, 2021; Pinzolits, 2023). Additionally, analyses by (Sullivan *et al.*, 2023; Dergaa *et al.*, 2023; Enríquez *et al.*, 2025; Wang & Li, 2024) emphasize alternative explanatory mechanisms, such as academic integrity concerns, stress, and readiness, that overshadow planning behaviours or render them statistically insignificant. Moreover, surveys in medical and technical education also report substantial AI interest alongside uneven skill development, which complicates the translation from frequent use to better time allocation (Stewart *et al.*, 2023; Mehta *et al.*, 2021; Yeadon & Hardy, 2024; Nguyen *et al.*, 2022).

Hence, the balance of evidence supports a conditional mediation story that frequent AI use is more likely to yield higher academic performance when institutions and courses explicitly cultivate time-management routines that harness personalization, feedback, and task structuring. But when these routines are absent, the pathway weakens or is overtaken by other factors. These differences in past breakthroughs reveal a gap in the literature, which led to the development of hypothesis H8.

H8: There is a significant mediating role of time management skills in the relationship between frequency of AI use and students' academic performance.

2.11 Time Management Skills Mediate the Relationship between Familiarity with AI and Students' Academic Performance

Research increasingly recognizes that familiarity with AI can enhance students' academic performance, but this relationship often operates indirectly through self-regulatory behaviours such as time management skills. Studies by (Raisch & Krakowski, 2021; Tabesh, 2021) indicate that students who are both knowledgeable about AI and capable of organizing their time effectively tend to integrate these tools more productively into their academic routines, which leads to better academic performance. According to (Capinding & Dumayas, 2024; Fazil *et al.*, 2024) familiarity with AI allows learners to capitalize on automation, personalized feedback, and adaptive systems. However, without structured time management skills, these benefits may remain underutilized.

Empirical evidence shows that time management skills act as a behavioral bridge, enabling students to convert theoretical AI knowledge into sustained academic productivity, particularly when they apply scheduling, monitoring, and prioritization strategies to their learning activities (Jingyu *et al.*, 2024; Song, 2025). Furthermore, studies on AI literacy and educational design by (Nazari *et al.*, 2021; Almaraz-López *et al.*, 2023; Kouam, 2024) reveal that combining familiarity with AI and disciplined time management skills enhances decision-making and motivation, which fosters a continuous learning culture in digital classrooms.

Contrarywise, not all research confirms this mediating relationship. Investigations by (Crompton & Burke, 2023; Bahroun *et al.*, 2023; Grassini, 2023) report that time management skills do not significantly influence how familiarity with AI translates into academic performance. This suggests that AI competence may exert a direct or context-specific impact. Moreover, studies by (Wang, 2022; Sukor *et al.*, 2021; Shehri *et al.*, 2023; Li & Lin, 2025) highlight that emotional, motivational, and contextual variables such as engagement, self-efficacy, or prompt-engineering ability can overshadow time management skill's mediating role. Additionally, according to (Ghalia *et al.*, 2024; Curtis, 2023), familiarity with AI may improve academic outcomes independently when learners intuitively adapt technology to their needs, even without deliberate scheduling or time management skills.

Thus, the evidence from the literature suggests that time management skills strengthen the academic benefits of AI familiarity by converting awareness into effective performance behaviours. At the same time, its influence is conditional, and evident when students are both AI literate and capable of self-regulating their study time within structured and technology-supported learning environments. These variances in previous findings reveal a gap in the literature, which led to the realisation of hypothesis H9.

H9: There is a significant mediating role of time management skills in the relationship between familiarity with AI and students' academic performance

2.12 Time Management Skills Mediate the Relationship between Duration of AI Use and Students' Academic Performance

Evidence from recent literature suggests that time management skills can play a pivotal role in enhancing the positive effects of prolonged AI use on academic performance. Several studies demonstrate that students who effectively manage their study schedules while using AI tools tend to experience higher academic achievement, as they can balance the advantages of technology with disciplined learning behavior. Research by (Zhang & Zhang, 2022; Bahroun *et al.*, 2023) shows that efficient time management skills not only mitigate procrastination but also help students use AI technologies to optimize their learning pace and task completion. This improves their grades and reduces stress. Moreover, (Hong *et al.*, 2021; Yu, 2023; Fazil *et al.*, 2024) emphasize that time management

skills serve as a critical mediator that amplifies the benefits of extended AI use. This allows students to sustain focus, set realistic goals, and engage with AI-driven tasks more strategically. Furthermore, findings from higher education by (Lodge *et al.*, 2023; Al-Abdullatif, 2023) reveal that consistent AI engagement, when coupled with structured time allocation, can enhance students' metacognitive regulation and performance efficiency. Therefore, leading to improved academic outcomes.

In contrast, several studies reveal that time management skills do not significantly mediate the relationship between AI use duration and academic performance. Researchers (Mariano *et al.*, 2022; Noraini *et al.*, 2023; Makarenko *et al.*, 2024) argue that prolonged AI use produces mixed outcomes that are largely independent of students' time management skill abilities. According to them, factors such as digital literacy, ethical awareness, and cognitive load may play a more decisive role in determining academic performance. Additionally, (Çayir, 2023; Xing, 2023; Begum, 2024) find that AI's educational impact often occurs directly, bypassing the moderating influence of self-regulatory behaviours like time management skills. This suggests that its effectiveness depends more on instructional design and integration quality.

Therefore, the reviewed past studies indicate that time management skills mediate the relationship between AI use duration and academic performance only when students maintain discipline and intentional engagement. Conversely, its mediating influence appears conditional. It functions effectively only when AI use is structured, ethically guided, and aligned with learner self-regulation strategies. These contradictory findings reveal a gap in the literature, which led to the formation of hypothesis H10.

H10: There is a significant mediating role of time management skills in the relationship between duration of AI use and students' academic performance.

2.13 Proposed Conceptual Framework

The purpose of this study is to examine how students' interaction with artificial intelligence, particularly in terms of frequency, familiarity, and duration of use, influences their academic performance. Time management functions as a mediating factor in this study. The proposed conceptual framework in Figure 1 is grounded in Zimmerman's Self-Regulated Learning theory (Zimmerman, 1989), which emphasizes how learners plan, monitor, and evaluate their study activities to achieve better performance. When students manage their time effectively, they can organize their learning processes, maintain focus, and use AI tools more strategically. Through consistent self-regulation, effective time management transforms AI usage into meaningful learning behaviours that contribute to improved academic performance.

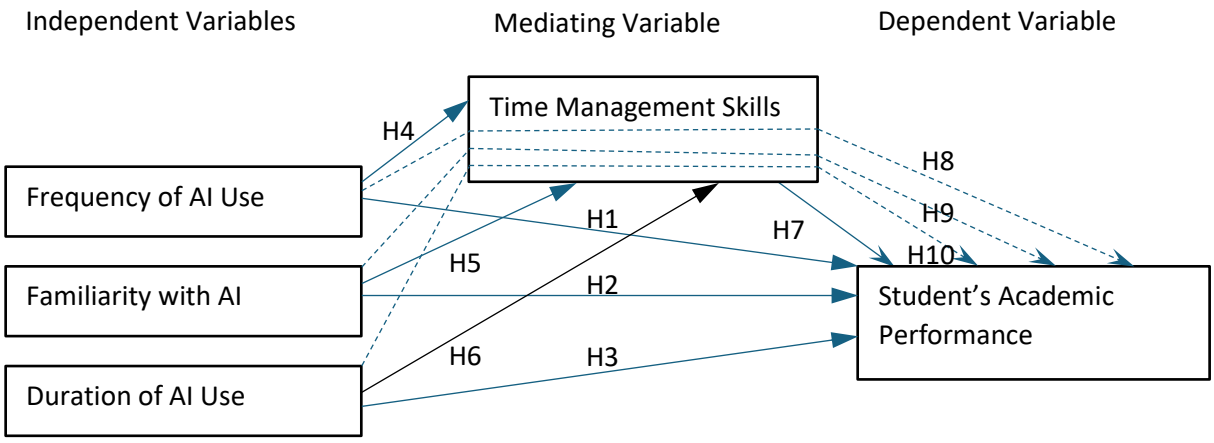


Figure 1: Proposed Conceptual Framework

3. Methodology

This study adopted a quantitative research design to examine how the frequency, familiarity, and duration of AI tool use affect students' academic performance, with time management serving as a mediating variable. The target population comprised of students enrolled in three private universities located in Klang Valley, Selangor, Malaysia, with an estimated total population of 9,000 students. Using (Krejcie & Morgan, 1970) tabulation, a sample size of approximately 368 respondents was determined as sufficient to ensure reliability and statistical validity. Convenience sampling was employed due to accessibility and time considerations, targeting students from business, engineering, health science and social science majors. A total of 700 questionnaires were distributed, and 341 responses were received. As some were incomplete, only 313 responses provided the data for analysis.

Data were collected using a structured, self-administered questionnaire divided into four sections covering demographic details, AI usage patterns, time management skills, and academic performance. All items were rated using a five-point Likert scale adapted from validated instruments. Prior to the main data collection, a pilot test involving 30 respondents was conducted to assess the reliability of the questionnaire. The Cronbach's alpha values for all constructs indicated strong internal consistency.

Data analysis was carried out using SPSS version 30. Descriptive statistics summarized respondents' demographic characteristics, while inferential techniques such as multiple regression and mediation analysis (Hayes PROCESS macro) tested the study's hypotheses. These methods enabled the evaluation of direct and indirect relationships among variables, ensuring that the findings were both statistically robust and theoretically meaningful.

4. Findings and Interpretation

This section provides the findings of this study.

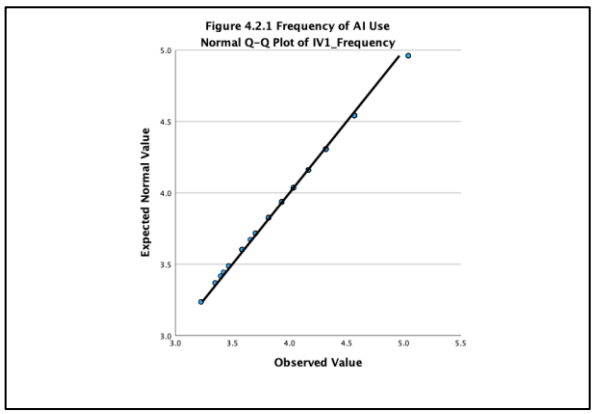
4.1 Reliability Test

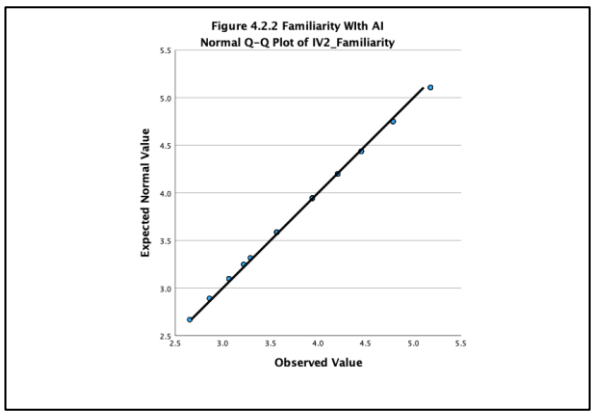
Table 1: Reliability Test (N=30)

Variables	Cronbach's Alpha	No of Items
Independent Variables		
Frequency of AI Use	0.892	6
Familiarity With AI	0.881	7
Duration of Ai Use	0.914	7
Mediating Variable		
Time Management Skills	0.936	7
Dependent Variable		
Students' Academic Performance	0.893	6

The internal consistency of all constructs was assessed using Cronbach's Alpha, as presented in Table 1. The reliability analysis demonstrates that all variables in the study achieved high internal consistency, indicating that the items used to measure each construct were reliable and cohesive. As shown in Table 1, Cronbach's alpha values range between 0.881 and 0.936, all exceeding the acceptable threshold of 0.70. The mediating variable, time management skills, recorded the highest alpha value of 0.936, signifying excellent reliability, while the independent and dependent variables also displayed strong consistency. These results confirm that the measurement instruments were dependable, ensuring that subsequent statistical analyses based on these constructs can be interpreted with confidence and validity.

4.2 Normality Test (Q-Q Plot)





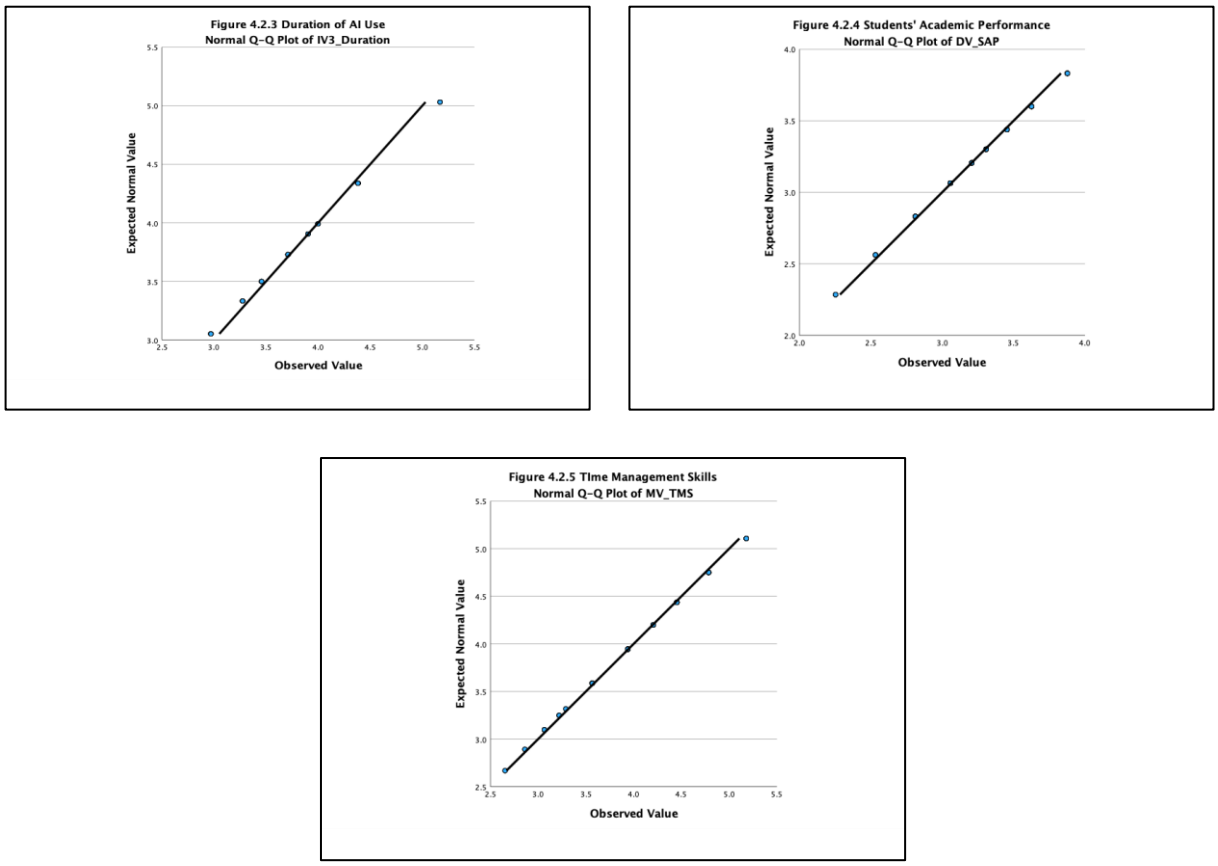


Figure 2: Q-Q Plot Results

The Q-Q plots in Figures 4.2.1 – 4.2.5 demonstrate that the data for all variables (frequency of AI use, familiarity with AI, duration of AI use, time management skills, and students' academic performance) are approximately normally distributed. The data points closely align with the diagonal reference line, indicating minimal deviation from normality. This linear alignment suggests that the residuals are symmetrically distributed and that the assumption of normality is satisfied for each variable. As a result, the data meet the statistical requirements for further parametric analysis, such as correlation and regression testing, ensuring that the subsequent results are both reliable and valid for interpretation.

4.3 Demographic Profile of Respondents

Table 2: Demographic Profiles of Respondents (N = 313)

Categories	Frequency	Percentage
Age		
18-24	93	29.7%
25-30	98	31.3%
31-40	114	36.4%
> 40	8	2.6%
Educational Level		
Diploma	24	7.7%
Bachelor's Degree	184	58.8%
Master's Degree	105	33.6%
Doctorate	0	0.0%
Study Major		
Business / Management	124	39.6%
Engineering / Technology	88	28.1%
Health Sciences	9	2.9%
Social Sciences	92	29.4%
Study Mode		
Part-time	19	6.1%
Full-time	33	10.5%
Online learning	261	83.4%
Course Completion		
1 course	17	5.4%
2 courses	4	1.3%
More than 3 courses	287	91.7%
None	5	1.6%

Table 2 presents the demographic characteristics of 313 respondents. The majority were aged between 31-40 years old (36.4%). Most participants held a bachelor's degree (58.8%). In terms of study major, business and management students comprised the largest group (39.6%). A significant portion of respondents engaged in online learning (83.4%), reflecting the growing prevalence of digital education. Moreover, 91.7% had completed more than three courses, indicating a highly experienced and academically active sample population.

4.4 Correlation Analysis

To study the correlation between variables, the correlation test is done, and the analysis is exhibited in Table 3.

Table 3: Pearson's Correlation Analysis Among Variables (N=313)

Variables	FR	FA	DU	TMS	SAP
Frequency of AI use (FR)	1				
Familiarity with AI (FA)	0.733	1			
Duration of AI use (DU)	0.637	0.505	1		
Time management skills (TMS)	0.705	0.539	0.802	1	
Students' academic performance (SAP)	0.709	0.835	0.536	0.550	1

Correlation is significant at the 0.01 level (2-tailed)

The Pearson's correlation results in Table 3 reveal significant positive relationships among all variables at the 0.01 level, indicating strong interconnections between AI-related factors, time management skills, and students' academic performance. Familiarity with AI shows the strongest association with academic performance (r = 0.835), suggesting that students who better understand AI tend to perform well academically. Frequency of AI use also demonstrates a strong correlation with performance (r = 0.709), while duration of AI use (r = 0.536) shows a moderate link. Additionally, time management skills correlate positively with all independent variables, emphasizing their mediating role in enhancing learning outcomes.

4.5 Model Fit, Direct Effect, and Mediation Results

To provide a comprehensive overview of the findings, Table 4 integrates the model fit, direct effect, and mediation outcome into a single table.

Table 4: Summary of Regression and Mediation Analyses (N=313)

Predictor	Model Fit (R^2 for X→M / X+M→Y)	Mediation Path X→M (Time Management Skills)	Mediation Path X→Y (Direct Effect)	Mediation Path M→Y	Indirect Effect (95% CI)
Frequency of AI Use	0.497 / 0.508	β = 1.026, p < 0.001	β = 0.780, p < 0.001	β = 0.083, p = 0.078	β = 0.086 (CI: – 0.140, 0.295)
Familiarity with AI	0.290 / 0.711	β = 0.705, p < 0.001	β = 0.833, p < 0.001	β = 0.119, p < 0.001	β = 0.084 (CI: 0.005, 0.186)
Duration of AI Use	0.644 / 0.328	β = 0.694, p < 0.001	β = 0.194, p < 0.001	β = 0.282, p < 0.001	β = 0.196 (CI: 0.076, 0.321)

Table 4 above examined how time management skills act as a mediator between frequency, familiarity, and duration of AI use and students' academic performance. The three models revealed a distinct pattern of influence, reflecting how students' interaction with AI aligns with the mechanisms proposed in the Self-Regulated Learning (SRL) framework.

Firstly, the frequency of AI use model significantly predicted time management skills ($\beta = 1.026$, $p < 0.001$), accounting for roughly 50% of its variance. When both predictors were entered, the model explained 51% of the variance in academic performance ($R^2 = 0.508$). Although frequent use of AI strongly improved students' academic performance ($\beta = 0.780$, $p < 0.001$), time management showed only a marginal contribution ($\beta = 0.083$, $p = 0.078$). The indirect effect was positive but insignificant ($\beta = 0.086$, CI [–0.140, 0.295]). This suggests that frequent AI use enhances academic results mainly through direct experience and exposure rather than through time-management skills.

Secondly, in the familiarity with AI model, students' know-how with AI predicted higher time management skills ($\beta = 0.705$, $p < 0.001$), explaining 29% of the mediator's variance. When predicting academic performance, both familiarity ($\beta = 0.833$, $p < 0.001$) and time management ($\beta = 0.119$, $p < 0.001$) were significant, and the model captured 71% of the variance. The indirect effect ($\beta = 0.084$, CI [0.005, 0.186]) confirmed partial mediation. This indicates that students familiar with AI tools not only achieve better grades directly but also perform well because they plan their study time more efficiently.

Thirdly, in the duration of AI use model, the amount of time spent using AI was a powerful predictor of time management ($\beta = 0.694$, $p < 0.001$), explaining nearly 64% of its variance. When predicting performance, both duration ($\beta = 0.194$, $p < 0.001$) and time management ($\beta = 0.282$, $p < 0.001$) remained significant, although the overall variance explained by the model was lower ($R^2 = 0.328$). The indirect effect ($\beta = 0.196$, CI [0.076, 0.321]) was statistically significant, showing that prolonged AI engagement fosters better performance entirely through improved time management skills. Sustained exposure likely strengthens organizational discipline and focus, key elements in the SRL model.

Hence, the results illustrate that frequency of AI use exerts a direct effect, familiarity influences performance both directly and indirectly, and duration enhances performance primarily through time management. These findings indicate that while using AI tools can enhance students' academic performance, the benefits are strongest when paired with good time management skills. These skills align with the principles of Self-Regulated Learning model (Zimmerman, 1989), which highlights the importance of students planning, monitoring, and managing their study time effectively. When students take control of their learning process, they are better able to use AI tools productively and achieve higher academic performance.

4.6 Summary of the Hypotheses Results

Table 5 below provides a summary of the hypothesis results obtained in this study.

Table 5: Summary of the Hypotheses Results

No	Hypothesis	Result
H1	There is a significant relationship between frequency of AI use and students' academic performance.	Supported
H2	There is a significant relationship between familiarity with AI and students' academic performance.	Supported
H3	There is a significant relationship between duration of AI use and students' academic performance.	Supported
H4	There is a significant relationship between frequency of AI use and time management skills.	Supported
H5	There is a significant relationship between familiarity with AI and time management skills.	Supported
H6	There is a significant relationship between duration of AI use and time management skills.	Supported
H7	There is a significant relationship between time management skills and students' academic performance.	Supported
H8	Time management skills mediate the relationship between frequency of AI use and students' academic performance.	Not supported
H9	Time management skills mediate the relationship between familiarity with AI and students' academic performance.	Supported
H10	Time management skills mediate the relationship between duration of AI use and students' academic performance.	Supported

The findings in Table 5 show that most of the proposed hypotheses were supported. The results indicate that frequent, familiar, and prolonged use of AI tools contributes positively to students' academic performance. These factors also enhance time management abilities, suggesting that students who use AI regularly tend to organize and plan their studies more effectively. The mediation analysis revealed that time management skills play a significant role in familiarity and duration of AI use, but not for frequency. Hence, these outcomes suggest that academic performance is achieved when AI engagement is complemented by effective time management skills.

5. Discussion

This discussion section integrates the findings and analyses to explain how the frequency, familiarity, and duration of AI use influence students' academic performance through the mediating role of time management skills. The results confirm that AI engagement significantly enhances academic performance, but the nature of its effect varies depending on how often students use AI, how well they understand it, and how long they have been using it.

The answer for RQ1 and hypothesis H1 demonstrate that the frequency of AI use significantly predicts students' academic performance. Frequent engagement with AI tools yielded a strong direct effect ($\beta = 0.780$, $p < 0.001$), indicating that students who consistently use AI achieve higher academic results. This supports the assertions of

(Abbas *et al.*, 2023; Abubakar *et al.*, 2024), who found that frequent AI use enhances learning efficiency and motivation. However, the mediation analysis revealed that time management skills did not significantly mediate this relationship. This implies that frequent AI users may rely more on immediate technological feedback rather than deliberate planning. This finding echoes the concern raised by (Abuzaid *et al.*, 2022; Klímová *et al.*, 2023) that excessive AI reliance may reduce critical thinking and structured learning habits.

Responding to RQ2 and hypothesis H2, familiarity with AI was found to be a strong predictor of academic performance. Students who were more familiar with AI tools achieved better academic performance ($\beta = 0.833$, $p < 0.001$), which supports the arguments of (Chan & Hu, 2023; Xie, 2023) that AI literacy enables effective self-regulated learning. Importantly, the mediation analysis revealed a significant indirect effect through time management skills ($\beta = 0.084$, 95% CI [0.005, 0.186]), confirming that familiarity fosters both direct and indirect academic benefits. This implies that students who understand AI better are not only more capable of using it productively but also more disciplined in organizing their study schedules. Moreover, this aligns with the principles of Self-Regulated Learning model (Zimmerman, 1989).

The results addressing RQ3 and hypothesis H3 show that the duration of AI use significantly predicts academic performance ($\beta = 0.194$, $p < 0.001$). This finding aligns with studies by (Deng & Yu, 2023; Mishra, 2025), which suggest that sustained AI use enhances problem-solving and analytical reasoning. The mediation effect through time management skills was significant ($\beta = 0.196$, 95% CI [0.076, 0.321]), demonstrating that longer AI exposure enhances academic performance primarily by strengthening students' time-management abilities. This finding supports the view that repeated and purposeful engagement with AI cultivates self-discipline and structured learning behaviour.

RQ4 to RQ6 examined the relationships between AI engagement and time management skills. The results indicate that frequency ($\beta = 1.026$, $p < 0.001$), familiarity ($\beta = 0.705$, $p < 0.001$), and duration ($\beta = 0.694$, $p < 0.001$) of AI use each have significant positive effects on time management skills. These findings are consistent with (Meron & Araci, 2023; Strzelecki, 2023), who observed that frequent and prolonged AI interaction promotes better organization and scheduling. This reinforces the notion that AI tools can enhance cognitive regulation when integrated thoughtfully into learning routines.

Answering RQ7 and hypothesis H7, time management skills significantly predicted academic performance ($\beta = 0.282$, $p < 0.001$), aligning with previous research by (Al-Yami *et al.*, 2021; Woods *et al.*, 2024), who emphasized that effective planning and prioritization improve academic outcomes. This relationship illustrates that AI tools achieve their full potential when combined with learners' self-regulatory abilities.

The mediation results related to RQ8–RQ10 reveal distinct patterns. Time management skills did not mediate the relationship between frequency of AI use and performance ($\beta = 0.086$, 95% CI [–0.140, 0.295]). This shows a direct, rather than an indirect

effect. However, mediation was evident in the relationships involving familiarity (β = 0.084, 95% CI [0.005, 0.186]) and duration (β = 0.196, 95% CI [0.076, 0.321]). These outcomes confirm that students' understanding and sustained use of AI influence academic success most strongly when coupled with strong time management practices. This is consistent with the findings by (Capinding & Dumayas, 2024; Zhang & Zhang, 2022), who observed that structured time regulation transforms AI interaction into effective academic behaviours.

Thus, the results affirm that frequency, familiarity, and duration of AI use significantly contribute to students' academic performance, although the underlying mechanisms differ. Frequency of use exerts a direct influence, while familiarity and duration operate through both direct and mediated pathways. The findings collectively validate the Self-Regulated Learning model by (Zimmerman, 1989). This proves that AI-enhanced education is most effective when students actively plan, monitor, and reflect on their learning through sound time management skills. This study, therefore, contributes empirical evidence that supports the integration of AI literacy and self-regulation training in higher education, particularly in Malaysian universities where online learning is becoming increasingly prevalent. By developing structured time management habits alongside AI adoption, students can achieve more sustainable and meaningful academic growth.

6. Conclusion

This study's primary objective lies in investigating the relationship between AI engagement (frequency, familiarity, and duration) and students' academic performance in higher education. The aim of this study is also to explore the mediating effect of time management skills on these relationships.

The first research objective RO1 explored how the frequency of AI use affects students' academic performance. The results revealed that regular interaction with AI tools improved academic outcomes by enhancing engagement and learning efficiency, as highlighted by (Abbas *et al.*, 2023; Abubakar *et al.*, 2024). This study therefore confirms that repeated AI use can support the performance phase of the SRL model (Zimmerman, 1989), where learners monitor and adjust their learning strategies. However, the insignificant mediating effect of time management skills suggests that frequent AI use may influence performance directly rather than through deliberate behavioural control. This narrows the literature gap noted by (Abuzaid *et al.*, 2022; Klímová *et al.*, 2023), who questioned whether habitual technology use enhances or undermines academic self-regulation.

The second research objective RO2 examined the relationship between familiarity with AI and academic performance. The findings showed that students with higher AI familiarity achieved stronger academic outcomes, aligning with the works of (Chan & Hu, 2023; Xie, 2023). The results also confirmed a partial mediation through time

management skills. This result implies that understanding AI tools not only enables better task execution but also fosters greater autonomy in learning. This supports the forethought phase of the SRL model (Zimmerman, 1989), where knowledge and planning influence motivation and goal setting. The outcome bridges the earlier research divide by showing that AI familiarity leads to effective academic behaviours when students are trained to apply it reflectively rather than dependently, a position debated by (AlZaabi *et al.*, 2023; Zhang *et al.*, 2024).

The third research objective RO3 investigated the duration of AI use in relation to academic performance. Prolonged AI engagement was found to improve academic performance. This supports the findings of (Deng & Yu, 2023; Mishra, 2025). The results indicated that extended AI exposure enhances students' academic achievements. This confirms that consistent and structured interaction with AI nurtures persistence and self-discipline, in line with the SRL model (Zimmerman, 1989). This finding addresses the ambiguity noted by (Sun & Zhou, 2024; Shah *et al.*, 2025), who observed inconsistent outcomes regarding long-term AI use, by clarifying that meaningful duration yields benefit when guided by reflective learning practices.

The fourth, fifth, and sixth research objectives (RO4 – RO6) focused on the relationship between AI engagement and time management skills. The results confirmed that frequent, familiar, and prolonged AI use each contributed positively to students' ability to plan and manage their time effectively. This supports (Meron & Araci, 2023; Bhatnagar & Raja, 2025). Therefore, this reinforces the proposition that AI can serve as a cognitive foundation that aids students in structuring their academic routines. However, it also validates the caution raised by (Han *et al.*, 2023) who warned that overuse of AI without guidance may weaken self-regulatory behaviour. By revealing the balance between efficiency and dependency, the study narrowed the theoretical uncertainty about whether AI improves or undermines time-control strategies.

The seventh research objective (RO7) investigated the relationship between time management skills and students' academic performance. The results supported previous findings by (Al-Yami *et al.*, 2021; Woods *et al.*, 2024), who confirm that well-developed time management skills enhance academic performance. Within the SRL framework (Zimmerman, 1989), this finding reflects the learner's ability to translate goal setting and progress monitoring into consistent academic achievement. It also reconciles conflicting observations by (Aeon *et al.*, 2021; Ariarta *et al.*, 2024), who suggested that contextual factors may weaken this relationship.

The final three research objectives (RO8 – RO10) explored the mediating effect of time management skills on the relationships between AI variables and academic performance. The findings revealed that time management skills mediated the effects of AI familiarity and duration but not frequency. This demonstrates that while frequent use produces direct learning benefits, familiarity and sustained engagement improve outcomes through organized study behaviours. These results support (Capinding & Dumayas, 2024; Zhang & Zhang, 2022), who observed that self-regulatory skills

transform AI use into measurable academic performance. The mediation findings provide a critical theoretical contribution by linking technological engagement with behavioural regulation. This clarifies how SRL processes by (Zimmerman, 1989) interact with AI-supported learning environments.

Hence, this research contributes to the growing body of evidence that AI engagement must be coupled with self-regulatory capacity to yield sustainable academic performance. It strengthens the Self-Regulated Learning model (Zimmerman, 1989) by showing that AI tools can function as instruments of autonomy rather than dependency when integrated with disciplined time management skills. Additionally, this research bridges existing theoretical gaps by demonstrating that academic performance is not determined solely by access to technology but by how students strategically manage their learning processes within AI-mediated environments. Consequently, universities in Malaysia can benefit from adopting educational frameworks that integrate AI literacy with structured self-regulation training. This will foster a generation of learners who are both technologically skilled and behaviourally self-directed.

7. Limitations and Future Research

This study focused on university students in Klang Valley, limiting broader generalization. Future research could explore larger or cross-regional samples, include qualitative insights, and examine additional mediating or moderating variables such as motivation, self-efficacy, or digital literacy to better understand how artificial intelligence enhances academic achievement across diverse learning contexts.

Acknowledgements

The researchers express sincere gratitude to the participating universities, academic mentors, and respondents for their invaluable cooperation, support, and contribution, which made this study possible and meaningful.

Conflict of Interests Statement

The researchers affirm that this research was conducted independently and without any conflict of interest. No external organization provided financial support or influenced the study's design, analysis, or conclusions. The work presented is entirely original, and no part of it has been submitted or published elsewhere.

About the Authors

Kumaran Kanapathipillai, a prominent figure in academia, earned his PhD in management and business from Management and Science University (Malaysia). With an impressive tenure of 24 years in the academic world, he has honed expertise in areas such as Management, Marketing, Supply Chain Management, and Logistics Management. Within academia, he plays a pivotal role in guiding and assessing both

master's and PhD candidates. He also serves as an external examiner for several universities in Europe and Asia. Additionally, he is a peer reviewer for numerous academic journals. Beyond academia, he provides specialised training sessions on entrepreneurship, creative problem-solving, and project management across diverse industries. His scholarly pursuits predominantly concentrate on contemporary entrepreneurship, management, and marketing.

Wan Rahafiz Bin Wan Abdul Rahim is an Engineering Head at FarmByte Sdn Bhd and he has 15 years of experience in building software platforms and leading high-performing teams. He is a computer science and information technology graduate who is studying for his MBA, majoring in Marketing and Branding from Unitar International College. His work is all about translating ideas into reliable and scalable products and matching technology decisions to customer and business results. He is an avid technology, AI and marketing enthusiast who loves to delve into how data and machine learning can be utilized to improve product strategy, growth and user experience. He is also passionate about mentoring engineers and fostering a culture of learning, collaboration and accountability.

Muhamad Khairul Anwar Bin Mat Azidin is a Senior Manager at a private company, with a main portfolio as a Head of Customer Acquisition and Digital Marketing Strategy, and has more than 18 years of working experience. He is currently pursuing a Master of Business Administration (MBA) at UNITAR International University. With extensive experience in marketing, digital marketing, business development, and community engagement, Khairul Anwar is passionate about applying his experience and knowledge to empower communities through marketing.

Norhafizah Binti Hambali serves as the General Manager of Avisena Renal Care, a subsidiary of the Avisena Healthcare group in Malaysia. Her professional background spans more than two decades in renal care, encompassing clinical practice, operational management, and healthcare leadership. She began her career in 2003 at KPJ Selangor Specialist Hospital, where she developed a strong foundation in haemodialysis and patient care. She is currently pursuing a Master of Business Administration at UNITAR International University, focusing on strategic management and organizational development within the healthcare sector. Her academic and professional interests include quality improvement, service innovation, and sustainable growth in renal healthcare delivery.

References

Abass, S. H. Z., & Shalaby, S. F. (2021). Investigating time management habits and its related factors among medical sciences faculty students. *Egyptian Journal of Health Care, 12*(3), 1282-1291. https://doi.org/10.21608/ejhc.2021.195261

Abbas, N., Ali, I., Manzoor, R., Hussain, T., & Hussain, M. H. A. I. (2023). Role of artificial intelligence tools in enhancing students' educational performance at higher levels. *Journal of Artificial Intelligence, Machine Learning and Neural Network, (35)*, 36-49. https://doi.org/10.55529/jaimlnn.35.36.49

Abdullahi, N. J. K. (2025). Managing artificial intelligence-driven platforms for student development. *International Journal of Engineering Technology and Natural Sciences, 7*(1), 75-86. https://doi.org/10.46923/ijets.v7i1.467

Abubakar, U., Falade, A. A., & Ibrahim, H. A. (2024). Redefining student assessment in Nigerian tertiary institutions: the impact of AI technologies on academic performance and developing countermeasures. *Advances in Mobile Learning Educational Research, 4*(2), 1149-1159. https://doi.org/10.25082/amler.2024.02.009

Abuzaid, M., Elshami, W., & McFadden, S. (2022). Integration of artificial intelligence into nursing practice. *Health and Technology, 12*(6), 1109-1115. https://doi.org/10.1007/s12553-022-00697-0

Addae, R. K., & Brown, C. (2025). The role of artificial intelligence in enhancing human longevity. *Golden Ratio of Social Science and Education, 5*(2), 302-318. https://doi.org/10.52970/grsse.v5i2.1275

Aeon, B., Faber, A., & Panaccio, A. (2021). Does time management work? A meta-analysis. *Plos One, 16*(1). https://doi.org/10.1371/journal.pone.0245066

Agormedah, E. K., Britwum, F., Amoah, S. O., Acheampong, H. Y., Adjei, E., & Nyamekye, F. (2021). Assessment of time management practices and students' academic achievement: the moderating role of gender. *International Journal of Social Sciences & Educational Studies, 8*(4). https://doi.org/10.23918/ijsses.v8i4p171

Ahmad, S. F., Alam, M. M., Rahmat, M. K., Mubarik, M. S., & Hyder, S. I. (2022). Academic and administrative role of artificial intelligence in education. *Sustainability, 14*(3), 1101. https://doi.org/10.3390/su14031101

Ajalo, E., Mukunya, D., Nantale, R., Kayemba, F., Pangholi, K., Babuya, J., & Kiguli, S. (2025). Widespread use of chatgpt and other artificial intelligence tools among medical students in Uganda: a cross-sectional study. *Plos One, 20*(1). https://doi.org/10.1371/journal.pone.0313776

Akavova, A., Temirkhanova, Z., & Lorsanova, Z. (2023). Adaptive learning and artificial intelligence in the educational space. E3S Web of Conferences, 451, 06011. https://doi.org/10.1051/e3sconf/202345106011

Al-Abdullatif, A. M. (2023). Modeling students' perceptions of chatbots in learning: integrating technology acceptance with the value-based adoption model. *Education Sciences, 13*(11). https://doi.org/10.3390/educsci13111151

AL-Tkhayneh, K. M., Alghazo, E. M., & Tahat, D. (2023). The advantages and disadvantages of using artificial intelligence in education. *Journal of Educational and Social Research, 13*(4), 105. https://doi.org/10.36941/jesr-2023-0094

Al-yami, A. A., Abdulwahed, A., Azhar, A., Binsaddik, A., & Bafaraj, S. M. (2021). Impact of time-management on the student's academic performance: a cross-sectional study. *Creative Education, 12*(03), 471-485. https://doi.org/10.4236/ce.2021.123033

Al-Roomi, K., Alzayani, S., Almarabheh, A., Alqahtani, M. M., Aldosari, F., Aladwani, M., & Salem, A. H. (2024). Familiarity and applications of artificial intelligence in health professions education: Perspectives of students in a community-oriented medical school. *Cureus*. https://doi.org/10.7759/cureus.73425

AlAfnan, M. A., Dishari, S., & MohdZuki, S. F. (2024). Developing soft skills in the artificial intelligence era: communication, business writing, and composition skills. *Journal of Artificial Intelligence and Technology 4*(4). https://doi.org/10.37965/jait.2024.0496

Alenezi, A. (2024). Obstacles to the use of AI applications in Blackboard for faculty members at Northern Border University, Saudi Arabia. *MIER Journal of Educational Studies Trends and Practices*, 248-268. https://doi.org/10.52634/mier/2024/v14/i2/2581

Ali, J. K. M., Shamsan, M. A., Hezam, T. A., & Mohammed, A. A. (2023). Impact of ChatGPT on learning motivation. *Journal of English Studies in Arabia Felix, 2*(1), 41-49. https://doi.org/10.56540/jesaf.v2i1.51

Almaraz-López, C., Menéndez, F. A., & López-Esteban, C. (2023). Comparative study of the attitudes and perceptions of university students in business administration and management, and in education toward artificial intelligence. *Education Sciences, 13*(6), 609. https://doi.org/10.3390/educsci13060609

Almusaed, A., Almssad, A., Yitmen, I., & Homod, R. Z. (2023). Enhancing Student Engagement: Harnessing "AIED"'s Power in Hybrid Education—A Review Analysis. *Education Sciences, 13*(7), 632. https://doi.org/10.3390/educsci13070632

Alotaibi, M. S., Fox, M., Coman, R., Ratan, Z. A., & Hosseinzadeh, H. (2022). Perspectives and experiences of smartphone overuse among university students in Umm al-Qura University (UQU), Saudi Arabia: a qualitative analysis. *International Journal of Environmental Research and Public Health, 19*(7), 4397. https://doi.org/10.3390/ijerph19074397

Al Zaabi, A., Al Maskari, S., & Al Abdulsalam, A. (2023). Are physicians and medical students ready for artificial intelligence applications in healthcare? *Digital Health, 9*. https://doi.org/10.1177/20552076231152167

Amal, B., Khaierunnisa, A., Rahmawati, E., Syifa, N., Dewani, P. N., Septariyani, P. R., & Fauzi, S. (2024). Use of artificial intelligence applications: friend or threat for Indonesian language and literature education students at Singaperbangsa University of Karawang. *Internet of Things and Artificial Intelligence Journal, 4*(4), 677-688. https://doi.org/10.31763/iota.v4i4.821

Amer, F. G. M., Alanazi, M. A., Shaban, M., Abdelgawad, M. E., Mohammed, H. H., Hassan, S., & Sabek, E. M. (2025). Artificial intelligence–based chabots' and

nursing students' academic performance: the mediating role of technophobia and technophilia. *International Nursing Review, 72*(3). https://doi.org/10.1111/inr.70056

Anatasya, E. P., & Sayekti, A. (2022). Pengaruh manajemen waktu terhadap prestasi akademik pada mahasiswa aktivis di organisasi kemahasiswaan fem IPB. *Jurnal Manajemen Kewirausahaan, 19*(2), 155. https://doi.org/10.33370/jmk.v19i2.875

Aproda, R. W., Prado, M. C., Maria, A. P. J., & Victoriano, N. S. (2024). The impact of ChatGPT on academic integrity and undergraduate students' learning. *Cognizance Journal of Multidisciplinary Studies, 4*(12), 256-264. https://doi.org/10.47760/cognizance.2024.v04i12.025

Ariarta, A. P., Mu'in, M. L. A., Latif, M. S., Saadah, A. H., & Harini, S. (2024). Learning quality, time management and social support on student academic achievement. *EDUKASIA: Jurnal Pendidikan Dan Pembelajaran, 5*(2), 11-22. https://doi.org/10.62775/edukasia.v5i2.778

Aryal, M. (2024). Beyond the books: role of extracurricular activities in medical students. *Journal of Nepal Medical Association, 62*(274), 414-415. https://doi.org/10.31729/jnma.8613

Bahroun, Z., Anane, C., Ahmed, V., & Zacca, A. (2023). Transforming education: a comprehensive review of generative artificial intelligence in educational settings through bibliometric and content analysis. *Sustainability, 15*(17), 12983. https://doi.org/10.3390/su151712983

Begum, I. U. (2024). Role of artificial intelligence in higher education- an empirical investigation. *International Research Journal on Advanced Engineering and Management (IRJAEM), 2*(3), 49-53. https://doi.org/10.47392/irjaem.2024.0009

Beig, S., & Qasim, S. H. (2023). Assessing students' attitude towards artificial intelligence with respect to gender and use of computer and mobile devices. *International Journal for Multidisciplinary Research*, 5(3). https://doi.org/10.36948/ijfmr.2023.v05i03.4130

Bhatnagar, R., & Raja, A. S. (2025). Role of AI in assisting college students with academic performance. *ComFin Research, 13*(S1-i2), 137-143. https://doi.org/10.34293/commerce.v13is1-i2.8752

Bhattacharya, R., Tipu, M. N. A., Sarker, B., & Durud, M. S. (2022). Exploring the interrelation between time management and academic achievement among university students. *Asian Research Journal of Arts & Social Sciences*, 28-37. https://doi.org/10.9734/arjass/2022/v17i230302

Boillat, T., Nawaz, F. A., & Rivas, H. (2022). Readiness to embrace artificial intelligence among medical doctors and students: questionnaire-based study. *JMIR Medical Education, 8*(2), e34973. https://doi.org/10.2196/34973

Bond, M. (2024). A meta-systematic review of artificial intelligence in higher education. *International Journal of Educational Technology in Higher Education, 21*(1), Article 24. https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-023-00436-z SpringerOpen

Brian, R., Murillo, A., Gomes, C., & Alseidi, A. (2024). Artificial intelligence and robotic surgical education. *Global Surgical Education - Journal of the Association for Surgical Education, 3*(1). https://doi.org/10.1007/s44186-024-00262-5

Buchanan, C., Howitt, M. L., Wilson, R., Booth, R., Risling, T., & Bamford, M. (2021). Predicted influences of artificial intelligence on nursing education: scoping review. *JMIR Nursing, 4*(1). https://doi.org/10.2196/23933

Buctot, D. B., Kim, N., & Kim, S. H. (2021). Personal profiles, family environment, patterns of smartphone use, nomophobia, and smartphone addiction across low, average, and high perceived academic performance levels among high school students in the Philippines. *International Journal of Environmental Research and Public Health, 18*(10), 5219. https://doi.org/10.3390/ijerph18105219

Burger, B., Kanbach, D. K., Kraus, S., Breier, M., & Corvello, V. (2023). On the use of AI-based tools like ChatGPT to support management research. *European Journal of Innovation Management, 26*(7), 233-241. https://doi.org/10.1108/ejim-02-2023-0156

Calatayud, V. G., Espinosa, M. P. P., & Roig-Vila, R. (2021). Artificial intelligence for student assessment: a systematic review. *Applied Sciences, 11*(12), 5467. https://doi.org/10.3390/app11125467

Capinding, A. T., & Dumayas, F. T. (2024). Transformative pedagogy in the digital age: Unraveling the impact of artificial intelligence on higher education students. *Problems of Education in the 21st Century, 82*(5), 630-657. https://doi.org/10.33225/pec/24.82.630

Çayir, A. (2023). A literature review on the effect of artificial intelligence on education. *İnsan Ve Sosyal Bilimler Dergisi, 6*(2), 276-288. https://doi.org/10.53048/johass.1375684

Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education, 20*(1). https://doi.org/10.1186/s41239-023-00408-3

Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education, 20*(1). https://doi.org/10.1186/s41239-023-00411-8

Chen, P. S., Li, J., & Kim, S. (2021). Structural relationship among mobile phone dependence, self-efficacy, time management disposition, and academic procrastination in college students. *Iranian Journal of Public Health.* https://doi.org/10.18502/ijph.v50i11.7582

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education, 20*(1). https://doi.org/10.1186/s41239-023-00392-8

Crompton, H., & Song, D. (2021). The potential of artificial intelligence in higher education. *Revista Virtual Universidad Católica Del Norte, (62),* 1-4. https://doi.org/10.35575/rvucn.n62a1

Cukurova, M. (2024). The interplay of learning, analytics and artificial intelligence in education: A vision for hybrid intelligence. *British Journal of Educational Technology, 56*(2), 469-488. https://doi.org/10.1111/bjet.13514

Curtis, N. (2023). To ChatGPT or not to ChatGPT? The impact of artificial intelligence on academic publishing. *Pediatric Infectious Disease Journal, 42*(4), 275-275. https://doi.org/10.1097/inf.0000000000003852

Dacholfany, M. I., Marjoni, M. R., Erwis, F., Siswanto, E., & Susanto, A. (2023). Harnessing artificial intelligence to increase the efficiency of education management in the future. *Al-Fikrah: Jurnal Manajemen Pendidikan, 11*(2), 245. https://doi.org/10.31958/jaf.v11i2.10557

Delcker, J., Heil, J., Ifenthaler, D., Seufert, S., & Spirgi, L. (2024). First-year students' AI-competence as a predictor for intended and de facto use of AI-tools for supporting learning processes in higher education. *International Journal of Educational Technology in Higher Education, 21*(1). https://doi.org/10.1186/s41239-024-00452-7

Dempere, J., Modugu, K. P., Hesham, A., & Ramasamy, L. K. (2023). The impact of ChatGPT on higher education. *Frontiers in Education, 8*. https://doi.org/10.3389/feduc.2023.1206936

Deng, X., & Yu, Z. (2023). A meta-analysis and systematic review of the effect of chatbot technology use in sustainable education. *Sustainability, 15*(4), 2940. https://doi.org/10.3390/su15042940

Dergaa, I., Chamari, K., Żmijewski, P., & Saad, H. B. (2023). From human writing to artificial intelligence-generated text: Examining the prospects and potential threats of ChatGPT in academic writing. *Biology of Sport, 40*(2), 615-622. https://doi.org/10.5114/biolsport.2023.125623

Dhulipala, A. B. M. (2025). Analyzing the impact of AI on exam preparation and student performance in higher education. *Journal of Informatics Education and Research, 5*(2). https://doi.org/10.52783/jier.v5i2.2924

Dobrovská, D., Vaněček, D., & Yorulmaz, Y. İ. (2024). Students' attitudes towards ai in teaching and learning. *International Journal of Engineering Pedagogy (iJEP), 14*(8), 88-106. https://doi.org/10.3991/ijep.v14i8.52731

Dong, L., Zhang, Y., & Xu, H. (2025). Examining the effect of artificial intelligence in relation to students' academic performance: A meta-analysis. *Discover Education, 4*(1), 45. https://www.sciencedirect.com/science/article/pii/S2666920X25000402 ScienceDirect

Drouet, E. M. R., Salazar, D., Domínguez, T. L. C., & Pinthsa, P. J. C. (2024). Analysis of the repercussions of artificial intelligence in the personalization of the virtual educational process in higher education programs. *Data and Metadata, 3*, 386. https://doi.org/10.56294/dm2024386

Ebrahimi, A. (2023). Self-directed and self-designed learning: integrating imperative topics in the case of COVID-19. *Technologies, 11*(4), 85. https://doi.org/10.3390/technologies11040085

Elmahdy, M., & Anwer, M. (2023). Effect of time-management on the academic performance of medical students, Benha University: a cross-sectional study. *The Egyptian Journal of Hospital Medicine, 93(1)*, 7382-7392. https://doi.org/10.21608/ejhm.2023.324583

Enríquez, B. G. A., Jordan, O. H., Angaspilco, J. E. M., Heredia-Pérez, O., Ruiz-Carrillo, J. R., Blanco-García, L. E., & Villalobos, S. M. V. P. d. (2025). The mediating role of work stress and the performance expectations in the effect of academic overload on the use of AI models among preservice teachers: a cross-sectional study. *BMC Psychology, 13*(1). https://doi.org/10.1186/s40359-025-03367-8

Erbaşı, Z., Tural, B., & Çoşkuner, İ. (2023). The role and potential of artificial intelligence and gamification in education: the example of Vakıf Participation Bank. *Orclever Proceedings of Research and Development, 3*(1), 243-254. https://doi.org/10.56038/oprd.v3i1.329

Ezeoguine, E. P., & Eteng-Uket, S. (2024). Artificial intelligence tools and higher education students' engagement. *Edukasiana: Jurnal Inovasi Pendidikan, 3*(3), 300-312. https://doi.org/10.56916/ejip.v3i3.733

Faridoon, N., Talpur, Q., Latif, F., Naz, G., & Shahzad, T. (2025). The role of AI tutors in improving academic performance and student engagement. *ACADEMIA International Journal for Social Sciences, 4*(3), 5897-5910. https://doi.org/10.63056/acad.004.03.0837

Fauzi, F., Tuhuteru, L., Sampe, F., Ausat, A. M. A., & Hatta, H. R. (2023). Analysing the role of ChatGPT in improving student productivity in higher education. *Journal on Education, 5*(4), 14886-14891. https://doi.org/10.31004/joe.v5i4.2563

Fazil, A. W., Hakimi, M., Shahidzay, A. K., & Hasas, A. (2024). Exploring the broad impact of AI technologies on student engagement and academic performance in university settings in Afghanistan. *RIGGS: Journal of Artificial Intelligence and Digital Business, 2*(2), 56-63. https://doi.org/10.31004/riggs.v2i2.268

Fitria, T. N. (2023). The use of artificial intelligence in education (AIED): Can AI replace the teacher's role? *EPIGRAM (E-Journal), 20*(2), 165-187. https://doi.org/10.32722/epi.v20i2.5711

Ganzon, W. J., & Edig, M. M. N. (2022). Time management and self-directed learning as predictors of academic performance of students in mathematics. *Journal of Social, Humanity, and Education, 3*(1), 57-75. https://doi.org/10.35912/jshe.v3i1.1212

Gao, H. (2022). Online AI-Guided Video Extraction for Distance Education with Applications. *Mathematical Problems in Engineering, 2022(*1), 5028726.

George, B., & Wooden, O. S. (2023). Managing the strategic transformation of higher education through artificial intelligence. *Administrative Sciences, 13*(9), 196. https://doi.org/10.3390/admsci13090196

Ghafar, Z. N. (2023). The relevance of time management in academic achievement: a critical review of the literature. *International Journal of Applied and Scientific Research, 1*(4), 347-358. https://doi.org/10.59890/ijasr.v1i4.1008

Ghaffar, Z., Hussain, M., Mobeen, M., Lak, T. A., & Sadia, H. (2025). Artificial intelligence integration: its role and usage among university students. *The Knowledge, 4*(2), 95-110. https://doi.org/10.55737/tk/2k25b.42061

Ghalia, N., Isami, E., Bsoul, M., Aabed, S., Haeb, R. S., & Mustafa, M. S. S. (2024). Impact of artificial intelligence in education: insights from students and faculty members at Yarmouk University. *Journal of Ecohumanism, 3*(8). https://doi.org/10.62754/joe.v3i8.4807

González-Rico, P., & Sintes, M. L. (2024). Empowering soft skills through artificial intelligence and personalised mentoring. *Education Sciences, 14*(7), 699. https://doi.org/10.3390/educsci14070699

Grassini, S. (2023). Shaping the future of education: exploring the potential and consequences of AI and ChatGPT in educational settings. *Education Sciences, 13*(7), 692. https://doi.org/10.3390/educsci13070692

Guo, Z., Zhu, H., & Xu, X. (2023). Analysis of the impact of artificial intelligence on college students' learning. *The Frontiers of Society, Science and Technology, 5*(13). https://doi.org/10.25236/fsst.2023.051318

Han, S. J., Nagduar, S., & Yu, H. (2023). Digital addiction and related factors among college students. *Healthcare, 11*(22), 2943. https://doi.org/10.3390/healthcare11222943

Herath, D. B., Ode, E., & Herath, G. B. (2025). Can AI replace humans? comparing the capabilities of AI tools and human performance in a business management education scenario. *British Educational Research Journal, 51*(3), 1073-1096. https://doi.org/10.1002/berj.4111

Hidayat, M. T., & Hasim, W. (2023). Putting it off until later: a survey-based study on academic procrastination among undergraduate students. *Journal of Educational, Cultural and Psychological Studies (ECPS Journal), (28).* https://doi.org/10.7358/ecps-2023-028-taha

Hong, W., Liu, R., Ding, Y., Jiang, S., Yang, X., & Sheng, X. (2021). Academic procrastination precedes problematic mobile phone use in Chinese adolescents: a longitudinal mediation model of distraction cognitions. *Addictive Behaviors, 121*. https://doi.org/10.1016/j.addbeh.2021.106993

Hoque, K. E., Wang, X., Yang, Q., & Norzan, N. (2023). The factors associated with teachers' job satisfaction and their impacts on students' achievement: a review (2010–2021). *Humanities and Social Sciences Communications, 10*(1). https://doi.org/10.1057/s41599-023-01645-7

Hu, L., Xiao, W., Zhu, W., Zhu, L., & Hu, Y. (2024). Impact of artificial intelligence, smart learning and belief about the future on academic performance & moderating effect of desire for knowledge. *Profesional De La Información, 33*(4). https://doi.org/10.3145/epi.2024.ene.0418

Hua, J. (2023). Beyond exams: investigating AI tool impact on student attitudes, ethical awareness, and academic dishonesty in online college assessments. *International*

Journal of Educational Management and Development Studies, 4(4), 160-185. https://doi.org/10.53378/353030

Huang, J., Saleh, S., & Liu, Y. (2021). A review of artificial intelligence in education. *Academic Journal of Interdisciplinary Studies, 10*(3).

Hussain, H. N., Alabdullah, T. T. Y., Jamal, K. A. M., & Ahmed, E. R. (2023). Time management as a critical success factor in the oil industry of Basra governorate: an accounting information systems study. *International Journal of Scientific and Management Research, 6*(06), 59-76. https://doi.org/10.37502/ijsmr.2023.6605

Ifelebuegu, A. O., Kulume, P., & Cherukut, P. (2023). Chatbots and AI in education (AIED) tools: the good, the bad, and the ugly. *Journal of Applied Learning & Teaching, 6*(2). https://doi.org/10.37074/jalt.2023.6.2.29

Jeong, A., Ryu, S., Kim, S., Park, H., Hwang, H., & Park, K. (2023). Association between problematic smartphone use and physical activity among adolescents: a path analysis based on the 2020 Korea youth risk behavior web-based survey. *Korean Journal of Family Medicine, 44*(5), 268-273. https://doi.org/10.4082/kjfm.22.0154

Jingyu, X., Alibakhshi, G., Zamanpour, A., Zarei, M. A., Sherafat, S., & Behzadpoor, S. (2024). How AI literacy affects students' educational attainment in online learning: testing a structural equation model in higher education context. *The International Review of Research in Open and Distributed Learning, 25*(3), 179-198. https://doi.org/10.19173/irrodl.v25i3.7720

Kawatra, M. B. (2024). Evolution of AI in academic research. *Advances in Educational Technologies and Instructional Design*, 18-22. https://doi.org/10.4018/979-8-3693-1798-3.ch002

Kelly, R. (2024). Survey: 86% of students already use AI in their studies. Campus Technology. https://campustechnology.com/articles/2024/08/28/survey-86-of-students-already-use-ai-in-their-studies.aspx Campus Technology

Khan, M. S. and Irfan, R. (2025). The role of artificial intelligence in academic achievement in the current scenario. *International Journal for Multidisciplinary Research, 7*(4). https://doi.org/10.36948/ijfmr.2025.v07i04.49965

Kharis, M., Ediyanto, E., Wijaya, D. N., Yafie, E., Waluyo, B., & Resultay, R. G. (2024). The impact of AI usage on transforming student learning culture in Indonesia in alignment with SDG 4. *Journal of Ecohumanism, 3*(8). https://doi.org/10.62754/joe.v3i8.4845

Klímová, B., Pikhart, M., & Kacetl, J. (2023). Ethical issues of the use of AI-driven mobile apps for education. *Frontiers in Public Health, 10.* https://doi.org/10.3389/fpubh.2022.1118116

Kostas, A. and Manousou, E. (2025). Benefits and challenges of AI in higher distance education: students' perceptions and practices in Hellenic Open University (HOU). *Advances in Mobile Learning Educational Research, 5*(2), 1560-1574. https://doi.org/10.25082/amler.2025.02.011

Kouam, A. W. F. (2024). AI in academic writing: Ally or foe? *International Journal of Research Publications, 148*(1). https://doi.org/10.47119/ijrp1001481520246427

Krejcie, R.V., & Morgan, D.W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement, 30*, 607-610. https://doi.org/10.1177/001316447003000308

Kuleto, V., Ilić, M., Dumangiu, M. A., Ranković, M., Martins, O., Păun, D., & Mihoreanu, L. (2021). Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions. *Sustainability, 13*(18), 10424. https://doi.org/10.3390/su131810424

Kwak, Y., Ahn, J., & Seo, Y. H. (2022). Influence of AI ethics awareness, attitude, anxiety, and self-efficacy on nursing students' behavioral intentions. *BMC Nursing, 21*(1). https://doi.org/10.1186/s12912-022-01048-0

Lai, J. W., Qiu, W., Thway, M., Zhang, L., Jamil, N., Su, C. L., & Lim, F. S. (2025). Leveraging process-action epistemic network analysis to illuminate student self-regulated learning with a Socratic chatbot. *Journal of Learning Analytics, 12*(1), 32-49. https://doi.org/10.18608/jla.2025.8549

Lai, T., Zeng, X., Xu, B., Xie, C., Liu, Y., Wang, Z., & Fu, S. (2023). The application of artificial intelligence technology in education influences Chinese adolescent's emotional perception. *Current Psychology, 43*(6), 5309-5317. https://doi.org/10.1007/s12144-023-04727-6

Leeuwen, K. G. v., Rooij, M. d., Schalekamp, S., Ginneken, B. v., & Rutten, M. (2021). How does artificial intelligence in radiology improve efficiency and health outcomes?. *Pediatric Radiology, 52*(11), 2087-2093. https://doi.org/10.1007/s00247-021-05114-8

Lei, T., & Pan, F. (2023). Practice and exploration of conducting artificial intelligence teacher training in universities under the background of industry education integration. *Adult and Higher Education, 5*(13). https://doi.org/10.23977/aduhe.2023.051318

Li, S., & Lin, J. (2025). Enhancing academic engagement and needs satisfaction through AI: a mixed-methods study in the Chinese EFL tertiary education context. *European Journal of Education, 60*(2). https://doi.org/10.1111/ejed.70110

Liu, X., & Huang, X. (2022). [Retracted] Design of Artificial Intelligence-Based English Network Teaching (AI-ENT) System. *Mathematical problems in engineering, 2022*(1).

Liulka, V., Savenkova, O., & Dedukhno, A. (2024). The peculiarities of using artificial intelligence in teaching foreign languages in higher education institutions in Ukraine. *Humanities Science Current Issues, 2*(73), 195-201. https://doi.org/10.24919/2308-4863/73-2-30

Lodge, J. M., Thompson, K., & Corrin, L. (2023). Mapping out a research agenda for generative artificial intelligence in tertiary education. *Australasian Journal of Educational Technology, 39*(1), 1-8. https://doi.org/10.14742/ajet.8695

Makarenko, O., Borysenko, O., Horokhivska, T., Kozub, V., & Yaremenko, D. (2024). Embracing artificial intelligence in education: shaping the learning path for future

professionals. *Multidisciplinary Science Journal*, 6. https://doi.org/10.31893/multiscience.2024ss0720

Mariano, L. A., Madel, N. S., & Miranda, A. T. (2022). The relationship between time management skills and academic performance of working students in an open high school program. *Asian Journal of Education and Social Studies*, 61-66. https://doi.org/10.9734/ajess/2022/v36i2776

Mehta, N., Harish, V., Bilimoria, K., Morgado, F., Ginsburg, S., Law, M., & Das, S. (2021). Knowledge and attitudes on artificial intelligence in healthcare: a provincial survey study of medical students. *MedEdPublish*, 10(1). https://doi.org/10.15694/mep.2021.000075.1

Merkaš, M., Selak, M. B., & Žulec, A. (2024). Problematic smartphone use and communication in families with adolescents. *Adolescents, 4*(1), 107-119. https://doi.org/10.3390/adolescents4010008

Meron, Y., & Araci, Y. T. (2023). Artificial intelligence in design education: evaluating ChatGPT as a virtual colleague for post-graduate course development. *Design Science, 9*. https://doi.org/10.1017/dsj.2023.28

Ministry of Finance Malaysia. (2023). Malaysia's first artificial intelligence learning centre to be set up in UTM: PM Anwar. https://www.mof.gov.my/portal/en/news/press-citations/malaysia-s-first-artificial-intelligence-learning-centre-to-be-set-up-in-utm-pm-anwar Ministry of Finance Malaysia

Ministry of Higher Education (MOHE) Malaysia. (2023). Statistics portal. https://www.mohe.gov.my/en/download/statistics mohe.gov.my

Mishra, V. (2025). Impact of artificial intelligence on students' academic performance. *International Journal of Innovative Science and Research Technology*, 2549-2552. https://doi.org/10.38124/ijisrt/25jul1495

Moon, W., Kim, B., Kim, B., & Kim, J. (2024). Development of artificial intelligence education programs centered on deep learning principles. *Nanotechnology Perceptions, 20*(S2). https://doi.org/10.62441/nano-ntp.v20is2.6

Muslim, A. A., & Wahyuni, T. (2023). Spiritual Emotional Freedom Technique (SEFT) and time management to reduce academic stress in students during the COVID-19 pandemic. *Indonesian Journal of Instructional Media and Model, 5*(2), 85-95. https://doi.org/10.32585/ijimm.v5i2.4592

Namjoo, F., Liaghat, E., Shabaziasl, S., Modabernejad, Z., & Morshedi, H. (2023). Students' experience with self-study through AI. *AI and Tech in Behavioral and Social Sciences*, *1*(3), 35-42. https://doi.org/10.61838/kman.aitech.1.3.6

Napoles, M. A. R., Altubar, J. A. B., & Anding, H. K. T. (2023). The role of time management in the academic performance of college students during the pandemic. *International Journal of Social Sciences and Humanities Invention, 10*(02), 7731-7741. https://doi.org/10.18535/ijsshi/v10i02.05

Nazari, N., Shabbir, M. S., & Setiawan, R. (2021). Application of artificial intelligence-powered digital writing assistant in higher education: Randomized controlled trial. *Heliyon, 7*(5). https://doi.org/10.1016/j.heliyon.2021.e07014

Ngo, T. T. A. (2024). The importance of soft skills for academic performance and career development—from the perspective of university students. *International Journal of Engineering Pedagogy (iJEP), 14*(3), 53-68. https://doi.org/10.3991/ijep.v14i3.45425

Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguyen, B. T. (2022). Ethical principles for artificial intelligence in education. *Education and Information Technologies, 28*(4), 4221-4241. https://doi.org/10.1007/s10639-022-11316-w

Nickel, P. J. (2022). Trust in medical artificial intelligence: A discretionary account. *Ethics and Information Technology, 24*(1). https://doi.org/10.1007/s10676-022-09630-5

Nikolopoulou, K. (2024). Generative artificial intelligence in higher education: exploring ways of harnessing pedagogical practices with the assistance of ChatGPT. International *Journal of Changes in Education, 1*(2), 103-111. https://doi.org/10.47852/bonviewijce42022489

Noraini, A. W., Hanis, M. K. N., Aini, H. N., Salwana, M. S., & Syazana, R. N. (2023). Student's perceptions of the effectiveness on time management skills in assisting their online distance learning. *Jurnal Intelek, 18*(2). https://doi.org/10.24191/ji.v18i2.22383

Onal, S., Kulavuz-Onal, D., & Childers, M. (2025). Patterns of chatgpt usage and perceived benefits on academic performance across disciplines: insights from a survey of higher education students in the United States. *Journal of Educational Technology Systems, 54*(1), 34-66. https://doi.org/10.1177/00472395251341214

Onesi-Ozigagun, O., Ololade, Y. J., Eyo-Udo, N. L., & Ogundipe, D. O. (2024). Revolutionizing education through AI: a comprehensive review of enhancing learning experiences. *International Journal of Applied Research in Social Sciences, 6*(4), 589-607. https://doi.org/10.51594/ijarss.v6i4.1011

Orioque, J., & Selpa, H. D. (2021). Digital gaming: implications for undergraduate students' study habits, academic achievement and time management. *Journal of Innovative Technology Convergence, 3*(2), 11-20. https://doi.org/10.69478/jitc2021v3n2a02

Owusu, S. K., Zimpa, J. B., Atta, F. A., & Darling, M. (2024). Evaluating the impact of AI-personalised learning systems in higher education, examining how they affect academic performance across different age groups at Kumasi Technical University. *Journal of Artificial Intelligence, Machine Learning and Neural Network*, (45), 19-29. https://doi.org/10.55529/jaimlnn.45.19.29

Pan, J. (2024). AI-driven English language learning program and academic writing integrity in the era of intelligent interface. *English Language Teaching and Linguistics Studies, 6*(4). https://doi.org/10.22158/eltls.v6n4p120

Pinzolits, R. F. J. (2023). AI in academia: an overview of selected tools and their areas of application. *MAP Education and Humanities, 4*(1), 37-50. https://doi.org/10.53880/2744-2373.2023.4.37

Puteri, S. A., Saputri, Y., & Kurniati, Y. (2024). The impact of artificial intelligence (ai) technology on students' social relations. BICC Proceedings, 2, 153-158. https://doi.org/10.30983/bicc.v1i1.121

Raisch, S., & Krakowski, S. (2021). Artificial intelligence and management: the automation–augmentation paradox. *Academy of Management Review, 46*(1), 192-210. https://doi.org/10.5465/amr.2018.0072

Ranieri, M., Biagini, G., & Cuomo, S. (2025). AI literacy in higher education. *International Journal of Digital Literacy and Digital Competence, 16*(1), 1-25. https://doi.org/10.4018/ijdldc.388469

Rienties, B., Herodotou, C., Tessarolo, F., Domingue, J., Duttaroy, S., & Whitelock, D. (2024). An institutional AI digital assistant: What do distance learners expect and value? Ubiquity Proceedings, 7. https://doi.org/10.5334/uproc.129

Romero, M., Casadevante, C., & Santacreu, J. (2023). Time management, fluid intelligence and academic achievement. *Psychological Studies, 69*(1), 59-68. https://doi.org/10.1007/s12646-023-00764-0

Rudolph, J., Tan, S., & Tan, S. (2023). War of the chatbots: Bard, Bing Chat, ChatGPT, Ernie and beyond. the new AI gold rush and its impact on higher education. *Journal of Applied Learning & Teaching, 6*(1). https://doi.org/10.37074/jalt.2023.6.1.23

Saranya, D., & Praveen, S. (2025). A study on the impact of AI apps usage among students. *Juni Khyat, 15*(03), 76-84. https://doi.org/10.36893/jk.2025.v15i3.018

Seo, K., Tang, J., Roll, I., Fels, S., & Yoon, D. (2021). The impact of artificial intelligence on learner–instructor interaction in online learning. *International Journal of Educational Technology in Higher Education, 18*(1). https://doi.org/10.1186/s41239-021-00292-9

Shah, S., Jabeen, A., & Masood, F. (2025). Artificial intelligence in education for personalized learning: A case study of Mirpur University of Science and Technology (MUST). *ACADEMIA International Journal for Social Sciences, 4*(3), 5031-5041. https://doi.org/10.63056/acad.004.03.0775

Shehri, F. A., Maham, R., Malik, A., & Saif, O. B. (2023). Effects of ChatGPT on students' academic performance: Mediating role of prompt engineering. *The Asian Bulletin of Big Data Management, 3*(2), 137-147. https://doi.org/10.62019/abbdm.v3i2.58

Siminto, S., Akib, A., Hasmirati, H., & Widianto, D. S. (2023). Educational management innovation by utilizing artificial intelligence in higher education. *Al-Fikrah: Jurnal Manajemen Pendidikan, 11*(2), 284. https://doi.org/10.31958/jaf.v11i2.11860

Song, C. S. (2025). Harmonising minds: How AI-powered learning tools shape music education students' cognitive load, well-being and academic success. *European Journal of Education, 60*(2). https://doi.org/10.1111/ejed.70122

Stewart, J., Lü, J., Gahungu, N., Goudie, A., Fegan, P. G., Bennamoun, M., & Dwivedi, G. (2023). Western Australian medical students' attitudes towards artificial

intelligence in healthcare. *PlosOne, 18*(8). https://doi.org/10.1371/journal.pone.0290642

Strzelecki, A. (2023). Students' acceptance of ChatGPT in higher education: an extended unified theory of acceptance and use of technology. *Innovative Higher Education, 49*(2), 223-245. https://doi.org/10.1007/s10755-023-09686-1

Suan, A. F. (2023). Self–regulation as an antecedent of academic achievement: a mixed-method study. *British Journal of Multidisciplinary and Advanced Studies, 4*(4), 20-43. https://doi.org/10.37745/bjmas.2022.0246

Sukor, R., Ayub, A. F. M., Nor-Khaizura, M. A. R., & Farawahida, A. H. (2021). Relationship between students' engagement and academic performance among non-food science students enrolled in the food science course. *Journal of Turkish Science Education, 18*(4), 638-648. https://doi.org/10.36681/tused.2021.95

Sullivan, M., Kelly, A., & McLaughlan, P. (2023). ChatGPT in higher education: considerations for academic integrity and student learning. *Journal of Applied Learning & Teaching, 6*(1). https://doi.org/10.37074/jalt.2023.6.1.17

Sulton, N. (2024). Elements of artificial intelligence course curriculum and content in general secondary schools. *International Journal of Pedagogics, 4*(3), 44-49. https://doi.org/10.37547/ijp/volume04issue03-08

Sun, J. C., Wang, Y., Hu, Z., Liu, Y., & Sun, Y. (2024). Cognitive offloading bias in primary and secondary school students and its relationship with metacognitive monitoring. *British Journal of Developmental Psychology*. https://doi.org/10.1111/bjdp.12540

Sun, L., & Zhou, L. (2024). Does generative artificial intelligence improve the academic achievement of college students? a meta-analysis. *Journal of Educational Computing Research, 62*(7), 1676-1713. https://doi.org/10.1177/07356331241277937

Sun, W., Jiang, Z., & Hai, S. (2025). The double-edged sword effect of interaction frequency with AI on college students: The moderating role of peer support. *Behavioral Sciences, 15(*9). https://doi.org/10.3390/bs15091267

Susilo, T. and Aritonang, S. (2023). Optimizing the potential of artificial intelligence in education management for ERA 5.0. *Al-Fikrah: Jurnal Manajemen Pendidikan, 11*(2), 219. https://doi.org/10.31958/jaf.v11i2.10371

Syofyan, R. (2023). The influence of student activity in organizations on students' readiness in entering the world of work. *Advances in Economics, Business and Management Research*, 296-302. https://doi.org/10.2991/978-94-6463-158-6_26

Tabesh, P. (2021). Who's making the decisions? how managers can harness artificial intelligence and remain in charge. *Journal of Business Strategy, 43*(6), 373-380. https://doi.org/10.1108/jbs-05-2021-0090

Tanjga, M. (2023). E-learning and the Use of AI: A Review of Current Practices and Future Directions. *Qeios*. https://doi.org/10.32388/AP0208

Tapalova, O., & Zhiyenbayeva, N. (2022). Artificial intelligence in education: AIED for personalised learning pathways. *Electronic Journal of E-Learning, 20*(5), 639-653. https://doi.org/10.34190/ejel.20.5.2597

Tartuk, M. (2023). Metaphorical perceptions of middle school students regarding the concept of artificial intelligence. *International Journal of Education and Literacy Studies, 11*(2), 108-116. https://doi.org/10.7575/aiac.ijels.v.11n.2p.108

Tiwari, R. (2023). The integration of AI and machine learning in education and its potential to personalize and improve student learning experiences. *International Journal of Scientific Research in Engineering and Management, 7*(02). https://doi.org/10.55041/ijsrem17645

Trisnawati, W., Putra, R. E., & Balti, L. (2023). The impact of artificial intelligence in education toward 21st-century skills: A literature review. *PPSDP International Journal of Education, 2*(2), 501-513. https://doi.org/10.59175/pijed.v2i2.152

Ullah, R., Asghar, A., Ali, M., & Jan, R. (2024). Studying how AI tools integrated with social media can help teachers manage classrooms by providing insights into student behavior, engagement levels, and areas needing improvement. *Review of Education, Administration & Law, 7*(4), 413-426. https://doi.org/10.47067/real.v7i4.393

Umaiba, N. (2025). The role of artificial intelligence in higher education: a special focus on commerce studies. *Thiagarajar College of Preceptors Edu Spectra, 7(*S1), 89-95. https://doi.org/10.34293/eduspectra.v7is1-feb25.011

UNESCO. (2024). Malaysia | Global AI Ethics and Governance Observatory: National AI Governance & Ethics Guidelines (AIGE). https://www.unesco.org/ethics-ai/en/malaysia unesco.org

Vieriu, A.-M., Manta, N., & Iacob, N. (2025). The impact of artificial intelligence on students' learning processes and academic performance. *Education Sciences, 15*(3), 343. https://www.mdpi.com/2227-7102/15/3/343 MDPI

Wang, K., Cui, W., & Xue, Y. (2025). Artificial intelligence in higher education: the impact of need satisfaction on artificial intelligence literacy mediated by self-regulated learning strategies. *Behavioral Sciences, 15*(2), 165. https://doi.org/10.3390/bs15020165

Wang, X. (2022). Enhancing Chinese EFL students' academic engagement: the impact of L2 enjoyment and academic motivation. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.914682

Wang, X., & Li, P. (2024). Assessment of the relationship between music students' self-efficacy, academic performance and their artificial intelligence readiness. *European Journal of Education, 59*(4). https://doi.org/10.1111/ejed.12761

Wei, L. (2023). Artificial intelligence in language instruction: impact on English learning achievement, L2 motivation, and self-regulated learning. *Frontiers in Psychology, 14*. https://doi.org/10.3389/fpsyg.2023.1261955

Woods, D., Poe, L., Brooks, N., Korzaan, M., & Hulshult, A. (2024). Assessing student focus areas for self-directed metacognition and self-improvement. *Journal of Effective Teaching in Higher Education, 7*(1), 96-117. https://doi.org/10.36021/jethe.v7i1.362

Wu, R., & Yu, Z. (2023). Do AI chatbots improve students' learning outcomes? Evidence from a meta-analysis. *British Journal of Educational Technology, 55*(1), 10-33. https://doi.org/10.1111/bjet.13334

Xames, M. D., & Shefa, J. (2023). ChatGPT for research and publication: opportunities and challenges. *Journal of Applied Learning & Teaching, 6*(1). https://doi.org/10.37074/jalt.2023.6.1.20

Xia, Q., Chiu, T. K., Chai, C. S., & Xie, K. (2023). The mediating effects of needs satisfaction on the relationships between prior knowledge and self-regulated learning through an artificial intelligence chatbot. *British Journal of Educational Technology, 54*(4), 967–986. https://bera-journals.onlinelibrary.wiley.com/doi/10.1111/bjet.13305

Xiao-yang, H., Junzhi, Z., Jingyuan, F., & Zhang, X. (2021). Effectiveness of ideological and political education reform in universities based on data mining artificial intelligence technology. *Journal of Intelligent & Fuzzy Systems, 40*(2), 3743-3754. https://doi.org/10.3233/jifs-189408

Xie, X. (2023). Influence of AI-driven inquiry teaching on learning outcomes. *International Journal of Emerging Technologies in Learning (iJET), 18(*23), 59-70. https://doi.org/10.3991/ijet.v18i23.45473

Xing, C. (2023). Research on the application of artificial intelligence empowered education management. *Journal of Artificial Intelligence Practice, 6*(6). https://doi.org/10.23977/jaip.2023.060602

Xu, S., Chen, P., & Zhang, G. (2024). Exploring Chinese university educators' acceptance and intention to use AI tools: an application of the UTAUT2 model. *Sage Open, 14*(4). https://doi.org/10.1177/21582440241290013

Yas, M. A., İşçi, N., Alaçam, B., Caliskan, R., & Kulekci, E. (2021). Relationship between level of internet addiction and time management skills among nursing students. *Perspectives in Psychiatric Care, 58*(2), 758-766. https://doi.org/10.1111/ppc.12845

Yeadon, W., & Hardy, T. A. (2024). The impact of AI in physics education: A comprehensive review from GCSE to university levels. *Physics Education, 59*(2), 025010. https://doi.org/10.1088/1361-6552/ad1fa2

Yim, I. H. Y., & Wegerif, R. (2024). Teachers' perceptions, attitudes, and acceptance of artificial intelligence (AI) educational learning tools: An exploratory study on ai literacy for young students. *Future in Educational Research, 2*(4), 318-345. https://doi.org/10.1002/fer3.65

Youn, Chu & Hj Salam, Abdul Rahim & Rahman, Aida. (2025). AI-Driven Tools in Providing Feedback on Students' Writing. *International Journal of Research and Innovation in Social Science. IX*. 58-67. https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0006

Yu, H. (2023). Reflection on whether ChatGPT should be banned by academia from the perspective of education and teaching. *Frontiers in Psychology, 14*. https://doi.org/10.3389/fpsyg.2023.1181712

Yu, H., & Guo, Y. (2023). Generative artificial intelligence empowers educational reform: current status, issues, and prospects. *Frontiers in Education, 8*. https://doi.org/10.3389/feduc.2023.1183162

Zhai, G., Guo, K., & Li, S. (2023). Research on innovation of ideological and political education in universities based on artificial intelligence. *Advances in Social Science, Education and Humanities Research*, 27-32. https://doi.org/10.2991/978-2-38476-158-6_5

Zhang, C., & Zhang, W. (2022). The impact of academic procrastination on second language writing: The mediating role of l2 writing anxiety. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.851120

Zhang, J. (2021). Reform and innovation of artificial intelligence technology for information service in university physical education. *Journal of Intelligent & Fuzzy Systems, 40*(2), 3325-3335. https://doi.org/10.3233/jifs-189372

Zhang, R. (2024). Application of "artificial intelligence + education" innovation model in higher education management and student training. *Applied Mathematics and Nonlinear Sciences, 9*(1). https://doi.org/10.2478/amns-2024-1027

Zhang, S., Diao, J., Ma, X., Tang, X., & Ding, X. (2024). What qualities do teachers need in the era of artificial intelligence: Analysis based on international experience. *STEM Education Review, 2.* https://doi.org/10.54844/stemer.2024.0557

Zhang, S., Zhao, X., Zhou, T., & Kim, J. H. (2024). Do you have an AI dependency? The roles of academic self-efficacy, Academic Stress, and Performance Expectations on problematic ai usage behavior. *International Journal of Educational Technology in Higher Education, 21*(1). https://doi.org/10.1186/s41239-024-00467-0

Zhang, Y., Rong-hua, L., Zhu, Y., & Yin, Y. (2021). Educational robots improve K-12 students' computational thinking and STEM attitudes: systematic review. *Journal of Educational Computing Research, 59*(7), 1450-1481. https://doi.org/10.1177/0735633121994070

Zhao, C. (2025). Who is writing? the development and application of the AI-integrated writing framework (AWAI). *Journal of Educational Technology and Innovation, 7*(2). https://doi.org/10.61414/h2a5bt21

Zhou, J., Zhang, J., & Li, H. (2023). Exploring the use of artificial intelligence in teaching management and evaluation based on citation space analysis. *Journal of Education and Educational Research, 3*(2), 42-45. https://doi.org/10.54097/jeer.v3i2.9014

Zhu, L. (2023). Research on the practice of artificial intelligence technology promoting educational reform and innovation. *The Frontiers of Society, Science and Technology, 5*(14). https://doi.org/10.25236/fsst.2023.051412

Zimmerman, B.J. & Moylan, Adam. (2009). Self-regulation: Where metacognition and motivation intersect. Handbook of metacognition in education. 299-315. Retrieved

from https://www.researchgate.net/publication/285323162_Self-regulation_Where_metacognition_and_motivation_intersect