



The Impact of AI-Supported Digital Learning on Academic Performance: Examining The Moderating Effect of Digital Self-Efficacy among University Students

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ABSTRACT

This study examined the impact of AI-supported digital learning on academic performance among university students, with particular emphasis on the moderating role of digital self-efficacy. The study was significant because the increasing integration of Artificial Intelligence into higher education has created new opportunities for personalized, accessible, and technology-enhanced learning, while students' ability and confidence to use digital technologies may influence the extent to which they benefit from these opportunities. A quantitative, cross-sectional research design was adopted, and data were collected from 371 university students in Punjab and Sindh, Pakistan, through a structured questionnaire administered using Google Forms. The data were analyzed by using techniques of descriptive statistics, reliability analysis, Pearson correlation, regression analysis, and moderation analysis. The findings demonstrated that AI-supported digital learning was positively associated with academic performance and significantly contributed to explaining differences in students' academic outcomes. Digital self-efficacy was also positively related to academic performance, indicating that students with greater confidence in using digital technologies tended to achieve better academic outcomes. Furthermore, the findings showed that digital self-efficacy significantly strengthened the relationship between AI-supported digital learning and academic performance, suggesting that students with higher digital self-efficacy were better positioned to benefit from AI-supported learning environments. The study concludes that effective integration of AI into higher education should be accompanied by the development of students' digital confidence, competence, and responsible AI-use skills. The findings provide useful implications for universities, educators, and policymakers seeking to maximize the educational benefits of AI-supported learning.

Introduction

Artificial Intelligence (AI) has changed how digital learning is used in higher education. It offers intelligent learning tools that support students in different ways, such as providing immediate feedback and guidance. These tools can assist students while they complete traditional learning activities or when they are developing explanations and understanding new concepts. The

advanced AI systems can now support learners in accomplishing a variety of learning tasks i.e. information seeking and learning task adaptation while providing learners with feedback in a timely manner. In effect, AI is beginning to be integrated as a systematic and intentional tool and/or practice for instruction (Bond et al., 2025; Portuguese-Castro & Castillo-Martínez, 2026).

AI-based learning systems are especially useful at enhancing digital learning opportunities offered at universities because the majority of university students now engage with their education through AI-based learning systems and online resources. There is sufficient empirical evidence to support the use of AI to enhance learning through personalized instruction, assessment, feedback, and information seeking; and in the context of more complex and advanced learning activities (Mustafa & Altrad, 2026). A recent addition to the evidence suggests generative AI has the potential to enhance university students' learning outcomes if considered in the broader context of the learner and the situation (Cheung et al., 2025).

The success of AI-mediated learning depends on students' interactions with technologies, evaluations of AI-generated information, management of their own learning, and application of technologies when fulfilling academic tasks. More and more studies focus on how learner characteristics and context affect the contemporary implications of AI for education (Adewale et al., 2024). Analyzing AI-centered digital learning and students' individual digital capabilities will enrich our understanding of the reasons some students benefit more from AI-supported learning than others.

AI-Supported Digital Learning

Digital learning combined with AI refers to the use of various AI technologies in digital environments of education and learning in order to facilitate, personalize, or optimize the learning process of students. Digital learning integrated with AI may include AI tutors, adaptive learning systems, intelligent suggestions, feedback, learning analysis systems, natural language interfaces, and other similar applications, including ChatGPT. Unlike other forms of digital learning, AI-integrated learning environments can dynamically respond to learners' questions and activities and can stimulate learning based on learners' interactions with the system (Katonane Gyonyoru, 2024).

AI-supported digital learning is beginning to change how students learn and how they engage with learning materials. This is due to the efficiency with which AI tools explain concepts, assist with problem solving, provide practice and feedback, and create examples (Deng & Li, 2024). With all of these learning-related activities, students used ChatGPT and other generative AI technologies, and in most cases, learning was improved with positive outcomes (Acuña, 2026). AI-integrated digital learning is not better simply because the technology is available. Students should be able to use the digital systems appropriately, ask relevant questions, understand and articulate Socratic critique of current information, and integrate the AI technology within their own learning processes. The value of AI is dependent on technology and users. New studies suggest it is time to examine the differences in educational outcomes from AI-supported learning at the learner level (Niyazova et al., 2026).

Generally, the effects of AI-supported learning on student learning outcomes have been well documented and have been found to be generally positive. For example, in open and distance learning, documented the positive effects of AI on academic performance, while (Chen et al., 2025) found positive and significant effects of generative AI on the learning outcomes of some university students. Furthermore, in the case of ChatGPT, some experimental studies have documented positive effects on students' academic performance and higher-order thinking. Therefore, it can be predicted that AI-based digital learning will have positive effects on academic performance, but the strength of these positive effects may be dependent on how students are able to use educational technology.

Academic Performance

Academic performance describes the degree to which students achieve the desired outcomes from their studies. In higher education, this is usually apparent through grades, course results, the completion of assessments, or other indicators on the attainment of the academic goals. Academic performance is therefore an important variable for assessing whether educational innovations and technologies of learning actually serve their purpose of advancing the attainment of students' learning goals (Richardson et al., 2012).

Several factors, including students' abilities, self-regulation, engagement, learning, and interaction, affect the extent to which students profit from educational resources in digital learning environments. The extent to which students interact with resources is comparable to the effects of educational resources in traditional learning environments. Digital learning environments and technologies alter the learning context, and e-learning research has shown that the academic results of learners cannot be separated from the learners and their learning environment (Deepa et al., 2022; Jan et al., 2016).

In technology-augmented learning environments, AI can provide students with a range of academic support and services, and although this is often of significant value to students, it does not ensure that learning occurs. Students may use AI to receive explanations, or to gain practice questions and responses, or to request assistance for difficult academic activities. The educational value is determined by the learning activity. Recent research, synthesized and analyzed systematically and meta-analytically, shows AI can enhance academic results and learning outcomes, while demonstrating substantial differences across learning contexts and students' characteristics.

The evidence is clearer for the expectation that AI-based digital learning technology leads to better academic results with greater and more effective engagement.

AI can potentially deliver customized step-by-step explanations, instant assessments, and personalized digital tools that can enhance the learning process and lead to the completion of the required academic assignments (Fenollar et al., 2007). Due to the variation in students' capabilities of navigating and engaging with online technologies, this additional support may not impact all learners uniformly.

Digital Self-Efficacy

Digital self-efficacy is students' understanding of their ability to use digital technology and digital resources to complete and assist with their learning activities and tasks in an academic setting. This self-efficacy is heavily linked to the broader self-efficacy theory. According to this theory, a person's belief in their ability is linked to the level of their effort, persistence, and the eventual outcome of the endeavor. Digital self-efficacy is brought about by students' confidence to use digital technology to navigate and critically analyze digital information, communicate with others digitally, solve digital tech related problems, and use various digital tools to aid their learning. (Bandura & Wessels, 1997).

The need for digital self-efficacy in higher learning today is apparent. This is mainly because most academic tasks are now done in digital environments. In this case, students with digital self-efficacy show more confidence while performing tasks that require learning in a digital environment. In addition, they are more persistent and explore digital resources available more than their counterparts. There is a positive relationship between self-efficacy with computers and learning performance and self-efficacy regarding online learning and self-efficacy and learning performance in digital learning environments (Ulfert-Blank & Schmidt, 2022).

Digital self-efficacy plays an integral role in students' ability to meaningfully engage with digitally advanced learning technologies that include artificial intelligence (AI). Using AI and related technologies effectively requires more than just owning a digital device; students need to be confident in communicating with AI and in their ability to use, navigate, and integrate digital resources in their academic tasks. New research links digital self-efficacy and other forms of digital competence directly to academic performance; therefore, it is likely that if students are more confident and capable in digital environments, then their academic engagement would improve (Maran et al., 2022).

Generally, higher confidence in digital technologies enables students to better engage with technology-integrated learning and achieve better learning outcomes. More recently, researchers have begun to examine digital self-efficacy as a predictor of the academic performance of university students. Given these relationships, it is likely that digital self-efficacy has a positive relationship with academic performance. Students who have confidence in their self-efficacy of digital learning technologies are likely to engage more effectively and persistently with the digital resources in order to support their academic performance.

Moderating Role of Digital Self-Efficacy

The explanation for the effect of AI-assisted digital learning on academic performance is more complete if we consider the role of digital self-efficacy. A moderating factor does not provide an explanation for how and why AI-assisted learning improves academic performance. It explains why and how the relationship between digital self-efficacy and academic performance differs between students. In this framework, AI-assisted digital learning is likely to be more useful to students who are more confident in their ability to use digital technology. These students are likely to be more effective in collaborating with AI and using digital technology to complete learning tasks (Ghali & Amari, 2024).

Self-efficacy theory is the principal theory for this argument. Individuals' beliefs about their capabilities determine how much effort they exert, how long they persist in the face of difficulty, and whether they undertake difficult tasks. In an AI-supported learning environment, students who have higher digital self-efficacy would be more likely to engage critically with AI tools,

examine the outputs, ask for help, and use AI to extend their knowledge. On the other hand, students who have lower digital self-efficacy may experience more challenges in an AI-supported learning environment, and therefore would derive less benefit from the same educational technologies (Shen et al., 2013).

There is evidence that learning performance and engagement are enhanced by computer self-efficacy and that digital self-efficacy is crucial for the achievement of learning goals in digital platforms that are used for learning in combination with technology (Al-Hattami, 2025). Furthermore, a more recent focus on AI-based learning systems has shown that self-efficacy can modify the relationship on AI-based learning and learning outcomes, thus providing evidence for the study of self-efficacy as a moderating factor in AI-based learning.

The research mentioned above shows that AI-based learning systems can support digital learning in a positive way. In addition, digital self-efficacy will define if, and to what extent, AI-supported learning opportunities will be converted into learning outcomes. Thus, learners with high digital self-efficacy may establish a more positive relationship between AI-based learning and digital learning outcomes in comparison to learners with low digital self-efficacy. This moderating perspective is important because it moves the focus from the general rigid question of whether AI works to the more important question of for whom and under what circumstances AI-based learning and digital learning are effective.

Research Objectives

- To examine the relationship between AI-supported digital learning and academic performance among university students.
- To assess the relationship between digital self-efficacy and academic performance among university students.
- To determine the moderating effect of digital self-efficacy on the relationship between AI-supported digital learning and academic performance among university students.

Problem Statement

Artificial Intelligence (AI) is dominant in educational settings and is develop rapidly. The impacts AI will have on university learners are still uncertain. Previous studies document positive benefits of AI and generative AI on learning. However, they describe the potential of AI and predict learning outcomes and performance; they don't describe the user characteristics that highlight the positive benefits of AI (Al Shaibani et al., 2026). Of concern is the lack of evidence about digital self-efficacy and its influence on the AI-supported digital learning - performance nexus. Students who have digital self-efficacy may have superior control of AI tools and critically assess generated data, and bolster their academic portfolios through smart digital resources integration. Students who are less self-assured may be poorly served by AI. This study will address the gap and test whether digital self-efficacy describes the performance-AI-supported digital learning nexus at university.

Significance of the study

This study will improve understanding of how AI-supported digital learning influences university students' performance and where digital self-efficacy is implicated in the AI-supported digital learning - performance nexus. The implication is that universities may develop informed, advanced AI structured learning approaches. The presence of AI will not ensure enhanced learning outcomes without innovative teaching approaches. The study may also help us understand how important it is to develop students' confidence and competence with using digital and AI-based learning tools, so they know how to best use the technology tools for learning. The results may also help educational policy makers figure out how to develop AI-based and digital learning tools, and may be of interest to future researchers studying the user of AI in digital learning tools.

Literature Review

AI-Supported Digital Learning

AI-based digital learning is a new direction in higher education. Digital learning environments enhanced by AI may provide students with personalized information as well as automated feedback and support, as well as provide interactive academic assistance. Unlike the previous iterations of digital learning, AI-based learning may address students' needs in real time through intelligent tutoring systems, learning analytics, adaptive systems, and other generative AI tools/systems. Research published in

the peer-reviewed literature indicates that AI is increasingly deployed in higher education in numerous ways to support formal and informal learning (Katonane Gyonyoru, 2024).

From the perspective of existing literature, the use of AI-supported learning provides positive educational outcomes. According to one recent study, a systematic review and meta-analysis of 57 studies, (Geroche & Guay, 2024) reported that generative AI had a large overall positive effect on university students' learning outcomes and academic achievement and enhanced higher-order thinking. Positive effects of generative AI on learning achievement and motivational outcome have also been reported. Thus, the potential role of AI technology in supporting university-level learning is becoming more and more evident.

Even though some studies have found positive results for specific educational contexts, the use of AI-based learning may result in different outcomes in different educational contexts. It has been reported that positive results for supporting educational activities using different forms and/or periods of application of AI-based technologies/services have been obtained depending on the type of activity and the discipline. For example, in their recent study, Aimicheva et al. (2025) reported a positive effect of GenAI on learning outcomes, although there was considerable variation depending on the studies.

Academic Performance

Academic performance is measured by the outcomes of educational activities and is most often characterized by performance on tasks and exams. Traditionally, academic performance has been critically important in gauging the quality of instruction and the technology used to support the learning process. There have been increasing numbers of studies that treat academic performance as the main outcome of educational activities integrated with artificial intelligence.

The impact of artificial intelligence (AI) on education has led to much interest in whether the support of technology can be measured in academic improvement. One of the first meta-analyses to study the impact of generative AI on learning, reported a positive impact on learning. In addition, a second meta-analysis of AI and academic performance also reported positive educational impacts. These findings show that academic performance can be improved by using AI in educational activities.

There are other factors beyond technological support that affect academic performance. Such factors include existing skills and motivation to learn, the level of involvement, efficiency in using strategies for learning, and the ability to use digital tools and resources in education. A recent meta-analysis reported that variables such as education, learning strategies, and the domain of the teaching and learning activity; as well as the duration of the intervention and AI, can influence the outcome of the educational impact of AI. For these reasons, academic performance is a good indicator of the effects of AI on digital learning. Specifically, students' confidence with digital tools is a factor for how students convert AI-supported resources to scholarly advantage.

Digital Self-Efficacy

Digital self-efficacy is a student's confidence level about the use of digital tools and technology to accomplish tasks pertaining to learning. Bandura and Wessels (1997) defines self-efficacy as the confidence one has in their own abilities, and thus, in their willingness to work hard, maintain perseverance, and believe in their capability to succeed. In higher education, digital self-efficacy has a growing importance as students will be required to interact using online infrastructure, digital resources, and educational software, as well as AI-based applications, in their academic activities.

Digital self-efficacy plays an important role in using AI-based learning systems. This includes being able to navigate digital systems, framing appropriate requests, assessing generated information, and incorporating AI into learning. Thus, students who possess digital self-efficacy can adjust to and benefit from AI-based learning systems. This is supported by recent studies on the use of AI-based learning systems that emphasize the importance of self-efficacy as a learner characteristic in shaping the impact of AI learning on students. The available literature evidences the importance of digital self-efficacy on the part of the student as an important individual learning characteristic as well as a condition shaping the effectiveness of learning supported by AI. Considering it as a moderator can help us articulate reasons why students studying in varying AI-powered learning environments may end up with differing academic results. Examining the reason students who have been taught with similar AI-supported learning systems may have brought about differing academic results as a moderator will help as this will create pragmatic reasoning for the students varied academic results.

Relationship Between AI-Supported Digital Learning and Academic Performance

There is an increasing amount of research that shows positive associations between AI-assisted learning and performance in academics. AI technologies can quickly provide learners with a number of different resources, build an explanation on a step-by-

step basis, provide targeted instructional feedback, and offer various types of elaborative supports. (Zhang et al., 2025) saw positive AI-based learning effects on university students, with significant positive learning outcomes. Further, (Alam et al., 2026) reported significant positive effects on learning outcomes. Furthermore, concepts from broader meta-analyses reinforce this association. also reported a significant positive overall effect of generative AI on learning outcomes, with positive effects on learning outcomes also reported when studying AI-based interventions specifically aimed at achieving goals within academia.

AI has been shown to have beneficial effects when incorporated into learning. Although the literature points to the lack of uniformity of this association. also reported high levels of overall heterogeneity, citing the AI effects largely dependent on characteristic and contextual factors of a learner as well as of an educational system. Similar to this, (Altememy et al., 2023) reported the presence of several contextual factors, as well as learner, instructional, and tool-related factors. As such, increased exposure to AI will not necessarily benefit learning achievement. In general, current studies have shown that AI-based learning will most likely improve performance in academics. However, more studies are needed to better understand what factors drive this association. Accordingly, this study aims to fill the existing literature gap by analyzing digital self-efficacy as a moderating factor for this association.

Relationship Between Digital Self-Efficacy and Academic Performance

Previous studies show that a student's confidence while using digital technologies can lead to positive adjustment in technology-based learning. Digital self-efficacy can lead to students searching for technology-based resources, remaining persistent with technological challenges, and completing academic work via digital means. The importance of this variable in digital self-efficacy and higher education has been recently researched among university students, especially since it has been found to be a predictor of their academic performance (Zakir et al., 2025).

The relationship between the two can be explained within the framework of self-efficacy established. Accordingly, believing in one's capabilities can increase persistence and the willingness to engage in a set of tasks that one perceives to be difficult. Students who believe they can operate tools in digital learning environments may be willing to use digital tools several times, intentionally and carefully, in the completion of their academic activities.

Given that one's education at the university level often relies on digital technologies and on resources supported by artificial intelligence, having high digital self-efficacy may also mean students are better prepared to analyze, assess, and apply the information they gain from digital learning environments. Therefore, it can be expected that students with higher digital self-efficacy may also gain a positive advantage from AI-based digital learning technologies.

Based on previous studies, digital self-efficacy may lead to a positive improvement in students' academic performance. More importantly, digital self-efficacy may also influence students' advantage of using AI-based technologies in digital learning.

Research Gap

Although recent research consistently indicates that AI-supported and generative AI learning can improve students' academic achievement and broader learning outcomes, substantial variation remains in the magnitude of these effects across learners and educational contexts (Chen & Cheung, 2025; Liu et al., 2025; Han et al., 2025). Existing studies have examined several contextual moderators, such as discipline, intervention duration, learning strategy, and type of AI tool, but comparatively limited attention has been given to digital self-efficacy as a moderating factor that may determine how effectively university students benefit from AI-supported digital learning. Therefore, a specific gap remains in explaining whether students with higher digital self-efficacy obtain greater academic benefits from AI-supported digital learning than students with lower digital self-efficacy. Addressing this gap can provide a more learner-centred understanding of when and for whom AI-supported digital learning is most effective, particularly in the university context.

Hypotheses

H1: There is a significant positive relationship between AI-supported digital learning and academic performance among university students.

H2: AI-supported digital learning significantly predicts academic performance among university students.

H3: There is a significant positive relationship between digital self-efficacy and academic performance among university students. Recent evidence supports this relationship, including research identifying digital self-efficacy as a significant factor associated with academic performance.

H4: Digital self-efficacy significantly moderates the relationship between AI-supported digital learning and academic performance among university students, such that the positive relationship is stronger among students with higher digital self-efficacy. Recent AI-learning research supports the broader proposition that self-efficacy can condition the academic benefits obtained from AI-supported learning.

Methodology

Research Design

A quantitative, cross-sectional research design was used to examine AI-based digital learning, digital self-efficacy, and their impact on academic performance of the university students. The primary data were collected using a structured questionnaire. The items of the questionnaire were of the Likert scale type. A quantitative survey was considered appropriate because this study intended to analyze the relationships and the predictive effects as opposed to providing a qualitative study on students' experiences.

Population

The population was the university students from the public and private higher education sector of Punjab and Sindh, Pakistan. These students were from Bahauddin Zakariya University, University of the Punjab, The University of Lahore, The University of Sindh, University of Karachi, and Shah Abdul Latif University. These universities were included because they covered students of different fields and Institutes from the two provinces in Pakistan

Target Audience

The target audience was undergraduate and postgraduate students who were involved in digital learning and had used digital or AI-based educational tools. By including students from different fields, the study aimed to cover a range of university students and analyze AI-based learning within the higher education context.

Sampling Technique

As non-probability sampling was employed, convenience sampling, as the questionnaire was sent electronically, was used. Participation was based on the students' accessibility and willingness to complete the questionnaire. The methodology aimed to reach university students across different institutions and geographic areas through online communication. Convenience sampling has been used by some recent studies involving Pakistani university students to study AI-based learning.

Sample Size

A total of 371 valid responses were collected from university students in Punjab and Sindh, Pakistan. The data were obtained through an online questionnaire completed by the participants. The sample included students of all educational levels and academic backgrounds, which enabled the researcher to perform correlation, regression, group comparison, and moderation analyses.

Data Collection

Data were collected using an online structured questionnaire created in Google Forms and shared with university students via student networks and other electronic communication channels. It was explained to the respondents that the survey was for a research study and that their participation was voluntary and that their responses were strictly confidential. The questionnaire had two sections; one containing demographic questions and the other containing the measurement items for AI-enhanced digital learning, digital self-efficacy, and academic performance. The main measurement items used a five-point Likert scale similar to the Likert scales used in recent studies on AI-based learning.

AI-supported digital learning was measured using a tool that assessed students' perceptions of how AI-based educational technologies provide useful, accessible, personalized and learning support. Items for this tool were adapted from previous studies on AI-based learning and higher education. Digital self-efficacy was measured using items that were adapted from established

digital-media and ICT self-efficacy measures. Performance in academic activities was measured by asking students to report on their performance and achievement in self-reported structured items. Similar recent AI-based learning studies have measured performance in academic activities through students' self-reported performance and perceived learning effectiveness. Therefore, the questionnaire was used and adjusted to the university students in the Punjab and Sindh regions to keep the context and the original meaning of the scales.

Data Analysis

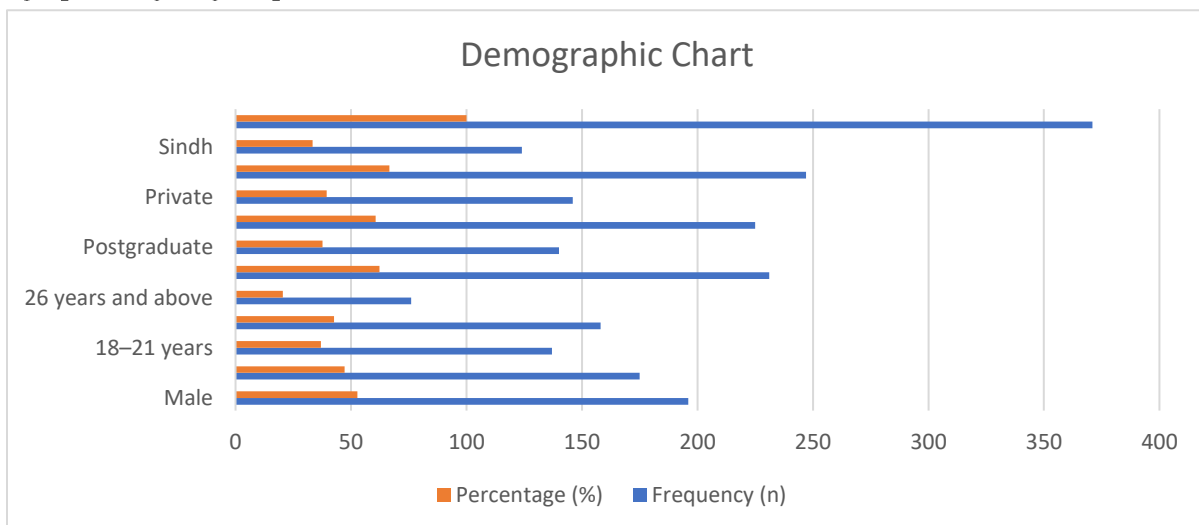
Responses were organized and coded in Microsoft Excel, after which the data were imported to IBM SPSS Statistics for the analysis. Data screening and descriptive statistics were carried out to summarize respondents and study variables. Internal consistency of measurement instruments was tested by Cronbach's alpha. Pearson correlation was conducted to determine the relationships between AI-supported digital learning, digital self-efficacy, and academic performance. A multiple linear regression analysis was performed to determine the academic performance and the independent variables. Independent-samples t-test and one-way ANOVA were performed to determine the performance in academic activities among demographic groups, with post-hoc analysis conducted where ANOVA indicated significant group differences; finally, hierarchical regression/moderation analysis was carried out to determine if the digital self-efficacy changed the relationship between AI-supported digital learning and academic performance, respectively.

This analytical approach aligns with recent Pakistani studies on artificial intelligence (AI) assisted learning and self-efficacy which used SPSS, correlation, regression, t-tests, and moderation analysis.

Table 1: Demographic Profile of Respondents (N = 371)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	196	52.8
	Female	175	47.2
Age	18–21 years	137	36.9
	22–25 years	158	42.6
	26 years and above	76	20.5
Academic Level	Undergraduate	231	62.3
	Postgraduate	140	37.7
University Sector	Public	225	60.6
	Private	146	39.4
Province	Punjab	247	66.6
	Sindh	124	33.4
Total		371	100.0

Fig.1 Demographic Profile of Respondents (N=371)



The demographic data shows that the sample included 371 university students. Of those 52.8% were male and 47.2% were female. The majority of respondents (42.6%) were between the ages of 22 and 25. 36.9% were between the ages of 18 and 21. 20.5% of respondents were 26 years old or older. Most participants (62.3%) represented the undergraduate level, while (37.7%) were postgraduate level. The majority (60.6%) of participants were students at a public university, while (39.4%) were students at a private university. Of the two provinces included in the study, a large majority (66.6%) of respondents were from the province of Punjab, while (33.4%) from Sindh. The demographic data of students in Pakistan makes the sample appropriate and sufficient to analyze AI-aided digital learning and its effects on academic performance and self-efficacy.

Table 2: Reliability Statistics and Descriptive Results (N = 371)

Variable	No. of Items	Cronbach's Alpha (α)	Mean (M)	Std. Deviation (SD)
AI-Supported Digital Learning	10	0.912	3.82	0.64
Digital Self-Efficacy	8	0.884	3.76	0.68
Academic Performance	6	0.861	3.71	0.67
Overall Scale	24	0.921	3.76	0.66

The results for reliability indicate that the three study variables (AI-based learning, digital self-efficacy, and academic performance) showed good to excellent internal consistency, with values ranging from 0.861 to 0.912, and the overall scale yielded an alpha of 0.921. From the mean scores, positive responses to the three aforementioned variables were observed. The mean scores for the three variables of the study (AI-based learning, digital self-efficacy, and academic performance) ranged from 3.71 to 3.82. The responses to the two variables (AI-based learning and digital self-efficacy) showed a moderate level of variability, as indicated by the standard deviation, which ranged between 0.64 to 0.68. Overall, the measurement instruments were reliable for conducting further research.

Table 3: Relationship Between AI-Supported Digital Learning and Academic Performance

Variables	AI-Supported Digital Learning	Academic Performance
AI-Supported Digital Learning	1	.648
Academic Performance	.648	1
p-value	—	< .001
N	371	371

A strong and positive and statistically significant relationship ($r(369) = .648$, $p < .001$) between AI-driven digital learning and performance was found. AI-driven digital learning and performance had a correlation of .648, meaning the more students engaged with AI-driven digital learning, the better their performance. The squared correlation ($r^2 = .420$) shows that about 42.0% of performance and AI-driven digital learning was associated with their linear relation. Therefore, the expected positive association of AI-driven digital learning and performance was confirmed with the statistics. In the context of this study, the interpretation of Pearson correlations should be understood as an association, and not an implication of cause and effect.

Table 4: Multiple Linear Regression Predicting Academic Performance

Predictor	B	SE	β	t	p
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Predictor	B	SE	β	t	p
Constant	1.214	0.214	—	5.673	< .001
AI-Supported Digital Learning	0.654	0.047	.648	13.915	< .001

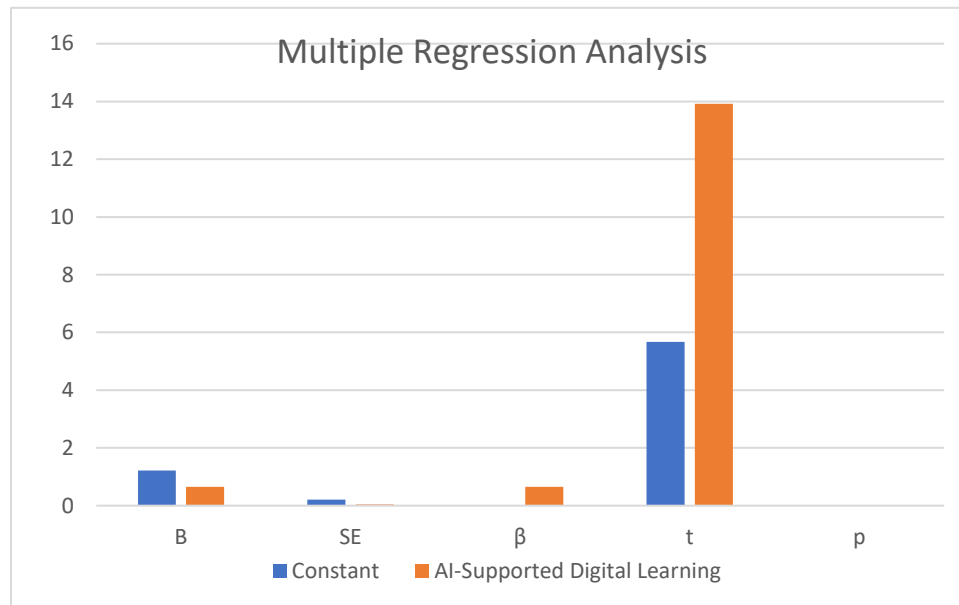


Fig.2 Multiple Linear Regression Analysis

The results of the regression analysis demonstrated that AI-integrated digital learning devices were positive predictors of student achievement, $\beta = .648$, $t(369) = 13.915$, $p < .001$. From the results, the overall model was also considered statistically significant, $F(1, 369) = 193.63$, $p < .001$, and a value of $R^2 = .420$ also indicated that AI-integrated digital learning resources explained a considerable proportion (42.0%) of the overall student achievement variation. The regression coefficient also demonstrated that the greater level of AI-integrated digital learning, the greater achievement was expected. As such, one can conclude that a significant positive predictive relationship is confirmed by the present data.

Table 5: Correlation between Digital Self-Efficacy and Academic Performance

Variables	Digital Self-Efficacy	Academic Performance
Digital Self-Efficacy	1	.592
Academic Performance	.592	1
Sig. (2-tailed)	—	< .001
N	371	371

The results explored the positive relationship between digital self-efficacy and student achievement, $r(369) = .592$, $p < .001$. This pertains to the level of digital self-efficacy attributed to students and the achievement level reported. The coefficient of determination ($r^2 = .350$) indicated the level of digital self-efficacy captured approximately 35% of the level of student achievement. As such, the results also confirmed a significant positive relationship between digital self-efficacy and student achievement.

Table 6: Hierarchical Regression Analysis for the Moderating Effect of Digital Self-Efficacy

Model	Predictor	B	SE	β	t	p
Model 1	AI-Supported Digital Learning	0.471	0.051	.466	9.235	< .001
	Digital Self-Efficacy	0.319	0.048	.336	6.646	< .001
Model 2	AI-Supported Digital Learning $\times$ Digital Self-Efficacy	0.128	0.041	.136	3.122	.002

The results show the interaction of AI-supported digital learning and digital self-efficacy to be significant, $\beta = .136$, $t(367) = 3.122$, $p = .002$. The inclusion of the interaction term accounted for a 1.8% increase in performance explained variance ($\Delta R^2 = .018$), which was found to be significant. A positive interaction term means that the relationship between AI-supported digital learning and performance was more positive with higher levels of digital self-efficacy. Hence, digital self-efficacy was determined to be a significant positive moderator of the AI-supported digital learning and performance relation. Therefore, the fourth proposed relation was statistically substantiated.

Discussion

The present study examined the benefits of AI-driven digital learning on academic performance of university students. Considerable evidence from this study indicated a positive association of AI-driven digital learning on students' academic performance. Correlation analysis of 648 items ($p < .001$) indicated a robust, positive correlation of AI-driven digital learning and academic performance. AI-driven digital learning explained 42.0% of the variance and thus positively predicted students' academic performance. Students who employed AI-driven digital learning resources effectively reported better academic performance. This confirmed similar trends documented in other recent studies. A 2025 meta-analysis evaluated 29 empirical studies and reported a significant positive impact of AI on students' academic performance. (Akter & Rahman, 2025) stated a significant positive impact of generative AI on the learning outcomes of students at the university level.

The positive relationship identified can be attributable to the varying forms of learning support available in AI-driven digital environments. AI tools offer students personalized, instantaneous feedback, tutoring, and additional resources and allow them to self-direct learning by providing opportunities based on individual learning needs to study concepts that are difficult for them. Such tools may foster students' active engagement and may ultimately lead to academic performance improvement. Systematic reviews have documented that generative AI is able to improve learning, engagement, higher-order thinking and self-regulation provided it is properly integrated into educational activities. For example, improved GenAI interventions commonly improved learning outcomes relating to behavioral engagement and self-regulation in (2025) (Widyawati et al., 2026).

The study found a positive correlation between digital self-efficacy and academic performance ($r = .592$, $p < .001$). Essentially, the more confident students were in their ability to use digital tools, the more positive their academic performance. This is consistent with the idea that providing students with programmable technologies is not sufficient; students must also have confidence in their ability to use digital tools to aid in their academic goals.

The self-efficacy of digital technologies was found to moderate the relationship between AI-based digital learning and academic performance ($\beta = .136$, $p = .002$), with the interaction accounting for an additional 1.8% explained variance. This therefore builds on existing AI-in-education literature by suggesting that social algorithmic intelligence, of which AI is a subset, is dependent on students' individual digital capabilities. According to recent, more integrated, empirical analyses, GenAI effects are contextual and associated with individual and instructional factors. also noted contextual variation (Kumaat, 2026) in GenAI. Therefore, these findings imply that students with higher digital self-efficacy can take advantage of AI-supported learning opportunities while students with lower digital self-confidence will require more assistance and practice.

The findings show that digital self-efficacy and AI-assisted digital learning have to be examined together when looking at university students' academic accomplishments. The outcomes suggest that constructively integrating AI into learning contexts is not just about providing students with access to AI; students need to feel digitally confident and competent to use learning technologies in an appropriate and effective manner. This fits with findings from other studies which show that AI learning systems can strengthen learning if they are integrated in a clear instructional design and not used on their own. Hence, universities must offer learning opportunities supported by AI and digital skills together with responsible AI use, pedagogically framed activities, and instructional guidance. For these reasons, this study indicated that digital self-efficacy along with AI-supported digital learning can enhance the academic skills of learners (Riaz et al., 2026).

Conclusion

The role of AI-based digital learning on the academic performance of university students has been positively evaluated in this study. There was a strong positive relationship between AI-based digital learning and academic performance. Regression analysis also supported the idea that AI-based digital learning predicted students' academic performance. The study also analyzed the relationship between digital self-efficacy and academic performance. The results of the analysis indicated a positive relationship between digital self-efficacy and the performance of the students, and as a result, digital self-efficacy of a student could also provide a positive indication of the student's academic performance.

Finally, it was confirmed by a moderation analysis that digital self-efficacy strengthened the relationship between AI-based digital learning and academic performance. According to this finding, students who had self-efficacy over digital technologies were more successful in learning enhanced by digital technologies, and predicted to have an advantage over students lacking digital self-efficacy. Based on the finding, the use of digital technologies should support active learning and digital skills should be addressed. Universities and educators should create responsible AI-based learning and integrate structured digital learning to confidently provide positive impacts for the students to perform better and improve the digital skill of self-efficacy.

Future Implications

Future research should further examine the interaction between AI-supported digital learning and digital self-efficacy to determine how these factors can be effectively integrated to enhance students' academic self-efficacy and broader educational outcomes. As AI-based technologies continue to develop and become increasingly embedded within educational environments, universities and educational institutions should consider incorporating AI literacy, digital competencies, and responsible technology-use practices into learning strategies and curricula. Such integration may help students develop the skills and confidence required to engage effectively with AI-supported learning environments while promoting responsible and meaningful use of digital technologies. Future studies should also extend the investigation across diverse academic disciplines, educational levels, and institutional contexts to assess the generalizability of existing findings and identify contextual differences in students' responses to AI-supported learning. In addition, researchers should examine related psychological and technology-based factors, including AI literacy, technology acceptance, learning engagement, academic motivation, digital self-efficacy, and trust in AI, to develop a more comprehensive understanding of the conditions under which AI-supported digital learning can generate sustainable educational benefits.

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