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Digital Literacy and Attitudes toward Artificial Intelligence as Predictors of Online Learning Preferences

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Abstract

This study aimed to examine how digital literacy and attitudes toward artificial intelligence (AI) predict undergraduate management students' online learning preferences at a public university in Thailand. Using a quantitative research design, data were collected from 177 participants through a structured questionnaire. The instruments included three scales measuring digital literacy, attitudes toward AI, and online learning preferences, each showing satisfactory reliability (α = .832-.866). Descriptive statistics, Pearson correlation, and multiple linear regression analyses were used. The results indicated that both digital literacy and attitudes toward AI significantly predicted online learning preferences (R^2 = .30, $p < .001$), with digital literacy serving as the stronger predictor (β = .423, $p < .001$). These findings suggest that students with stronger digital skills are better at adapting to and engaging in online learning. Simultaneously, positive attitudes toward AI also contribute to technology adoption. Although the model explained about 30% of the variance, it provides empirical evidence that incorporating digital and AI literacy is a crucial aspect of online learning readiness. Practically, the results suggest that universities should strengthen digital literacy by integrating embedded course modules and AI-awareness workshops. This study contributes to the global discourse on digital readiness and AI integration in higher education, offering insights for educators and policymakers seeking to enhance technology-mediated learning.

Keywords: Digital Literacy; Artificial Intelligence Attitudes; Online Learning Preferences; Higher Education

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Introduction

The rapid expansion of digital technologies has profoundly transformed higher education. Universities are now required to equip students not only with disciplinary knowledge but also with essential digital competencies that enable them to thrive in technology-rich learning environments. Digital literacy, broadly defined as the ability to effectively use, evaluate, and manage digital tools and information (UNESCO Institute for Statistics, 2021; Ng, 2012), has thus become a key skill for students' academic success and future employability. Research consistently shows that digital literacy extends beyond basic technical skills to include information literacy, communication, collaboration, content creation, and digital safety (Anderson et al., 2024; Kayyali, 2024). Additionally, recent findings suggest that digital literacy promotes adaptive learning and self-regulation, both of which are essential for achieving higher academic performance (Chen, 2025).

Concurrently, artificial intelligence (AI) has become a significant factor in the education sector. Increasingly, AI-based applications are integrated into teaching and learning to support personalization, efficiency, and student engagement. Students' attitudes toward AI play a central role in shaping how effectively these technologies are adopted and utilized. While prior studies indicated that students generally held positive attitudes toward AI and perceived clear benefits in academic contexts (Katsantonis & Katsantonis, 2024; Acosta-Enriquez et al., 2024; El-Shara'et al., 2025), concerns remained regarding credibility, ethical implications, and the potential for overreliance (Vaněček et al., 2024; Vieriu & Petrea, 2025). These findings suggested that attitudes toward AI are multidimensional, encompassing both opportunities and challenges in higher education.

Existing technology adoption models, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), emphasize that users' perceptions and attitudes directly shape their intention to adopt technology (Davis, 1989; Venkatesh et al., 2003). Similarly, Self-Determination Theory (Deci & Ryan, 2000) indicates that intrinsic motivation-fostered by competence and autonomy-boosts engagement in technology-mediated learning. Building on these theoretical frameworks, this study combines digital literacy (as a form of perceived competence) and attitudes toward AI (as a cognitive-affective orientation) to explain students' online learning preferences.

Alongside these technological advances, online learning has become more prominent, especially in response to the global COVID-19 pandemic. Online learning is widely regarded for its flexibility, accessibility, and cost-effectiveness (Gautam, 2022). However, students' preferences vary based on factors such as instructional design, content delivery, and learning needs. For instance, some students prefer short instructional videos for active pre-class learning, while others favor longer lectures for more profound understanding (Xu et al., 2022). Similarly, preferences for synchronous or asynchronous activities have been reported, highlighting the importance of diverse and engaging instructional strategies (Padohinog & Balsicas, 2023; Nurteti et al., 2024). These findings underscore that online learning outcomes are influenced not only by educational design but also by learners' skills and attitudes.

Despite extensive research on digital literacy, AI attitudes, and online learning individually, few studies have examined how these factors together influence students' online learning preferences. Prior findings indicated that digital literacy is a key factor in adaptability and readiness in online settings (Irpan et al., 2023; Liu et al., 2024; Vaszkun & Szakács, 2025; Alanoglu et al., 2025). Meanwhile, AI attitudes represent students' openness to technological change, which may further shape their learning preferences and engagement (Wang & Song, 2024; Vaněček et al., 2024). However, the combined impact of these two factors has not been empirically tested. To address this gap, the present study aims to explore how digital literacy and attitudes toward artificial intelligence predict students' online learning preferences.

While the study focuses on management students at a public university in Thailand, its findings add to the broader global discussion on digital readiness and AI integration in higher education. The study also recognizes the potential for self-report bias in survey research and highlights the need for future mixed-methods studies to confirm and expand these findings.

Research Objectives

1. To determine the levels of digital literacy, artificial intelligence attitudes, and online learning preferences among college students.

2. To investigate the influence of digital literacy and artificial intelligence attitudes on students' online learning preferences using multiple regression analysis.

Literature Reviews

Digital Literacy

Digital literacy is defined as the ability to use a broad range of digital technologies effectively for everyday purposes (UNESCO Institute for Statistics, 2021). This includes basic computer skills across all areas, as well as communication through online networks and applications. In higher education, digital literacy involves not just basic computer use but also technical and cognitive skills. According to the American Library Association, digitally literate individuals can operate a wide variety of digital tools and devices, including computers, mobile technologies, and apps. They can effectively search online, distinguish credible sources, create and engage with social media, protect personal info, avoid scams, and communicate in digital environments (Ng, 2012; Sun & Chen, 2016). Recent research emphasizes that digital literacy involves more than just the ability to use technology; it also includes critical thinking, adaptability, and self-regulation in digital learning environments (Ng, 2012; Chen, 2025). This aligns with the UNESCO Institute for Statistics (2021), which defines digital literacy as the ability to access, evaluate, and use digital information effectively across different contexts. By combining these views, digital literacy can be understood as both a technical skill set and a cognitive-behavioral competency essential for online learning.

A prior study on college students' digital literacy across five domains-information/data, communication/collaboration, digital content creation, digital safety, and technology agility-found significant skill improvements from pre- to post-college education. Findings showed that higher education level was positively correlated with digital proficiency, and interactive e-learning environments were especially effective in strengthening these skills (Anderson et al., 2024). Furthermore, another study has emphasized the significance of digital literacy in higher education for enhancing graduates' employment opportunities in today’s business environment. It highlighted that graduates must acquire advanced digital competencies beyond basic computer skills in order to enhance their prospects for future careers (Kayyali, 2024). These findings suggest that higher education must comprehensively develop digital literacy, including analytical, ethical, communicative, and cybersecurity skills. These interactive e-learning strategies can significantly enhance students' digital proficiencies.

Additionally, a recent study found a significant and positive correlation between digital literacy and students’ academic achievement. Both learning adaptation and online self-regulated

learning were found to mediate this relationship independently. Additionally, the study showed a step-by-step process in which digital literacy improved learning adaptation, which, in turn, supported self-regulated online learning, ultimately resulting in higher academic achievement. These findings emphasize that digital literacy is not only a key skill in higher education but also a catalyst for adaptive learning behaviors and effective self-regulation in digital settings (Chen, 2025).

The Technology Acceptance Model (TAM; Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003) propose that users' perceived competence and ease of use directly affect their willingness to adopt technologies. In this framework, digital literacy serves as a perceived competence that promotes positive technology adoption and engagement in online learning.

Artificial Intelligence Attitudes

Although AI offers valuable benefits across domains, its disadvantages are also considered to ensure proper use in education, social, and professional contexts. In light of these varying perspectives on AI usage, (Aktay et al., 2024) developed the Artificial Intelligence Attitude Scale to measure individuals' collective feelings, beliefs, and behavioral intentions toward AI technology. Attitudes toward AI indicate users' concerns and readiness to adopt, especially among college students, who shape future acceptance and use of AI in education and beyond.

Recent studies have shown that university students' attitudes toward AI and ChatGPT are mostly positive across cognitive, emotional, and behavioral domains (Katsantonis & Katsantonis, 2024; Acosta-Enriquez et al., 2024). Research shows that students have high awareness and positive attitudes toward AI in academic settings, with no significant differences by gender, level, or specialization. These results imply that widespread student acceptance and readiness provide a strong foundation for integrating AI applications in higher education (El-Shara' et al., 2025). An investigation into college students' use of AI tools in academics found that most were familiar with and frequently used them, and that these experiences were beneficial (Hermosura, 2025).

Theoretically, attitudes toward AI can be explained by the TAM and UTAUT models, which posit that perceived usefulness and positive emotions increase the likelihood of adopting intelligent systems (Davis, 1989; Venkatesh et al., 2003). Additionally, Self-Determination Theory (Deci & Ryan, 2000) suggests that intrinsic motivation-driven by competence and autonomy-

encourages engagement with innovative learning tools, such as AI applications. As a result, students with stronger digital skills and greater autonomy are more likely to hold positive attitudes toward AI-enabled learning technologies.

Online Learning Preferences

Online learning offers flexibility and accessibility, allowing students to learn at their own pace and from any location, at any time. This approach also helps lower costs related to travel and learning materials, making education more affordable (Gautam, 2022). Online learning preference is students' tendency to choose non-traditional study methods, such as online courses, outside the classroom. During COVID-19, it became popular due to social distancing. (Xu et al., 2022) studied students' preferences for online teaching videos. They found that a slight majority preferred short videos, especially for active learning before class. Meanwhile, a significant number still opted for longer videos, showing the diverse learning needs of the students. Similarly, (Padohinog & Balsicas, 2023) explored students' views on online learning. They noted that learners valued synchronous online lectures most, while moderately agreeing with other activities, such as asynchronous reading at their own pace. Their results highlight the need to include more interactive, innovative, and creative strategies in both synchronous and asynchronous learning to improve the overall online experience. Past research has also indicated that students' online learning preferences depend on the quality and quantity of materials, curriculum alignment, skills, and individual needs. These findings show that online learning has both advantages and disadvantages, with its effectiveness influenced by students' perceptions and contextual factors (Nurteti et al., 2024).

Previous research has also examined psychological and pedagogical factors influencing online learning preferences, such as self-efficacy, motivation, and teaching presence (Zimmerman, 2002; Sun & Chen, 2016). However, the combined impact of cognitive-technical (digital literacy) and affective (attitude toward AI) factors remains understudied. This study fills this gap by exploring how these factors interact to predict students' online learning preferences.

Digital Literacy and Online Learning Preferences

Various studies have explored the importance of digital literacy in online learning, offering diverse yet insightful findings (Irpan et al., 2023; Liu et al., 2024; Vaszkun & Szakács, 2025; Alanoglu et al., 2025). (Irpan et al., 2023) found no significant influence of digital literacy on

student outcomes. Conversely, (Vaszkun & Szakács, 2025) reported that digital literacy, alongside personal skills and learning habits, positively impacted online learning success. Similarly, (Liu et al., 2024) observed a positive link between digital literacy and satisfaction with online learning. More recently, (Alanoglu et al., 2025) demonstrated that digital literacy directly enhances online learning readiness, thereby fostering self-directed online learning. Collectively, these studies highlight digital literacy as a crucial factor in students' online learning experiences and their overall effectiveness.

AI Attitude and Online Learning Preferences

Wang & Song, (2024) developed an AI-driven portrait model that successfully categorized and predicted college students' online learning behaviors, providing a data foundation for personalizing and improving AI learning tools. (Vaněček et al., 2024) studied students' attitudes toward AI in higher education, finding widespread familiarity and use, with perceived benefits like efficiency and accessibility, but also concerns about credibility, reliance, and misuse. (Vieriu & Petrea, 2025) examined AI's impact on students' learning, noting benefits such as personalized learning, improved performance, and increased engagement, but also risks, including reduced critical thinking, privacy concerns, and cheating.

Overall, these studies suggest that AI can enhance higher education through personalization and efficiency, but its adoption requires safeguards to ensure ethical use and cognitive development. A structured framework and responsible implementation are crucial for maximizing the educational benefits of AI.

Prior research highlighted that digital literacy is a fundamental driver of students' adaptability, readiness, and effectiveness in online learning, though findings vary across contexts. At the same time, students' attitudes toward artificial intelligence are generally positive, supporting personalization and efficiency, yet concerns remain regarding ethics and overreliance. Together, these insights suggest that both digital literacy and attitudes toward AI may significantly influence students' online learning preferences and outcomes, warranting further empirical investigation. Thus, the proposition was that digital literacy and attitudes toward artificial intelligence both have a positive influence on students' online learning outcomes.

Although these findings improve understanding of each construct individually, few studies integrate them into a single framework. Using TAM (Davis, 1989), UTAUT (Venkatesh et al., 2003), and Self-Determination Theory (Deci & Ryan, 2000), this study views digital literacy as perceived

competence and attitude toward AI as emotional and cognitive factors influencing behavioral intention toward technology-enhanced learning. By linking these concepts, the research expands previous work and contributes to the ongoing global discussion on digital readiness and AI integration in higher education.

Aligned with these theoretical perspectives, the study hypothesizes that students with higher levels of digital literacy and more positive attitudes toward AI are more likely to show stronger preferences for online learning. Accordingly, two hypotheses were formulated.

H1a: Digital literacy positively influences students' online learning preferences.

H1b: Artificial intelligence attitudes positively influence students' online learning preferences.

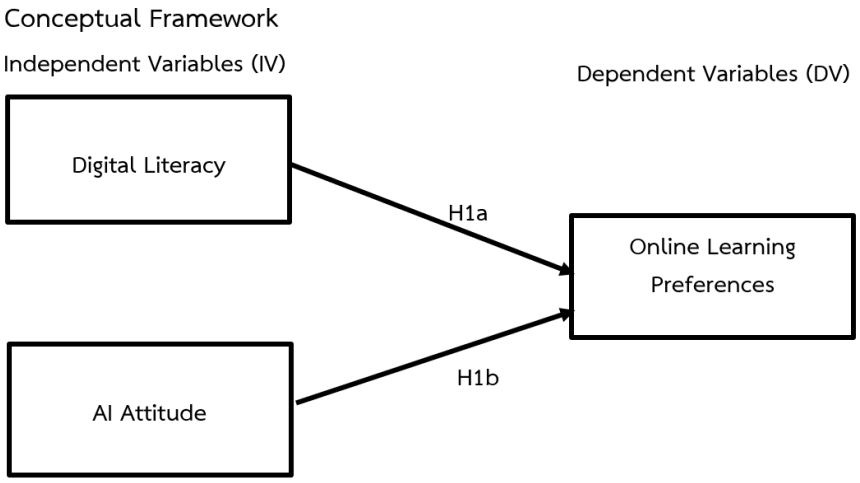

Figure1 Conceptual Framework
Source: Developed by the author

Methodology

This study employed a quantitative research design, using a questionnaire as the primary data collection instrument. The purpose was to investigate the influence of digital literacy and attitudes toward artificial intelligence on students' online learning preferences. The collected data were analyzed using appropriate statistical techniques to describe the characteristics of the population and sample, assess the reliability of the research instruments, and test the research hypotheses. As the data were collected through self-reported questionnaires, the study acknowledges the potential for social desirability and self-report bias. To mitigate this issue,

respondents were assured of their anonymity and encouraged to provide honest answers. The methodology encompassed the following key aspects:

Population and Samples

The study population included 333 undergraduate students majoring in management. The minimum required sample size was calculated using G*Power (version 3.1) for multiple linear regression with two predictors, with an f^2 of 0.0625 (considered a small effect). Although the calculated power was 0.70, slightly below the conventional threshold of 0.80 (Cohen, 1988), the final sample size of 177 was considered acceptable due to the exploratory nature of the study and resource limitations. The study ensured sufficient statistical power to detect the expected effects (Erdfelder et al., 1996). First-year students were excluded from the sampling frame because they had recently entered the program and lacked online learning experience. A simple random sampling method was used to ensure each student in the target population had an equal chance of being selected (Etikan & Bala, 2017). Since all participants were from a single university, the results should be interpreted within this institutional context. Caution should be exercised when generalizing beyond similar programs or institutions. Demographic data, including gender, year of study, and GPA, were collected to describe the sample and may serve as control variables in future replication studies.

Research Instruments

The research instrument used in this study was a structured questionnaire consisting of four parts, all of which employed a five-point Likert-type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Each part was adapted from previously validated instruments to fit the Thai higher-education context and the objectives of this study, as follows:

Part 1: General Information

This section collected data on gender, academic year, and GPA to characterize participants and serve as control variables where appropriate.

Part 2: Digital Literacy Scale

This part comprised 14 items adapted from the Digital Literacy Awareness Scale developed by (Promsri, 2019). The scale measured students' ability to access, evaluate, and use digital information effectively, covering five domains: information literacy, communication and collaboration, digital content creation, digital safety, and problem-solving competence.

Part 3: Artificial Intelligence Attitude Scale

This section consisted of 20 items adapted from the Artificial Intelligence Attitude Scale created by (Aktay et al., 2024). It assessed students' cognitive, affective, and behavioral attitudes toward AI applications in education, including perceived usefulness, trust, ethical concern, and intention to use AI-based tools in learning.

Part 4: Online Learning Preferences Scale

This part applied the Online Learning Preferences Scale, modified from the original version developed by (Demirel, 2022). It included 30 items rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) and covered preferences regarding learning modes (synchronous versus asynchronous), interaction, instructional design, and content delivery.

Before pilot testing, the questionnaire was evaluated for content validity by three experts in educational technology and measurement. The Index of Item–Objective Congruence (IOC) ranged from 0.67 to 1.00, indicating satisfactory content validity and item clarity (Rovinelli & Hambleton, 1977).

For the interpretation of mean scores, the following criteria, adapted from Best (1977), were applied:

1.00–1.50 = Very Low

1.51–2.50 = Low

2.51–3.50 = Moderate

3.51–4.50 = High

4.51–5.00 = Very High

This classification is widely used in educational research employing five-point Likert-type scales to ensure equal intervals across categories.

The reliability of each scale was evaluated using Cronbach's alpha. The coefficients were 0.866 for the Digital Literacy Scale (14 items), 0.846 for the Artificial Intelligence Attitude Scale (20 items), and 0.832 for the Online Learning Preferences Scale (30 items), indicating good to excellent internal consistency across all instruments (Nunnally & Bernstein, 1994) A pilot study with 30 undergraduate students outside the main sample confirmed these reliability levels (see Table 1).

The minimum required sample size was calculated using G*Power 3.1 for multiple regression with two predictors, assuming a small effect size ($f^2 = 0.0625$), as recommended

by Cohen (1988). Although the calculated power was 0.70-slightly below the usual threshold of 0.80-the sample size obtained (n = 177) was deemed sufficient for exploratory analysis in behavioral research (Tabachnick & Fidell, 2019).

Since all variables were gathered through self-reported questionnaires, precautions were taken to reduce potential social desirability bias. The survey was anonymous, and participants were assured that their responses would remain confidential and would be used only for academic purposes.

Table 1 Reliability Coefficients of the Research Instruments

Scale / Instrument	N of Items	Cronbach's Alpha	Interpretation
Digital Literacy	14	.866	Excellent
AI Attitude	20	.846	Good
OL Preference	30	.832	Good

Source: Developed by the author

Data Collection

Data were gathered from undergraduate students at a public university through an online questionnaire distributed via Google Forms. The survey link was shared with undergraduate management students through institutional email and official class communication channels. Participation was voluntary, and no incentives were offered. Respondents could withdraw at any time without facing any consequences.

Before participation, the researcher explained the study's objectives, scope, and confidentiality measures. Students were asked to give informed consent voluntarily, with the option to withdraw or stop participating at any time without negative consequences. The inclusion criteria required participants to be management students enrolled in the Faculty of Business Administration, in their second year or above, who agreed to participate and completed the entire questionnaire. Exclusion criteria included first-year students, those who declined consent, incomplete responses, skipped key items to the point that the questionnaire was unusable, and participants who withdrew partway through. Following this process, a total of 177 valid questionnaires were collected, which was enough for statistical analysis and satisfied research ethics requirements.

Prior to data collection, participants were furnished with an informed consent form outlining the study's aims, objectives, and procedures. They were advised that participation was voluntary, that they could withdraw at any point without penalty, and that no personal identifiers (such as names, student numbers, or contact details) would be collected. All responses were kept anonymous and confidential, with data stored securely in password-protected files accessible solely to the researcher.

The study involved minimal risk to participants and included no deception. It was reviewed and approved by the university's ethics committee to ensure adherence to both institutional and international ethical standards for human research. The research followed the ethical guidelines specified by the (British Educational Research Association, 2018) and the (American Psychological Association, 2020).

Data Analysis

The collected data were checked for completeness before analysis. Descriptive statistics (frequency, percentage, mean, and standard deviation) were used to summarize demographic information and overall levels of digital literacy, attitudes toward artificial intelligence, and online learning preferences. To test the research hypotheses, Pearson's correlation was employed to examine the relationships among the variables. At the same time, a multiple regression analysis was conducted to examine the effects of digital literacy and attitudes toward artificial intelligence on students' online learning preferences. Assumption checks for linearity, multicollinearity, normality, and homoscedasticity were performed following the guidelines of (Tabachnick & Fidell, 2019).

Results

The results of the present study are organized into three parts: first, the descriptive statistics of the study variables; second, the correlation analysis; and third, the multiple regression analysis.

Descriptive Statistics

To summarize respondents' characteristics and overall perceptions, descriptive statistics were calculated for each variable, including digital literacy, attitudes toward artificial intelligence (AI), and online learning preferences.

Table 2 Descriptive Statistics of the Sample by Gender, Age, Year of Study, and Cumulative GPA (n = 177)

Variable	Category	n	%
Gender	Male	61	34.5
	Female	116	65.5
Age	18–20 years	88	49.7
	21 years above	89	50.3
Year of Study	Second year	60	33.9
	Third year	72	40.7
	Fourth year	45	25.4
Cumulative GPA	2.00–2.49	40	22.6
	2.50–2.99	64	36.2
	3.00–3.49	53	29.9
	3.50–4.00	20	11.3
Total		**177**	**100.0**

Source: Developed by the author

Table 2 showed that the study sample consisted of 177 students. The majority were female (65.5%), while males accounted for 34.5%. In terms of age, the distribution was nearly balanced between students aged 18–20 years (49.7%) and those aged 21 years and above (50.3%). Regarding year of study, most respondents were in their third year (40.7%), followed by second-year students (33.9%), and fourth-year students (25.4%). For cumulative GPA, the most significant proportion of students reported a GPA in the range of 2.50–2.99 (36.2%), followed by 3.00–3.49 (29.9%), 2.00–2.49 (22.6%), and 3.50–4.00 (11.3%), respectively.

Table 3 Descriptive Statistics and Interpretation of the Study Variables (n = 177)

Variable	n	M	SD	Level
Digital Literacy	177	3.75	0.56	High
AI Attitude	177	3.60	0.52	High
Online Learning Preference	177	3.47	0.47	High

Source: Developed by the author

As shown in Table 3, digital literacy was reported at a high level (M = 3.75, SD = 0.56). Similarly, students' attitudes toward AI in academia were also rated highly (M = 3.60, SD = 0.52). Additionally, online learning preferences were high (M = 3.47, SD = 0.47).

Correlation Analysis

Pearson's correlation coefficients were calculated to explore the relationships among digital literacy, AI Attitude, and online learning preferences. The results offered initial evidence of the direction and strength of the associations between these variables.

Table 4 Pearson Correlation Coefficients Among Digital Literacy, Attitude toward Artificial Intelligence, and Online learning preferences (n = 177)

Variables	1	2	3
1. Digital Literacy	—		
2. AI Attitude	.523**	—	
3. Online learning preferences	.524**	.416**	

$p < 0.01$** (2-tailed)

Source: Developed by the author

Prior to conducting the regression analysis, Pearson correlation coefficients were calculated to examine the relationships among the study variables and to assess potential multicollinearity. As shown in Table 4, digital literacy was positively correlated with attitudes toward artificial intelligence ($r = 0.523$, $p < 0.001$) and online learning preferences ($r = 0.524$, $p < 0.001$). Similarly, attitude toward AI was significantly correlated with online learning preferences ($r = .416$, $p < .001$). All correlation coefficients were below .80, suggesting that multicollinearity among independent variables was unlikely to pose a problem (Tabachnick & Fidell, 2019).

Multiple Linear Regression Analysis

To examine how digital literacy and attitudes toward AI affect students' online learning preferences, a multiple linear regression analysis was conducted. Before conducting the analysis, the assumptions of normality, linearity, and multicollinearity were checked and confirmed to be met.

Table 5 Multiple Linear Regression Predicting Online learning preferences (n = 177)

Predictors	B	SE	β	t	p	Tolerance	VIF
(Constant)	1.482	0.237	—	6.252	<.001	—	—
Digital Literacy	0.359	0.063	0.423	5.692	<.001***	0.727	1.376
AI Attitude	0.178	0.068	0.195	2.625	<.009**	0.727	1.376
r = .550, R^2 = .303, Adjusted R^2 = .295, F(2, 174) = 37.765, p < .001, Std. Error of the Estimate = 0.39764, Durbin–Watson = 1.964							

p < .01 = **, p < .001 = ***

Source: Developed by the author

Following verification of acceptable correlations, the remaining assumptions of regression analysis were examined. The residuals demonstrated an approximate normal distribution, as evidenced by the histogram and Normal P–P plot, and the independence of errors was corroborated by the Durbin-Watson statistic (1.964). To assess multicollinearity, both Tolerance and Variance Inflation Factor (VIF) were evaluated. For both predictors, Tolerance was .727, and VIF was 1.376, indicating the absence of multicollinearity among the independent variables. As noted by (Tabachnick & Fidell, 2019), Tolerance values below .10 or VIF values exceeding 10 suggest multicollinearity concerns, whereas Hair et al. (2019) advocate for more conservative thresholds (VIF < 5, Tolerance > .20) within social science research. In summary, these findings confirm that the regression assumptions were adequately met.

Table 5 shows that the regression model was statistically significant ($F(2, 174) = 37.765$, $p < .001$), explaining approximately 30% of the variance in online learning preferences ($R^2 = 0.303$). Both predictors made significant contributions to the model. Digital literacy was the stronger predictor ($\beta = .423$, $t(174) = 5.69$, $p < .001$), followed by attitude toward AI ($\beta = .195$, $t(174) = 2.63$, $p = .009$). The regression equation can be expressed as: Online Learning Preference = 1.482 + 0.359(Digital Literacy) + 0.178(Attitude toward AI)

Therefore, Hypothesis H1a: “Digital literacy significantly predicts students’ online learning preferences” was supported. Likewise, Hypothesis H1b: “Artificial intelligence attitude significantly predicts students’ online learning preferences” was also supported.

The results indicate that students’ digital skills form a foundation for their confidence and independence when navigating online platforms, aligning with Self-Determination Theory

(Deci & Ryan, 2000). At the same time, students' positive attitudes toward AI continue to boost their openness and flexibility toward technology-mediated learning.

Although both predictors were significant, the higher standardized coefficient for digital literacy highlights its key role in predicting students' online learning preferences. This indicates that improving digital skills could offer more tangible benefits for online engagement than merely enhancing perceptions of AI.

Conclusion and Discussion

This study aimed to examine the impact of digital literacy and attitudes towards artificial intelligence (AI) on students' preferences for online learning. The findings provided important insights into how these factors are related in higher education.

The results showed that students reported high levels of digital literacy, positive attitudes toward AI, and a preference for online learning. This may be due to their increased exposure to digital tools and online platforms over the past few years, especially during and after the pandemic. The findings seem to align with previous studies indicating that higher education enhances digital skills (Anderson et al., 2024; Chen, 2025) and that students generally view AI favorably in academic settings (Katsantonis & Katsantonis, 2024; El-Shara' et al., 2025). Likewise, the strong preference for online learning aligns with earlier research highlighting students' appreciation for the flexibility and accessibility of online education (Xu et al., 2022; Padohinog & Balsicas, 2023).

The findings confirmed the research hypothesis by showing that both digital literacy and attitudes toward AI positively influenced students' online learning preferences. Digital literacy emerged as the stronger predictor, indicating that students with stronger digital skills were better able to adapt to and engage in online learning. This greater effect of digital literacy can be explained by Self-Determination Theory (Deci & Ryan, 2000), which posits that competence and autonomy enhance intrinsic motivation. Students with advanced digital skills are better prepared to self-regulate their learning and navigate online platforms confidently, leading to higher engagement.

This result aligned with previous research emphasizing digital literacy as a crucial factor in online learning readiness and effectiveness (Vaszkun & Szakács, 2025; Alanoglu et al., 2025). Attitudes toward AI also played a significant role, though to a lesser extent, consistent with

studies showing that students with positive perceptions of AI are more likely to adopt and benefit from technology-enhanced learning environments (Wang & Song, 2024; Vaněček et al., 2024). However, the small coefficient for AI attitude indicates that while positive perceptions foster openness to innovation, they may not lead to behavioral change without sufficient digital competence. Future research could examine whether self-efficacy or learning motivation mediates this relationship.

This study contributes by integrating digital literacy and attitudes toward AI into a single model, providing evidence that builds on existing research that examined these factors separately. This approach provides a foundation for future studies to explore causal mechanisms and changes in students' engagement with technology over time. By highlighting the interaction between skills and attitudes, the study improves understanding of how cognitive, emotional, and behavioral factors work together in technology-based learning. This creates a conceptual connection between motivation theories and technology-acceptance models, allowing researchers to better refine how readiness and trust in AI impact digital learning experiences.

Overall, this study confirmed that digital literacy and attitudes toward AI are significant predictors of students' online learning preferences. Students with higher digital literacy and more positive attitudes toward AI are more likely to prefer and engage actively in online learning environments. Universities should incorporate digital literacy into courses, hold AI-awareness workshops, and train faculty on ethical AI use. These efforts go beyond general advice, offering practical strategies to boost students' preparedness for tech-rich education. At the policy level, these findings justify integrating AI and digital literacy into national qualification frameworks to enhance the digital preparedness of higher education systems. For educators and administrators, the results highlight the significance of investing in both skill development and mindset cultivation to facilitate sustainable digital transformation.

These findings expand the existing literature by empirically examining the combined impact of digital literacy and AI attitudes, addressing a gap identified in previous studies that often examined these factors separately. Future research should increase the participant pool beyond a single discipline and use longitudinal or experimental designs to improve causal inference and generalizability. The current results highlight the importance of developing both digital skills and positive AI attitudes as essential components of online-learning success. Ultimately, the study demonstrates that digital competence and AI acceptance function as

strategic enablers for universities and policymakers aiming to foster inclusive, future-oriented online learning environments and ecosystems.

Recommendations and Implications

The findings of this study have important implications for educators, curriculum designers, and policymakers in higher education. These implications cover practical, policy, and theoretical areas, providing both immediate applications and guidance for future research.

Practical Implications

Curriculum Integration Universities should add digital literacy modules to undergraduate programs, especially in business and management courses. These include activities like information retrieval, online teamwork, data handling, and digital ethics. Embedding these skills enhances students' technical and critical-thinking abilities for online and tech-based learning.

AI Literacy and Ethics Workshops-Institutions should hold AI awareness and ethics workshops to help students evaluate AI tools, understand data privacy, and identify biases. These initiatives can boost students' confidence and promote responsible AI use.

Faculty Development-Faculty members are crucial in developing students'digital and AI literacy. They should receive ongoing training to ethically and effectively incorporate AI tools, such as adaptive quizzes, recommendation systems, and intelligent tutoring, into their teaching.

Infrastructure and Support Systems-Higher education institutions should expand e-learning helpdesks, digital resource centers, and peer mentoring programs, ensuring equitable access to digital resources to reduce disparities among students with different technological readiness.

Assessment Innovation-Universities should implement authentic assessments that evaluate digital problem-solving, collaboration, and creativity. These methods link learning outcomes with 21st-century skills, preparing students for future digital workplaces.

Policy Implications

Policymakers should recognize digital and AI literacy as essential graduate attributes within national qualification frameworks. Government agencies and educational authorities can support universities in developing interdisciplinary programs, AI ethics centers, and digital innovation hubs. Moreover, partnerships between academia, industry, and technology providers should be encouraged to foster AI-ready ecosystems, where students gain exposure to real-

world AI applications through internships, research collaborations, and project-based learning. Such initiatives are vital not only for enhancing graduate employability but also for boosting national competitiveness in the digital economy. By integrating AI literacy into higher education policies, governments can create a more equitable, future-ready workforce capable of adapting to rapid technological changes. These policy directions thus turn the study's empirical findings into practical strategies for sustainable digital transformation in education.

Theoretical Implications

The results enhance theoretical understanding by demonstrating how digital literacy functions as a competence-based component within Self-Determination Theory (Deci & Ryan, 2000). Students with stronger digital skills generally exhibit greater autonomy and motivation, resulting in greater engagement in online learning. Additionally, this research extends existing technology adoption models, such as TAM (Davis, 1989) and UTAUT (Venkatesh et al., 2003), by empirically integrating digital literacy and AI attitudes into a combined predictive framework. This approach provides a more comprehensive view of technology-mediated learning behaviors. Beyond expanding these models, the study clarifies the mechanism linking digital capability, motivational self-regulation, and AI acceptance, filling a gap in understanding how cognitive and emotional readiness influence learners' technology preferences. The findings thus help bridge motivational theories and technology acceptance frameworks, providing a conceptual foundation for future models of AI-supported learning.

Recommendations for Future Research

Future research should aim to replicate this model across diverse disciplines and institutional environments to evaluate its broader relevance. Using longitudinal or experimental methods helps identify causal relationships and monitor changes in students' digital and AI skills over time. Using mixed-methods approaches such as surveys, interviews, and analytics provides a fuller view of how digital literacy and AI attitudes affect online learning. Examining mediators like self-efficacy, motivation, and teaching presence clarifies how these factors influence students' engagement in online learning.

These recommendations aim to translate empirical insights into practical strategies that enhance digital skills and promote responsible AI use in higher education. Applying

these insights helps universities better prepare students for an AI-driven future and supports responsible participation in digital environments.

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