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Examining the Mediating Role of Artificial Intelligence Usage in the Relationship Between Digital Competencies and Academic Performance Among Higher Education Students

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Abstract

Higher education systems across the Arab world are accelerating digital transformation while generative AI tools are rapidly entering students' learning practices. This study examines how university students' digital competencies relate to academic achievement and whether artificial intelligence usage functions as a mediating mechanism, while also exploring whether these relationships vary across regional contexts. A quantitative, cross-sectional design was employed using an online questionnaire. Data were collected electronically from Arab undergraduate and graduate students across three regional clusters (Levant, Gulf, North Africa). Structural relationships were tested using PLS-SEM with multi-group analysis.The structural model supported all hypothesised relationships. Digital skills emerged as the primary driver, positively influencing both students' engagement with AI tools and their academic achievement. AI usage also contributed directly to academic achievement and operated as a partial mediator. Multi-group analysis showed that the overall pattern was consistent across the Levant, Gulf and North Africa; however, the strength of the relationship between digital skills and AI usage differed significantly by region, suggesting that contextual conditions shape how readily digital competence translates into AI engagement, while the remaining relationships were broadly stable. For educational leaders and policymakers, the findings highlight the need to strengthen students' digital competencies alongside structured AI literacy, and to address regional disparities through differentiated institutional supports, infrastructure investment, and pedagogical capacity-building that embed AI into learning ecosystems. The study contributes novel evidence from Arab higher education by testing AI usage as a mediator between digital competencies and academic achievement using a multidimensional achievement conceptualization and a multi-group comparative lens across distinct regional contexts.

1. Introduction

Strong academic performance in university students is essential for their personal educational achievement and serves as a significant measure of the educational system's efficacy and its impact on economic and social advancement at both national and global scales (Van Rooij et al., 2018). On a global scale, outstanding academic achievement is associated with multiple and extensive advantages. It opens wide doors to competitive and professional job opportunities, as institutions prefer university graduates with high academic performance for their analytical skills, discipline, and advanced cognitive abilities (Koçak et al., 2021).

Additionally, it is considered an essential qualification for obtaining prestigious scholarships for graduate studies, enabling students to continue their education at globally renowned institutions and develop their research and innovative expertise (Son & Cho, 2020). It also improves students' capacity to initiate successful entrepreneurial ventures, as specialized knowledge and management skills grounded in a robust academic foundation are significant draws for investors and business partners (Passaro et al., 2018). It directly enhances the state's human capital, positively impacting quality of life, innovation levels, and sustainable economic growth (Winters, 2011).

Nonetheless, despite these evident global benefits and the extraordinary circumstances of ongoing global conflicts, various issues arise that jeopardize academic success. Firstly, reports and studies indicate that conflicts adversely affect educational infrastructure, resulting in disruptions to academic pursuits and challenges in safely accessing educational institutions. Secondly, Arab universities encounter substantial challenges in maintaining educational quality and adapting to contemporary technological advancements, which impacts the student learning experience (Iriqat et al., 2025). Thirdly, a recent study indicates that university students encounter numerous academic challenges, particularly due to the transition to remote education systems resulting from ongoing conflicts in unstable and insecure regions. The academic issues garnered significant acknowledgment in the research, signifying a distinct and measurable effect on the educational process (Sleem & AL-Qassem, 2025). The accumulation of these issues serves as a primary impetus for this study, which seeks to comprehend the determinants of academic achievement and suggest potential solutions.

According to pertinent literature, academic achievement is affected by various factors, including motivation (Bakhtiarvand et al., 2011), emotional intelligence (Mohzan et al., 2013), self-regulation (Zheng et al., 2021), and digital skills (Ben Youssef et al., 2022; Gaete-Bravo, 2023). Literature reviews reveal a lack of research on the relation between digital skills and academic performance; therefore, the present study will focus on measuring that relationship. From a theoretical perspective, digital skills are considered to be connected to academic achievement through the human capital theory (Pagani et al., 2016). This theory posits that a person's skills and knowledge function as capital investments that enhance their productivity and improve their personal and professional outcomes (Winters, 2011). Digital skills, defined as a human capital that one can develop and invest in, are theorized to increase academic performance through several avenues: the capacity to access and analyze academic resources; to self-direct learning and adaptability in e-learning contexts; and to the use of technological tools (Schultz, 1961), which is critical in many educational areas.

The resulting investment is expected to benefit academic performance and educational efficiency by building digital skills and competitive competencies in education more generally. Research (Holm, 2025; Pagani et al., 2016) that I conducted correlated a significant relationship between digital skills and academic performance. It found that students who demonstrate technological proficiency are generally more adept at learning in the academic context, and students in technology-focused environments are even more successful. The research gap is obvious, as illustrated by human capital theory, quantitative studies, and the actual academic performance of students. Therefore, the research aims to validate the correlation between digital competencies and performance.

It is common knowledge that mediating and moderating variables help to explain the link between the independent and dependent variables (Baron & Kenny, 1986). Prior studies have employed other mediating variables, including adaptability to learning (Chen, 2025), self-efficacy (Ibrahim & Aldawsari, 2023), and involvement in learning (Aftab, 2022). This study utilized a mediator that has not been previously deployed in the referred literature, specifically the application of artificial intelligence tools. The researchers believe that this application is a major contribution to the study because, to the best of their knowledge, no other research has used it before.

Theoretically, digital skills might seem to be associated with academic success according to self-efficacy theory (González-Prida et al., 2024; Ibrahim & Aldawsari, 2023). In this model, the confidence in one's ability to learn new skills and activities is a key factor in successful academic performance. From such a worldview, digital tools are not only technical facilities or tools but also a source of psychological self-efficacy that makes the learner feel they can learn and assimilate themselves within the new educational environment. On the other hand, digital self-efficacy is a relationship between technical knowledge and confidence, and is one that enhances cognitive assurance. Empirical evidence indicates a positive relationship between digital skills and academic achievement that strengthens the evidence for the correlation of the two (Pagani et al., 2016; Rodríguez et al., 2024). Unified Theory of Acceptance and Use of Technology (UTAUT) theory, extending the Technology Acceptance Model (TAM) (Venkatesh et al., 2003) can help unpack the academic results of artificial intelligence features. According to this theory, the adoption and use of the new technology relies on the expected performance, ease of use, social influence, and institutional support, among other variables.

The study used the usage dimension as the basic building block to put into action the theory and verify the relationships among variables. So, several AI tools can help the technology to become part of educational cognition and the way students get engaged on their learning process through personalization, informed participation, and giving real-time assistance (Ayeni et al., 2024). The empirical data show a theoretical alignment between the use of artificial intelligence tools and academic success. Eltahir et al. (2024) indicate that the use of artificial intelligence tools in e-learning contexts influences students' academic performance positively. According to Oyeyemi et al. (2024), there is also evidence of positive correlation between the perceived influence of AI tools and academic performance. Cotton et al. (2025) noted the significance of learners' digital skills relating to use of AI systems. Similarly, poor digital skills also affect students' usage of artificial intelligence tools, the investigation finds.

The previous theoretical and empirical evidence suggests that the relationship between digital skills, artificial intelligence tools and academic achievement is one of the main areas of research, so it deserves deeper exploration. This will be discussed in the theoretical framework section of this paper and hypotheses formulated.

2. Conceptual Framework and Hypotheses Development

2.1 Digital Competencies

Digital skills are a set of skills for people, which help them use digital technologies. These skills encompass computer skills, information management, software and application integration, and communication through digital platforms (UNESCO, 2018). 21st century teaching needs these skills so that students can learn on their own, think critically, interact with others, and work together in digital teaching (Redecker & Punie, 2017). Moreover, developing these skills leads to better academic performance; preparing students for competencies that are more appropriate in a knowledge economy and technology-based workforce (Van Laar et al., 2017).

Digital skills have shifted over time from a tool to a cognitive and skills-based system, considered one of the core components of education today. The European Digital Competence Framework (DigComp) identifies five related areas of digital skills; that is the deliberate management of data and information; the ability to communicate and work with others in digital situations; the creation of digital material; the importance of privacy and secure digital practices; and the ability to navigate complex situations (Ferrari, 2012; Carretero et al., 2017). Some conceptual lenses through which we can view these skills may be based on human capital theory, which holds that knowledge and skills are investments for investment in skills which would lead to enhanced performance on the individual and institutional scale (Schultz, 1961; Winters, 2011). Higher digital skills provide students access to skills needed for learning, improve students' functional independence and provide better flexible digital and mixed-medium learning environments. Experimental evidence suggests that a positive correlation exists between these skills and academic success. They have also seen that students who are good at using technology do better in school and can better cope with a new education approach. As Pagani et al.)2016(, Rodríguez et al.)2024(and Holm)2025(all state, there's a direct and positive relation between people who have digital skills and those who use artificial intelligence (AI) tools. Thus, this study postulates the following hypothesis:

H_1: **A correlation exists between digital competencies and academic achievement of Arab undergraduates.**

2.2 The Mediating Role of Using AI Tools:

Artificial intelligence tools are applications and technological systems that use machine learning and deep learning algorithms to analyze data while creating output that allow for decision making or autonomously generate content. To this end, there should be research studies on the performance of these generative AI technologies and their application in education (Zawacki-Richter et al., 2019). This influence is neither linear nor

homogeneous but is moderated by the person's capacity in digital skills, which mediates the relation between digital capabilities and academic achievement (Cotton et al., 2024).

Recent literature identifies the concept of using artificial intelligence as a multidimensional mediating variable (Rodríguez et al., 2024). It consists of four dimensions namely: (1) awareness and understanding of AI tools and their academic capabilities, (2) intended reasons for using AI tools, (3) its intensity and frequency, and (4) its proficient use, underpinned by ethical and strategic understanding, in aiding learning objectives. Such an approach is consistent with Task-Technology Fit theory (Goodhue & Thompson, 1995), which claims that the effectiveness of technology depends on the degree to which it is appropriate to user skillset.

H_2: In Arab university students, digital competencies are positively associated with the use of artificial intelligence.

The present study aims to examine the immediate impact of the use of artificial intelligence tools on academic performance. To understand academic attainment in its modern forms, a complete understanding of education is needed–there should be no static performance metric like the Grade Point Average (GPA), particularly considering the unprecedented rate of digital progress in higher education (Ben Youssef et al., 2022; Vallerand et al., 2003). The current study employs an expansive view of academic success by considering attributes reflective of an educational depth or learning quality.

Based on Self-Determination Theory of Ryan and Deci (2000) and research on academic engagement (Fredricks et al., 2004), the first dimension is academic passion (Vallerand et al., 2003) and is illustrated as 'harmonious passion, a passionate process developed out of intrinsic motivation' versus 'obsessive passion, which involves more emotional and motivational content'. The second dimension, critical thinking, is the ability to analyse, evaluate and independently infer results from the knowledge (Facione, 1990; Alsaleh, 2020).

The third aspect is understanding and applying, which refers to the ability of the learner to gain deep concepts and to generalize and apply knowledge to a wide range of situations (Ben Youssef et al., 2022; Biggs & Tang, 2003). This broad view of academic performance is vital to determining the real-world impact of digital competencies and the use of AI in higher education. Artificial Intelligence can contribute to the process of instruction and information access (Luckin et al., 2016). The improper use of it or over dependence may lead to superficial learning, or even nonacademic behavior especially to the under-technologized digital native (Cotton et al., 2024; Obaje, 2025). The following presumptions are made in the study:

H_3: **The utilization of artificial intelligence affects the academic performance of Arab university students.**

2.2 The intermediary function of utilizing artificial intelligence tools

The swift progression of technology has rendered digital skills a crucial determinant of university students' success. The contemporary world necessitates proficient digital citizenship and the capacity to utilize technology for learning, analysis, and the inventive application of knowledge (Holm, 2025). The emergence of AI tools like ChatGPT and Gemini has rendered the study of their impact on academic attainment increasingly complex and essential. Numerous research indicate a correlation between digital abilities and academic achievement (Pagani et al., 2016). Nonetheless, there is a dearth of research that specifically examines this link within Arab contexts, particularly given the swift incorporation of artificial intelligence technologies in education.

The principal assertion of this study is that the correlation between digital competencies and academic performance is not merely a direct association, but is also shaped by students' interactions with artificial intelligence technologies. The viewpoint of Complex Adaptive Systems serves as an appropriate framework for comprehension, as educational settings are perceived as dynamic networks wherein students (as agents) engage with tools (such as artificial intelligence), yielding emergent outcomes (Eltahir et al., 2024).

Artificial intelligence presents itself as potential intermediary tool in the digital competency-academic success equation. AI technologies can accurately predict academic performance and facilitate further understanding of the factors influencing educational success (Cruz-Jesus et al., 2020; Adewale et al., 2024). It has been shown that these tools can enhance critical thinking and provide immediate feedback, which facilitates learning (Obaje, 2025). However, over-reliance and inadequate performance are real hazards for those who lack sufficient digital competencies (Karamuk, 2025). Hence, the researcher derives the following hypothesis from the study:

H_4: **Artificial intelligence usage mediates the relationship between digital competencies and academic performance among Arab university students.**

3. Methodology

The quantitative research has adopted, a suitable study method that would allow us to analyze the structural relationships between variables according to our proposed model, in order to provide for rapid data from the study population and test the mediating effect and extension across settings (Creswell & Creswell, 2017). For data analysis we will use the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique

because PLS-SEM is flexible, has predictive power and can be used in complex models with many mediating variables. It is the best option for exploratory work (Hair, 2014).

3.1 Population of study and Sample

Target population: Arab university undergraduate and graduate students. This region's focus acquires scientific distinctiveness owing to the diversity of social and economic situations, the disparate levels of technology infrastructure, and the rate of incorporating artificial intelligence tools into educational institutions. Palestinian universities are pivotal in this study, exemplifying distinct challenges associated with inadequate digital infrastructure and the urgent need to transition to digital learning environments, thereby offering a valuable context to examine the correlation between digital skills, artificial intelligence utilization, and academic performance under challenging circumstances. The sample framework comprised students from several geographical regions, including the Levant (Syria, Lebanon, Jordan, Palestine), the Gulf Cooperation Council (Saudi Arabia, UAE, Qatar), and North African nations (Egypt, Tunisia, Morocco). Due to the geographically dispersed nature of the target community, a non-probability sampling method was employed through a convenience-quota sampling strategy. This approach facilitates access to broad segments of students via electronic distribution platforms while maintaining representation by establishing quotas based on academic level (Bachelor's, Graduate) and year of study.

3.2 Study method

A standard computerized questionnaire was used as the main instrument for data collection in the study, based on scientifically validated and credible scales identified in previous studies. The questionnaire was organized in three main dimensions: digital skills (applied according to the components of the DigComp framework) (Vuorikari et al., 2022). In recent studies (Rodríguez et al., 2024), a number of parameters were adopted, including the use of artificial intelligence structured around four dimensions: awareness and exposure; purposes of use; intensity and frequency of use; and skillful use, using technology adoption studies as a reference (Davis, 1989; Goodhue & Thompson, 1995).

In addition, multidimensional academic achievement was evaluated through three sub-dimensions: academic passion utilizing the Vallerand Passion Scale (Vallerand et al., 2003), critical thinking as per Alsaleh (2020), as well as understanding and application based on concepts of deep learning and knowledge transfer (Ben Youssef et al., 2022; Rodríguez et al., 2024). In order for the instrument to be comprehensible for all participants, the questionnaire was translated into Arabic, followed by a meticulous review to assure the precision of the translation and its correspondence with the original principles.

The data collection methods consisted of developing a questionnaire on an electronic survey platform (Google Forms), and a survey link was distributed through various channels, including social media (such as WhatsApp and Facebook) commonly used by students, as well as within academic networks and through student representatives in targeted universities. Given the differences in the academic calendars of Arab universities, the survey period was between April 22, 2025, and July 4, 2025; this was a reasonable window to conduct the survey according to the wide variety of academic groups. The wide response range and suitability of the responses to assess the proposed conceptual model were then facilitated by this method.

5. Results and Discussion

5.1 Measurement Model

The measurement model was rigorously examined to ensure indicator reliability, internal consistency, and both convergent and discriminant validity, following the procedures recommended by Ajouz et al. (2020) and Hair et al. (2019). After excluding nine items that failed to meet the minimum factor loading threshold of 0.701 (Joseph et al., 2022), all remaining items demonstrated statistically significant loadings ranging between 0.726 and 0.935, confirming acceptable indicator reliability. These results provide strong evidence that the retained indicators adequately represent their underlying latent constructs, thus ensuring the robustness of the measurement structure.

Table 1
Assessment of the Measurement Model for the three Regions Source: Author's Own Creation based on Smart-PLS Results

Constructs	Region 1			Region 2			Region 3		
	CA	CR	AVE	CA	CR	AVE	CA	CR	AVE
DS	**0.880**	**0.913**	**0.677**	**0.848**	**0.892**	**0.623**	**0.736**	**0.825**	**0.500**
ITD	0.745	0.855	0.663	0.718	0.842	0.640	0.664	0.817	0.598
DC	0.655	0.853	0.743	0.634	0.844	0.731	0.624	0.841	0.726
DCC	0.774	0.869	0.689	0.767	0.865	0.682	0.682	0.823	0.609
DS	0.871	0.907	0.661	0.865	0.903	0.651	0.777	0.849	0.530
DPS	0.774	0.869	0.690	0.751	0.858	0.668	0.560	0.772	0.532
AIU	**0.876**	**0.914**	**0.727**	**0.863**	**0.905**	**0.705**	**0.749**	**0.814**	**0.528**
AE	0.762	0.864	0.679	0.772	0.869	0.689	0.702	0.834	0.628
PU	0.789	0.865	0.618	0.844	0.897	0.686	0.739	0.837	0.574
IF	0.838	0.893	0.676	0.837	0.892	0.675	0.735	0.833	0.561
SU	0.780	0.872	0.694	0.786	0.875	0.700	0.602	0.781	0.548
AC	**0.896**	**0.935**	**0.828**	**0.868**	**0.919**	**0.792**	**0.869**	**0.919**	**0.792**
AP	0.821	0.882	0.652	0.816	0.879	0.645	0.75	0.842	0.572
CT	0.889	0.918	0.692	0.851	0.894	0.628	0.849	0.892	0.624
UA	0.891	0.92	0.697	0.862	0.901	0.646	0.831	0.881	0.598

Note: The results for DS (Digital Skills), AIU (Artificial Intelligence Usage), and AC (Academic Achievement) are based on Higher Order Construct estimations.

The measurement model was rigorously examined to ensure indicator reliability, internal consistency, and both convergent and discriminant validity, following the procedures recommended by Ajouz et al. (2020) and Hair et al. (2019). After excluding nine items that failed to meet the minimum factor loading threshold of 0.701 (Joseph et al., 2022), all remaining items demonstrated statistically significant loadings ranging between 0.726 and 0.935, confirming acceptable indicator reliability. These results provide strong evidence that the retained indicators adequately represent their underlying latent constructs, thus ensuring the robustness of the measurement structure.

The reliability of the constructs was evaluated using Cronbach's alpha and composite reliability measures (Rho_a and Rho_c). As presented in Tables 1 and 2, Cronbach's alpha values across the three regional samples ranged from 0.655 to 0.913, consistently exceeding the recommended benchmark of 0.70. Similarly, composite reliability values across all constructs ranged from 0.817 to 0.935, further supporting the internal consistency of the measurement model. These results indicate that the items measuring each construct are highly interrelated, thus confirming the internal reliability of the measurement model. The consistency of reliability indicators across the three regions also underscores the robustness and generalizability of the model in different educational contexts.

Table 2
Assessment of the Measurement Model for the Overall Model Source: Author's Own Creation based on Smart-PLS Results

DS	Constructs	Cronbach's Alpha	Composite Reliability	AVE
	Digital Skills	**0.854**	**0.896**	**0.633**
ITD	Information Technology and Data	0.722	0.844	0.643
DC	Digital Communication	0.646	0.849	0.738
DCC	Digital Content Creation	0.763	0.864	0.679
DS	Digital Safety	0.858	0.898	0.639
DPS	Digital Problem Solving	0.752	0.858	0.669
AIU	**Artificial Intelligence Usage**	**0.862**	**0.905**	**0.704**
AE	Awareness & Exposure	0.767	0.866	0.684
PU	Purposes of Use	0.811	0.878	0.646
IF	Integration & Frequency	0.826	0.886	0.661
SU	Skillful Use	0.773	0.869	0.688
AC	**Academic Achievement**	**0.880**	**0.926**	**0.806**
AP	Academic Passion	0.808	0.874	0.636
CT	Critical Thinking	0.867	0.904	0.653
UA	Understanding and Application	0.869	0.906	0.658

Note: The results for DS (Digital Skills), AIU (Artificial Intelligence Usage), and AC (Academic Achievement) are based on Higher Order Construct estimations.

Convergent validity was assessed using the Average Variance Extracted (AVE). Across all regions, AVE values ranged from 0.500 to 0.868, while in the overall model, values ranged from 0.633 to 0.806. All AVE values surpassed the recommended threshold of 0.50, signifying that each latent construct explains more than half of the variance in its observed indicators. Constructs such as Academic Achievement (AC) and Artificial Intelligence Usage (AIU) exhibited particularly high AVE values (0.806 and 0.704, respectively), demonstrating strong convergence among their items. These findings confirm that the measurement indicators effectively capture the conceptual domain of their corresponding constructs, providing evidence of convergent validity across regions.

Discriminant validity was evaluated using the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio. As reported in Tables 3 and 4, the square roots of the AVE values (italicized diagonals) were consistently higher than the inter-construct correlations, thereby satisfying the Fornell–Larcker criterion. Furthermore, all HTMT values were below the conservative threshold of 0.85 (Henseler et al., 2015), confirming that the constructs are empirically distinct. At the higher-order level, Digital Skills (DS), Artificial Intelligence Usage (AIU), and Academic Achievement (AC) demonstrated satisfactory discriminant validity, with AVE square roots ranging from 0.698 to 0.890 and HTMT values remaining below 0.85. This confirms that while the constructs are theoretically related, they maintain empirical distinctiveness, thereby supporting the discriminant validity of the model.

Table 3
Discriminant Validity Based the First-Order Construct for the Overall Model Source: Author's Own Creation based on Smart-PLS Results

ITD	ITD	DC	DCC	DS	DPS	AE	PU	IF	SU	AP	CT	UA
	0.802	**0.802**	**0.607**	**0.728**	**0.734**	**0.584**	**0.454**	**0.338**	**0.659**	**0.621**	**0.636**	**0.639**
DC	0.551	**0.859**	0.692	0.738	0.836	0.633	0.547	0.429	0.680	0.622	0.636	0.624
DCC	0.450	0.484	**0.824**	0.547	0.725	0.668	0.495	0.447	0.593	0.441	0.553	0.549
DS	0.577	0.556	0.443	**0.799**	0.825	0.547	0.419	0.291	0.610	0.538	0.514	0.529
DPS	0.543	0.586	0.548	0.663	**0.818**	0.734	0.556	0.420	0.738	0.578	0.647	0.647
AE	0.432	0.440	0.510	0.440	0.553	**0.827**	0.758	0.655	0.783	0.480	0.599	0.626
PU	0.357	0.407	0.398	0.361	0.448	0.607	**0.804**	0.879	0.774	0.345	0.475	0.463
IF	0.257	0.315	0.353	0.243	0.333	0.523	0.718	**0.813**	0.725	0.309	0.411	0.397
SU	0.490	0.478	0.456	0.497	0.562	0.603	0.624	0.584	**0.829**	0.560	0.696	0.656
AP	0.478	0.456	0.345	0.454	0.456	0.377	0.288	0.246	0.445	**0.797**	0.814	0.799
CT	0.503	0.477	0.450	0.444	0.521	0.486	0.406	0.347	0.569	0.685	**0.808**	0.884
UA	0.506	0.468	0.448	0.458	0.522	0.509	0.397	0.334	0.537	0.674	0.769	**0.811**

Notes: Diagonal and italicized are the square roots of the AVE. Below the diagonal elements are the correlations between the construct's values. Above the diagonal elements are the Heterotrait–Monotrait ratio of correlations values.

A comparative analysis of the measurement model across the three regions reveals a high level of consistency in psychometric properties. Region 1 exhibited slightly higher reliability indices (average Cronbach's alpha = 0.821) compared to Regions 2 and 3, suggesting a marginally more stable measurement configuration in that context. Nonetheless, the overall pattern of reliability and validity indicators across regions remains robust, confirming the conceptual coherence of the constructs across different educational and socio-technological environments. This cross-regional consistency strengthens the external validity of the model and enhances its applicability in diverse educational contexts.

Table 4
Discriminant Validity for the Higher-Order Construct for the Overall Model Source: Author's Own Creation based on Smart-PLS Results

Digital Skills	DS	AIU	AC
	0.698	**0.492**	**0.617**
Artificial Intelligence Usage	0.437	**0.727**	0.436
Academic Achievement	0.506	0.443	**0.890**

Notes: Diagonal and italicized are the square roots of the AVE. Below the diagonal elements are the correlations between the construct's values. Above the diagonal elements are the Heterotrait–Monotrait ratio of correlations values.

Overall, the results confirm that the measurement model demonstrates strong indicator reliability, internal consistency, and both convergent and discriminant validity. The findings substantiate the robustness of the constructs measuring digital skills, artificial intelligence usage, and academic achievement, thereby providing a solid empirical foundation for subsequent structural equation modeling and hypothesis testing. The methodological rigor applied in validating the measurement model ensures that the relationships examined in later stages of analysis are built upon reliable and valid latent constructs. Consequently, the model provides a credible framework for understanding the complex interplay between digital competence, technology integration, and academic performance across varied educational contexts.

5.2 Structural Model

The results of the hypotheses testing are presented in Table 4, and all four hypotheses (H_1–H_4) were supported in the complete sample. Digital Skills had a strong and significant influence on Artificial Intelligence Usage (H1: $\beta = 0.645$, $t = 31.70$, $p < 0.001$), confirming that stronger digital competencies directly facilitate greater adoption of AI technologies in academic contexts. Digital Skills also exerted a significant effect on Academic Achievement (H_2: $\beta = 0.491$, $t = 14.91$, $p < 0.001$), underscoring their central role in enhancing students' educational performance. Artificial Intelligence Usage was likewise found to have a significant impact on Academic Achievement (H_3: $\beta = 0.252$, $t = 8.46$, $p < 0.001$), indicating that students who actively use AI tools achieve higher levels of academic success. Furthermore, the mediating role of Artificial Intelligence Usage in the relationship between Digital Skills and Academic Achievement was supported (H_4: $\beta = 0.163$, $t = 8.54$, $p < 0.001$), showing that AI not only contributes directly to achievement but also strengthens the influence of digital competencies on learning outcomes.

At the regional level, the results were largely consistent with the overall sample, with some differences in effect sizes. For H_1, the relationship between Digital Skills and Artificial Intelligence Usage was significant in all three regions, strongest in the Levant (β = 0.660, t = 18.43, p < 0.001) and Gulf (β = 0.659, t = 29.04, p < 0.001), and weaker in North Africa (β = 0.437, t = 5.50, p < 0.001). For H2, Digital Skills significantly influenced Academic Achievement in each region, with the highest effects in the Gulf (β = 0.509, t = 10.93, p < 0.001) and Levant (β = 0.482, t = 10.12, p < 0.001), and a smaller effect in North Africa (β = 0.386, t = 3.64, p < 0.001).

The effect of Artificial Intelligence Usage on Academic Achievement (H3) was also significant across regions, though its strength varied: Levant (β = 0.321, t = 6.75, p < 0.001), North Africa (β = 0.275, t = 2.96, p = 0.003), and Gulf (β = 0.208, t = 5.36, p < 0.001). Finally, the mediating role of Artificial Intelligence Usage (H4) was confirmed in all three regions, with the strongest effect observed in the Levant (β = 0.212, t = 7.14, p < 0.001), followed by the Gulf (β = 0.137, t = 5.13, p < 0.001), and North Africa (β = 0.120, t = 2.83, p = 0.005).

Taken together, the findings confirm the pivotal role of digital skills in shaping both artificial intelligence usage and academic achievement across the Arab world. Importantly, artificial intelligence usage functions not only as a direct contributor to student success but also as a mediating mechanism that amplifies the impact of digital competencies on achievement. These results highlight the need for educational leaders and policymakers to strengthen digital literacy and ai integration in higher education, while recognizing regional variations in effect strength that may call for context-specific strategies.

Table 4
PLS-SEM Results: Path Coefficients of the Adjusted Model Source: Author's Own Creation based on Smart-PLS Results

H_X	Relationship	Region 1			Region 2			Region 3			Overall		
		Std Beta	T-Value	P-Value	Std Beta	T-Value	P-Value	Std Beta	T-Value	P-Value	Std Beta	T-Value	P-Value
H1	DS -> AC	0.660	18.43	0.000*	0.659	29.04	0.000*	0.437	5.50	0.000*	0.645	31.70	0.000*
H2	DS -> AIU	0.482	10.12	0.000*	0.509	10.93	0.000*	0.386	3.64	0.000*	0.491	14.91	0.000*
H3	AIU -> AC	0.321	6.75	0.000*	0.208	5.36	0.000*	0.275	2.96	0.003*	0.252	8.46	0.000*
H4	DS -> AIU -> AC	0.212	7.14	0.000*	0.137	5.13	0.000*	0.120	2.83	0.005*	0.163	8.54	0.000*
Note: * Relationships are significant at P < 0.05													

Table 5
PLS-SEM Results: Multi-Group Analysis.

Source: Author's Own Creation based on Smart-PLS Results

H_X	Relationship	Difference (Region 1 - Region 2)	Difference (Region 1 - Region 3)	Difference (Region 2 - Region 3)	(Region 1 vs Region 2) P-Value	(Region 1 vs Region 3) P-Value	(Region 2 vs Region 3) P-Value
H1	DS -> AC	0.001	0.223	0.222	0.960	0.007*	0.003*
H2	DS -> AIU	-0.028	0.095	0.123	0.672	0.415	0.299
H3	AIU -> AC	0.115	0.047	-0.068	0.065	0.677	0.501
H5	DS -> AIU -> AC	0.076	0.092	0.016	0.060	0.083	0.743
Note: *The Differences are significant in the relationships between the three Regions (P < 0.05).							
Multi-Group Analysis							

In the final stage of the analysis, a multi-group analysis (MGA) was conducted to assess the potential differences in the structural path relationships among digital skills, artificial intelligence usage, and academic achievement across three regional clusters: region 1 the Levant region (Jordan, Syria, and Palestine), region 2 the Gulf and neighboring states (UAE, Iraq, Saudi Arabia, Bahrain, Yemen, and Oman), and region 3 North African countries (Egypt, Sudan, Algeria, Libya, and Tunisia). The aim was to explore how regional contexts may influence the strength and direction of these relationships. The results, presented in Table 5, reveal meaningful variations between the regions.

Most notably, the relationship between digital skills and artificial intelligence usage showed statistically significant differences between the Levant (region 1) and North Africa (region 3) (p = 0.007), as well as between the Gulf region (region 2) and North Africa (p = 0.003). These results suggest that the influence of digital skills on AI usage is substantially stronger in North African countries compared to both the Levant and Gulf regions. This may reflect different levels of digital education integration, access to infrastructure, or localized educational policies that shape how digital competencies translate into AI engagement.

Conversely, the direct relationship between digital skills and academic achievement did not differ significantly across the three regions ($p > 0.05$ for all comparisons), indicating that digital skills contribute to academic outcomes in a relatively uniform manner across the Arab world. The path from AI usage to academic achievement, however, showed a marginally significant difference between the Levant and Gulf regions ($p = 0.065$), suggesting that the role of AI tools in enhancing academic performance may vary slightly between these contexts, possibly due to differences in AI adoption, curricular emphasis, or institutional support.

Finally, the indirect effect of digital skills on academic Achievement through AI usage showed marginal significance between the Levant and both the Gulf ($p = 0.060$) and North African regions ($p = 0.083$), pointing to regional variation in the mediating role of AI. These findings underscore the importance of regional context when interpreting the digital transformation of education in the Arab world, particularly with regard to AI implementation and its intersection with digital competence.

5.3 Discussion

The Smart-PLS multi-group analysis shows that the relationship between digital skills and academic achievement differs significantly across regions, reinforcing earlier work on the context-sensitive nature of digital competence (Pagani et al., 2016; Holm, 2025). Region 3 recorded the strongest path coefficients between digital competence and academic performance, exceeding Regions 1 and 2. Significant differences appeared in several paths: digital communication to critical thinking (Region 1 vs. Region 3, $p = 0.028$; Region 2 vs. Region 3, $p = 0.016$), digital communication to understanding and application (Region 1 vs. Region 2, $p = 0.029$), and the overall digital skills construct to academic passion (Region 1 vs. Region 3, $p = 0.002$; Region 2 vs. Region 3, $p = 0.013$), critical thinking (Region 1 vs. Region 3, $p = 0.000$; Region 2 vs. Region 3, $p = 0.003$), and understanding and application (Region 1 vs. Region 3, $p = 0.030$; Region 2 vs. Region 3, $p = 0.036$). These results confirm that digital competence does not generate uniform academic benefits; its impact is shaped by regional conditions.

A central explanation for these discrepancies lies in digital communication, which emerged as the most influential component within the digital skills construct. This aligns with digital literacy frameworks that define communication and interaction as core higher-order competencies (Ferrari, 2013; Ilomaki et al., 2016). The pattern indicates that students in Region 3 use digital communication more productively than students in Regions 1 and 2. Their use appears interactive, knowledge-based, peer-reviewed, and integrated into learning processes, consistent with Luckin et al. (2016). By contrast, students in Regions 1 and 2 seem more likely to use digital communication for information exchange or social interaction rather than for structured learning, supporting Cotton et al. (2024), who warn against superficial or non-pedagogical uses of digital technology.

These findings have theoretical significance. They suggest that digital communication is an important process linking digital skills to academic performance, which is compatible with Task-Technology Fit Theory (Goodhue and Thompson, 1995). According to this theory, technology improves performance only when it matches task demands and user capabilities. In this study, digital communication supports academic outcomes only when embedded in a digital learning ecosystem. In regions where infrastructure is strong, institutional policies encourage technology use, and educators are competent in digital pedagogy, digital communication can become a pedagogical intervention that promotes cognitive engagement, critical thinking, and applied knowledge, as shown by Obaje (2025) and Ben Youssef et al. (2022). Region 3 illustrates this clearly. In less mature ecosystems, the same digital competencies may remain underused or misapplied, limiting their academic value and reflecting the concerns raised by Karamuk (2025).

The study expands the concept of digital competence from a fixed set of technical abilities to an interactional and context-dependent phenomenon, consistent with digital literacy perspectives (Ferrari, 2013; Ilomaki et al., 2016) and findings by Rodriguez et al. (2024). It strengthens the connection between digital competence and academic engagement by showing that digital communication is the mechanism through which technological skills are transformed into higher-order cognitive outcomes. In this sense, digital communication helps convert competence into academic passion, critical thinking, and understanding and application, supporting the work of Fredricks et al. (2004) and Vallerand et al. (2003).

The practical implications are important. Because the regions differ in how effectively digital skills translate into academic gains, universities should avoid one-size-fits-all digital education policies. Instead, institutions in less digitalized regions should prioritize strengthening infrastructure, expanding equitable access to digital technologies, and creating environments where digital communication is used pedagogically rather than casually. Teachers' professional development should also move beyond technical training toward pedagogical innovation. Educators need support in designing technology-rich learning experiences that engage students, stimulate critical thinking, and connect digital tools to instructional goals, an approach recommended by Zawacki-Richter et al. (2019). The effectiveness of digital competence depends not only on what students can do technically, but also on whether institutions and teachers help channel those abilities into meaningful academic practices.

Overall, the study concludes that the observed regional differences are systemic rather than incidental. They reflect differences in how digital learning ecosystems are structured, supported, and enacted, which can be interpreted through the Complex Adaptive Systems perspective advanced by Eltahir et al. (2024). The stronger outcomes in Region 3 demonstrate that digital readiness, teacher competence, and institutional integration work together to amplify the relationship between digital skills and academic achievement. Digital skills alone are therefore insufficient to improve academic performance unless they are activated within supportive pedagogical systems. For higher education institutions, this means that digital transformation should involve building pedagogically grounded ecosystems that enable students to apply digital capabilities

meaningfully. The study recommends that future research use longitudinal and comparative designs to track how these relationships evolve as institutions undergo digital transformation, thereby offering deeper understanding of how digital learning shapes academic progress over time.

6. Conclusion

This study shows that digital competencies are a key foundation of academic success in higher education, but their benefits are strongest when students use AI tools effectively within supportive institutional environments. Across the full sample, digital competencies strongly improve both AI usage and academic performance. AI usage also directly enhances performance and partly explains how digital competencies translate into better results. In practice, students gain most when they use AI for feedback, personalization, organizing knowledge, and higher-order inquiry, which support critical thinking, understanding, and application.

The findings also show that context shapes outcomes. Differences across the Levant, Gulf, and North Africa suggest that the same digital skills produce different academic benefits depending on infrastructure, teacher digital pedagogy, institutional policies, and student engagement norms. More developed digital learning ecosystems show stronger links between competencies, AI use, and performance, while weaker ecosystems limit these gains.

The study argues that universities should go beyond isolated skills training by improving access and infrastructure, building educator capacity for AI-informed teaching, creating ethical AI policies, and supporting students' metacognition and digital self-efficacy. Although limited by cross-sectional, self-reported data, the research highlights that academic improvement depends on combining digital competence with guided, ethical, and context-sensitive AI integration.

Declarations

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Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Clinical trial number

Not applicable.

Ethics approval and consent to participate

This study was performed in accordance with the Declaration of Helsinki and applicable institutional and national ethical regulations. The protocol was approved by the Research Ethics Committee of Palestine Ahliya University, Bethlehem, Palestine (Approval No. 1/4/P.A.U/2025, dated 21 April 2025). Data were collected through an anonymous online questionnaire, and no personal identifiers or sensitive personal data were collected.

Consent to participate

Informed consent was obtained from all individual participants included in the study. Before accessing the questionnaire, participants were informed of the purpose of the study, the voluntary and anonymous nature of participation, and their right to withdraw at any time. Consent was provided electronically, and only consenting participants proceeded to the survey.

Consent for publication

Not applicable. (The manuscript does not contain any individual person's identifiable data, images, or personal details).

Competing interests

The authors declare no competing interests.

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