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Enhancing quality education through digital literacy: Examining the mediating impact of student engagement among university students in Cambodia

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Abstract: This study investigates the role of digital literacy in enhancing quality education through the mediating effect of student engagement in Cambodian public universities. Amid growing digital integration in education, the research addresses a critical gap in understanding how digital competencies translate into improved academic experiences and outcomes. Drawing on a quantitative methodology, data were collected from 306 valid student responses across five public universities. The structural equation modeling (SmartPLS 3.0) was used to test four hypotheses linking digital literacy, student engagement, and quality education. The findings reveal that digital literacy significantly influences both student engagement ($\beta = 0.430$, $p = 0.001$) and perceived quality education ($\beta = 0.294$, $p = 0.001$). Additionally, student engagement has a direct positive effect on quality education ($\beta = 0.380$, $p = 0.001$). Mediation analysis further confirms that student engagement significantly mediates the relationship between digital literacy and quality education (indirect effect = 0.163, $p = 0.001$). The model explains 32.2% of the variance in quality education ($R^2 = 0.322$) and 18.2% in student engagement ($R^2 = 0.182$). The effect size (f^2) analysis revealed that student-engagement (0.172) had moderate influences on the quality education and digital literacy (0.103) had small influences on the quality education. These results underscore the strategic importance of fostering digital competencies and cultivating active student engagement to realize sustainable improvements in higher education. The study offers critical insights for policymakers and educational leaders to align digital transformation with pedagogical practices that promote inclusivity, academic excellence, and lifelong learning.

Keywords: *Cambodian universities, Digital literacy, Digital transformation, Educational quality, Student engagement.*

1. Introduction

The integration of technology has emerged as a transformative force in modern education, reshaping instructional practices and redefining the student learning experience. In Cambodian higher education, the adoption of Information and Communication Technology (ICT) has gained momentum, supported by significant investments from government bodies and institutional stakeholders. Despite growing efforts to modernize learning environments, the actual impact of technology integration on student engagement and educational outcomes remains unclear. This study investigates the mediating role of student engagement in the relationship between technology integration and quality education among university students in Cambodia. Recognizing student engagement as a multidimensional construct encompassing cognitive, emotional, and behavioral elements, the research explores how technology-enhanced learning environments influence students' motivation, participation, and skill development. Amid global educational transformations driven by the COVID-19 pandemic and broader socio-technological shifts, traditional pedagogical approaches have increasingly given way to digital innovations. However, the challenge lies in determining whether these digital tools genuinely foster

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meaningful and sustained student engagement or merely serve as transient distractions. This study synthesizes contemporary literature and empirical data to critically examine the role of ICT in advancing educational quality through student engagement. It further assesses the current state, benefits, and challenges of technology integration in Cambodian universities. Through this analysis, the study aims to provide practical insights for educators, policymakers, and institutional leaders seeking to enhance learning effectiveness. Ultimately, the research underscores the need to align technological adoption with strategies that cultivate student engagement, ensuring that digital transformation leads to deeper learning, improved academic performance, and more equitable access to quality education [1].

The rapid integration of digital technologies into educational settings has revolutionized how teaching and learning are conceptualized and delivered across the globe. Digital literacy has become a critical skill for both educators and students. Within higher education, digital literacy enables learners to navigate complex digital environments, fosters autonomous learning, and equips them for participation in the global knowledge economy. In Cambodian universities, the increasing adoption of digital tools has become central to educational reform efforts aimed at improving quality, accessibility, and student outcomes. Digital literacy is not merely about operating devices or using software; it encompasses cognitive and socio-emotional competencies that enable individuals to engage meaningfully with digital content. In the context of higher education, these skills empower students to take ownership of their learning, collaborate in virtual settings, and access a wealth of information resources beyond the traditional classroom. As Cambodia transitions into a more digitally connected society, the importance of fostering digital literacy among university students has been emphasized by national policies and development strategies. For instance, the Ministry of Education, Youth and Sport (MoEYS) has launched several initiatives under its ICT in Education Policy to promote digital inclusion and integrate technology into higher education systems. While infrastructure investment and technology adoption are necessary, they are insufficient on their own to guarantee improved educational outcomes. What remains unclear is how digital literacy translates into enhanced educational quality, particularly through its influence on student engagement.

Student engagement has been widely recognized as a critical mediating factor in the relationship between technology integration and academic success. Defined as the degree of attention, curiosity, and investment students exhibit in the learning process, engagement spans cognitive, emotional, and behavioral dimensions. When students are engaged, they are more likely to persist in their studies, achieve better academic results, and develop essential 21st-century skills. Digital literacy plays a foundational role in enabling this engagement by facilitating access to interactive learning environments, collaborative tools, and problem-solving resources [2, 3]. However, the Cambodian higher education landscape presents both opportunities and challenges in harnessing digital literacy for educational advancement. On one hand, efforts such as the rollout of cloud-based education management systems and the provision of digital devices to underserved students demonstrate governmental commitment to digital transformation. On the other hand, issues related to digital inequality, lack of trained personnel, and varying levels of student readiness pose substantial barriers. Furthermore, research into the mediating role of student engagement in Cambodian universities remains scarce. Despite global recognition of student engagement as a key driver of educational quality, few empirical studies have explored how it interacts with digital literacy to influence outcomes in the Cambodian context. Existing literature suggests that student engagement may serve as a vital conduit through which digital literacy impacts educational quality. Engagement not only reflects the internal motivation and active participation of students but also signifies the effectiveness of pedagogical strategies and institutional support systems. The introduction of digital tools can create rich, student-centered learning environments that nurture curiosity, collaboration, and critical thinking. Conversely, the mere presence of technology does not guarantee educational improvement. Without adequate digital skills, students risk becoming distracted, frustrated, or disengaged. This underscores the need to develop digital competencies alongside establishing supportive environments that promote active and meaningful student engagement.

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Within Cambodian universities, where educational reforms are underway but digital capacity remains uneven, understanding this dynamic becomes particularly important. Many students, especially those from rural or poor backgrounds, face obstacles in accessing or utilizing digital resources. Even with improved ICT infrastructure, variations in students' digital literacy levels could exacerbate educational inequalities unless accompanied by targeted engagement strategies. As such, the present study seeks to explore whether student engagement mediates the relationship between digital literacy and perceived educational quality among university students in Cambodia. The obstacles to digital integration in Cambodian universities highlight the importance of guaranteeing equal access as a key factor in enhancing the quality of education [4]. The significance of this inquiry lies in its potential to provide actionable insights for educational institutions, policymakers, and practitioners seeking to enhance learning outcomes through digital transformation. By examining how digital literacy translates into quality education via student engagement, the study addresses a critical gap in the Cambodian academic landscape. While many international studies support the notion that technology improves education through increased student participation and interactivity, the local context necessitates a more nuanced understanding. This study is structured around the following guiding research questions:

RQ1: To what extent does digital literacy influence the quality of education in Cambodian universities?

RQ2: How does digital literacy affect student-engagement in Cambodian universities?

RQ3: What is the relationship between student-engagement and the quality of education in Cambodian universities?

RQ4: Does student-engagement mediate the relationship between digital literacy and quality education in Cambodian universities?

The primary objective of this research is to investigate the influence of digital literacy on the quality of education in Cambodian universities, with a specific focus on the mediating role of student engagement. Additionally, the study intends to identify barriers and enabling factors within the Cambodian higher education context that affect digital engagement, providing practical insights for universities, educators, and policymakers in designing effective digital learning environments that promote equity, inclusivity, and academic excellence.

2. Literature Review

Digital literacy has emerged as a foundational pillar in the integration of technology within higher education systems, particularly as universities strive to enhance teaching effectiveness, student learning outcomes, and institutional efficiency. Far beyond basic computer skills, digital literacy encompasses the ability to critically access, evaluate, and utilize digital tools and content to support problem-solving, communication, and autonomous learning. In the Cambodian context, where national initiatives are promoting Information and Communication Technology for Education (ICT4E), digital literacy is increasingly viewed as a key enabler of effective technology integration within both academic and administrative functions. The purposeful application of digital tools—such as cloud computing platforms, virtual learning environments, and collaborative applications allows institutions to foster flexible, interactive, and student-centered educational experiences. Technology integration, when underpinned by strong digital literacy, facilitates meaningful engagement with curricular content and supports educators in transitioning from traditional, didactic instruction to more dynamic, blended, and personalized approaches. However, digital literacy must be cultivated systematically to ensure all students and faculty can navigate emerging technologies with confidence and competence. Effective integration also requires adaptability to new pedagogical models and platforms, highlighting the importance of institutional support and professional development. According to [1, 5] successful technology integration relies on the intentional alignment of digital tools with educational goals, which fosters critical thinking, creativity, and collaboration. Likewise, Mardiana [6] emphasizes that technology adaptability is essential for educators navigating shifts from face-to-face to online modalities.

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Thus, digital literacy is not only a technical requirement but a strategic necessity in building resilient, inclusive, and future-ready higher education systems.

The concept of quality education encompasses more than just access to schooling; it integrates a comprehensive set of elements that foster holistic human development and societal advancement. Defined through various lenses, quality education is increasingly recognized as a transformative force that not only equips individuals with foundational academic skills but also nurtures cognitive, emotional, social, and ethical capacities. According to the The World Bank [7] quality education is defined by its outcomes—emphasizing effective teaching, measurable learning, and the relevance of education to real-life contexts. This perspective views education as a catalyst for personal empowerment and economic development, grounded in student competencies that are applicable in a rapidly changing global environment. Complementing this view, the UNESCO Education for Sustainable Development (ESD) framework emphasizes the importance of quality education in fostering responsible citizenship and promoting sustainable development. It underscores the need for education systems to develop not only intellectual capabilities but also critical thinking, empathy, creativity, and environmental consciousness. Quality education, therefore, becomes instrumental in preparing learners to actively participate in society and to address global challenges such as inequality, climate change, and social cohesion. Both frameworks reinforce that quality education is multidimensional—encompassing content, pedagogy, equity, relevance, and lifelong learning. In this sense, the focus is not solely on academic excellence but on the formation of well-rounded individuals who are prepared for life, work, and active citizenship. Thus, quality education must be viewed as both a foundational right and a strategic tool for individual and collective well-being.

Student engagement is widely recognized as a critical determinant of academic success, retention, and meaningful learning in higher education. Broadly defined, it refers to the degree to which students are invested in and actively participate in their educational experiences. This construct encompasses three core dimensions: behavioral, emotional, and cognitive engagement. Behavioral engagement involves students' active participation in academic tasks and institutional activities, such as class attendance, completing assignments, and participating in extracurricular events. Emotional engagement reflects students' affective reactions to learning such as interest, belonging, and enthusiasm—while cognitive engagement refers to their intellectual investment, critical thinking, and willingness to exert effort to master complex concepts [8]. As higher education institutions evolve in response to digital transformation and student diversity, understanding and enhancing student engagement has become increasingly important. Engaged students tend to display greater motivation, resilience, and satisfaction with their educational journey, making engagement a key performance indicator for universities. According to Kahu, et al. [9], student engagement is not only shaped by individual motivation but also by institutional practices, including teaching quality, learning environments, and meaningful faculty-student interactions. These elements collectively influence students' learning outcomes and overall educational experiences. In a rapidly changing educational landscape, fostering deep and sustained student engagement requires a holistic approach that integrates academic, emotional, and technological supports. As such, student engagement serves not only as a measure of educational effectiveness but also as a strategic tool to promote inclusive, student-centered learning across diverse higher education contexts.

2.1. Digital Literacy knowledge and Skills on Education Quality

The integration of digital literacy and ICT competence into teacher education has become a critical factor in improving education quality and fostering 21st-century skills. In Cambodia, the Ministry of Education, Youth, and Sport [10] has taken proactive steps to advance digital literacy by implementing nationwide initiatives, such as equipping all Teacher Education Colleges with digital tools and providing comprehensive ICT training for teacher educators. This reflects a strategic effort to embed ICT into all levels of education to enhance teaching effectiveness, self-directed learning, and long-term educational efficiency [10]. Teacher attitudes toward ICT have been identified as a decisive factor in

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determining the successful integration of digital tools in the classroom. Studies show that when teachers possess both the competence and a positive disposition toward ICT, they are more likely to incorporate digital literacy into instructional practices and drive pedagogical innovation [11, 12]. Furthermore, digital literacy in teacher education encompasses not only basic operational skills but also the effective application of multimedia resources, collaborative tools, and digital assessments to support interactive and personalized learning. This holistic integration allows educators to cater to diverse learner needs while promoting engagement, creativity, and critical thinking. Teachers with strong ICT competence are better prepared to design technology-rich environments that align with current educational standards and workforce demands. Therefore, fostering digital literacy and positive attitudes toward ICT among educators is essential for achieving sustainable improvements in teaching quality and equipping students with skills essential for success in a digitally driven society. Drawing from the theoretical insights and empirical evidence presented, the following hypotheses are proposed:

H_1: Digital literacy has a positively significant influence on quality education in universities of Cambodia.

2.2. Digital Literacy knowledge and Skills on Student Engagement

Digital literacy has increasingly become a crucial determinant of student engagement and academic success in technology-integrated learning environments. As education systems globally embrace digital transformation, students' ability to effectively access, evaluate, and utilize digital resources plays a central role in shaping their learning experiences. Digital literacy extends beyond technical know-how to encompass critical thinking, ethical use, and adaptability in navigating digital platforms. Research suggests that students with higher digital literacy are more inclined to actively participate in learning activities, collaborate with peers, and engage meaningfully with course content [13]. This engagement is often manifested across cognitive, emotional, and behavioral domains—ranging from curiosity and motivation to persistence and peer interaction. In the context of Learning Management Systems (LMS), digital literacy enables students to manage their learning, track progress, and communicate effectively. However, engagement levels may vary based on students' familiarity and comfort with digital tools. [14] found that digital literacy not only enhances student engagement but also reduces transactional distance, fostering stronger interactions with instructors and peers. These digital competencies are especially vital during disruptions such as the COVID-19 pandemic, which underscored the need for autonomous learning and digital readiness. Therefore, promoting digital literacy among students is essential not only for navigating digital platforms but also for sustaining engagement and academic achievement in increasingly blended and online educational environments. Institutions must invest in digital skill development and equitable access to devices to ensure inclusive, engaging, and future-ready education for all learners. Building on the theoretical perspectives and empirical evidence reviewed, the following hypotheses are suggested:

H2: Digital literacy has a positively significant influence on student-engagement in universities of Cambodia.

2.3. Effect of Student Engagement and Education Quality

Extensive empirical research has consistently demonstrated the positive impact of technology integration on student engagement across diverse educational settings. A meta-analysis conducted by Nkomo, et al. [15] synthesized findings from multiple countries and educational levels, revealing a strong positive correlation between the use of digital tools and increased student participation, motivation, and engagement. Interactive platforms, multimedia resources, and collaborative technologies were found to significantly enhance learning experiences by fostering deeper involvement and sustained interest among students. The study also highlighted the importance of interactivity and access to information as key drivers of engagement, while noting that cultural and contextual factors influence how students perceive and respond to technology-enhanced learning environments. However, despite these encouraging findings, global literature tends to overlook specific regional contexts such as Cambodian higher education. This presents a critical gap, as the effectiveness of technology integration

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is not universal and requires adaptation to local educational cultures, infrastructure, and learner needs. [16] emphasized the challenges that accompany digital transformation in education, including unequal access to technology, varying levels of digital competence, and the potential for distraction. Their review called for equity-driven policies and faculty development initiatives to ensure that technological advancements support inclusive and meaningful engagement for all students. These findings underscore the need for context-sensitive strategies in implementing educational technology, particularly in under-researched settings like Cambodia, where maximizing the benefits of digital tools requires addressing infrastructural limitations and promoting pedagogical innovation through localized policy frameworks. Drawing upon the established theoretical framework and supported by relevant empirical evidence, this study formulates the following hypotheses:

H_{3}: Student-engagement has a positively significant influence on quality education in universities of Cambodia.

2.4. Student Engagement, Digital Literacy and Educational Quality

Digital literacy has become a cornerstone of educational advancement, particularly in developing countries where access to traditional learning resources is often limited. As digital technologies increasingly permeate education systems, the capacity of students and educators to navigate, evaluate, and apply digital tools is essential for meaningful engagement and improved learning outcomes. Studies have consistently shown that when students possess strong digital literacy skills, they are more likely to participate actively in learning, collaborate with peers, and engage in problem-solving tasks that go beyond rote memorization. For instance, Hani Jarrah [17] found that digital technology significantly enhanced distance learning outcomes when mediated by student engagement, underscoring the role of digital competencies in fostering academic success. In addition, the Campus-Class-Technology (CCT) theory highlights the critical interplay between digital infrastructure, classroom climate, and institutional facilities in shaping student engagement and performance [18, 19]. Within this framework, digital literacy is not viewed merely as a technical skill but as a strategic enabler of educational equity and student empowerment. When integrated effectively, technology enhances not only the cognitive dimension of learning but also students' emotional and behavioral engagement. In developing countries, where challenges such as the digital divide and limited access to ICT persist, promoting digital literacy is essential for inclusive education. It equips students with the skills necessary to access global knowledge networks and participate in digitally mediated learning environments. Ultimately, digital literacy serves as a vital link between educational quality and student engagement, with the potential to drive social development and economic resilience. Based on the established theoretical framework and corroborating empirical evidence, this study proposes the following hypotheses:*H_{4}: Student-engagement has a positively significant mediating influence on the relationship between digital literacy and quality education in universities of Cambodia.*

2.5. Hypotheses and Theoretical Framework

- H_{1}: Digital literacy has a positively significant influence on quality education in universities of Cambodia.
- H_{2}: Digital literacy has a positively significant influence on student-engagement in universities of Cambodia.
- H_{3}: Student-engagement has a positively significant influence on quality education in universities of Cambodia.
- H_{4}: Student-engagement has a positively significant mediating influence on the relationship between digital literacy and quality education in universities of Cambodia.

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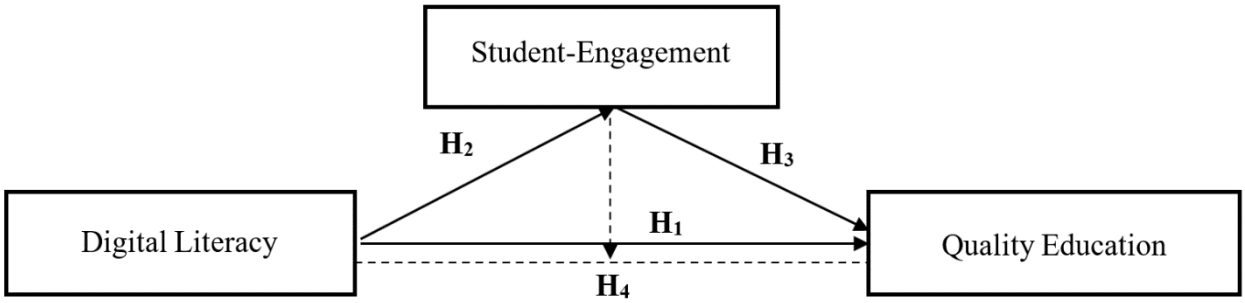

Figure 1.
Theoretical Framework.

3. Methodology

The research design can be defined as the framework that is appropriate for any given research, depending on its nature or the challenges it addresses. Davidavičienė [20] suggests that the research design should support and strengthen research activities, as well as show the framework of data collection and analysis to achieve the study's goal Azungah [21]. Moreover, Alvi [22] defined population as all individuals belonging to a specific group who meet the criteria set for a particular research study. Consequently, the present research focuses on students from five selected public universities in Cambodia. These public universities were chosen for this study for several key reasons. Furthermore, as highlighted by Additionally, Krejcie and Morgan [23] stated that the growing demand for research has driven efforts to develop a realistic approach for calculating the sample size required to accurately reflect the population under study.

Meanwhile, the questionnaire was meticulously developed using validated items corresponding to the study's key constructs. A pilot study was carried out to evaluate the instrument's internal consistency and reliability. The results revealed that Cronbach's alpha coefficients for the majority of the constructs ranged from 0.725 to 0.899, thereby exceeding the commonly accepted threshold of 0.70 Nunnally [24]. Following the pilot validation, hard copies of the finalized questionnaires were distributed to students at selected 5 public universities in Cambodia to ensure efficient and effective data collection. In total, 346 hard-copy questionnaires were distributed to students across selected public higher education institutions in Cambodia. This effort yielded 312 returned surveys, representing a response rate of approximately 90.1%. Upon screening the responses, 40 questionnaires were excluded due to substantial incomplete data. Consequently, 306 fully completed and valid questionnaires were retained for subsequent analysis. Thus, the overall response rate was 88.4%, which is considered acceptable for quantitative analysis.

The primary variables in the study were measured using a five-point Likert scale, with responses ranging from 1, indicating strong disagreement, to 5, indicating strong agreement. The questionnaire was divided into four sections. Items addressing digital literacy were designed to reflect the technological context, drawing on established frameworks.student engagment measures were adapted from previously validated scales, while quality education was assessed using multiple dimensions based on prior educational research.

SmartPLS software was utilized in the present study to evaluate the proposed research framework, as it is a widely adopted tool for quantitative data analysis. Specifically, SmartPLS facilitated the assessment of the structural model, enabling the examination of the model's predictive capacity and the relationships among the constructs [25]. In this study, SmartPLS 3.0 was employed to estimate both the measurement model (external model), which involved evaluating constructs' consistency and strength, and the structural model (internal model), which assessed the hypothesized relationships between latent variables.

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Table 1.
The demographic characteristics of the respondents.

Factors	Classification	Repetition	Proportion
Gender	Male	201	65.7
	Female	105	34.3
Age	Below 20yrs	65	21.2
	21-23yrs	194	63.4
	24-26yrs	42	13.7
	Above 26yrs	5	1.6
Institutions	Institute of Technology Cambodia	106	34.6
	Royal University of Phnom Penh	50	16.3
	Royal University of Agriculture	91	29.7
	National University of Battam Bang	44	14.4
	University of Heng Samrin Thboung Khmum	15	4.9
N		**306**	

4. Result

4.1. Measurement Model Evaluation

Table 2, the reliability and validity of the constructs were confirmed using Cronbach's alpha, composite reliability (CR), AVE, and discriminant validity, following [25]. All constructs demonstrated strong internal consistency (α and CR > 0.80) and convergent validity (AVE > 0.60). Items with loadings between 0.70 and 0.90 were r were kept in the model.

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Table 2.
Construct Reliability and Validity.

Construct	Items	Loadings	Cronbach Alpha	Composite Reliability	Average Variance Extracted
Degital Literacy	DIL1	0.870	0.894	0.922	0.704
	DIL2	0.865			
	DIL3	0.848			
	DIL4	0.781			
	DIL5	0.827			
Quality Education	QE1	0.829	0.956	0.962	0.717
	QE10	0.829			
	QE2	0.858			
	QE3	0.882			
	QE4	0.863			
	QE5	0.843			
	QE6	0.873			
	QE7	0.802			
	QE8	0.868			
	QE9	0.821			
Student Engagement	SE1	0.839	0.979	0.980	0.649
	SE10	0.791			
	SE11	0.794			
	SE12	0.769			
	SE13	0.837			
	SE14	0.809			
	SE15	0.842			
	SE16	0.888			
	SE18	0.799			
	SE19	0.784			
	SE2	0.822			
	SE20	0.765			
	SE21	0.817			
	SE22	0.729			
	SE23	0.746			
	SE24	0.819			
	SE25	0.807			
	SE26	0.827			
	SE27	0.768			
	SE28	0.779			
	SE3	0.797			
	SE4	0.874			
	SE5	0.899			
	SE6	0.725			
	SE7	0.780			
	SE8	0.805			
	SE9	0.803			

Table 3, discriminant validity was confirmed using the Fornell–Larcker criterion, ensuring that each construct is empirically distinct. The square root of the AVE for each construct Digital Literacy (0.839), Student-Engagement (0.805), and Quality Education (0.847) exceeded its correlations with other constructs, meeting the threshold proposed by (Fornell & Larcker, 1981). These results confirm the measurement model's discriminant validity and overall reliability [25].

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Table 3.
Latent Variable Correlations (Fornel-Larcker Criterion).

Constructs	DIL	QE	SE
Digital Literacy (DIL)	*0.839*		
Quality Education (QE)	0.453	*0.847*	
Student Engagement (SE)	0.426	0.502	*0.805*

Table 4, discriminant validity was further supported using the Heterotrait-Monotrait Ratio (HTMT), with all values below the 0.90 threshold [26] (0.017). Specifically, the values for DIL–QE (0.487), DIL–SE (0.451), and SE–QE (0.511) demonstrate a clear separation between the constructs, thereby confirming robust discriminant validity within the measurement model.

Table 4.
Discriminant Validity (Heterotrait-Monotrait Ratio - HTMT).

Constructs	DIL	QE	SE
Digital Literacy (DIL)			
Quality Education (QE)	*0.487*		
Student Engagement (SE)	*0.451*	*0.511*	

4.2. Structural Model Evaluation

After confirming the validity of the measurement model, the R^2 values were examined to determine how well the exogenous variables explain the endogenous constructs. Higher R^2 values reflect greater explanatory power. As noted by (Wynne W. Chin, 1998), The model involving Quality Education yielded an R-square of 0.322, indicating that 32.2% of the variance in the dependent variable is explained by this construct. The adjusted R-square value of 0.317 suggests a minimal reduction after accounting for the number of predictors, reflecting a stable and moderately strong model. The Student Engagement construct produced an R^2 value of 0.182, indicating that it accounts for 18.2% of the variance in the dependent variable. The adjusted R-square value (0.179) indicates that the model remains reliable even after controlling for potential overfitting in *Table 5*.

Table 5.
Coefficient of Determination (R Square).

Constructs	R-square	R-square adjusted
Quality Education	0.322	0.317
Student Engagement	0.182	0.179

Additionally, the f^2 effect sizes were computed to assess the impact of each exogenous variable on the R^2 values of the endogenous constructs, with [27] suggesting thresholds of 0.02 for small, 0.15 for medium, and 0.35 for large effects. The analysis reveals that Digital Literacy has a small effect size (0.103) on Quality Education, indicating that while it contributes to the model, its influence is limited. However, Student-Engagement demonstrates a moderate effect (0.172) on Quality Education, suggesting it plays a more substantial role in enhancing educational quality from the learner's perspective. In the second part of the analysis, Digital Literacy shows a moderate effect size (0.222) on Student-Engagement, implying that students with higher digital literacy skills are more likely to exhibit student-engagement behaviors such as independent learning, time management, and proactive participation in *Table 6*.

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Table 6.
Effect Sizes (f^2) Analaysis.

Quality Education	**Effect Size**	**Decisions**
Digital Literacy	0.103	Small
Student-Engagement	0.172	Moderate
Student-Engagement	**Effect Size**	**Decisions**
Digital Literacy	0.222	Moderate

Furthermore, Q^2 values were derived using the blindfolding procedure to evaluate the model's predictive relevance; values greater than zero suggest that the model has sufficient predictive accuracy [28]. The model's Q^2 value for Quality Education was 0.225, showing a moderate ability to predict this variable. This means the factors included in the model reasonably explain variations in how students perceive or experience quality education. For Student Engagement, the Q^2 value was 0.116, indicating a small predictive capability. Although lower than that of Quality Education, this value still exceeds the minimum threshold of 0.000, indicating that the model retains meaningful predictive power. However, the lower magnitude suggests that additional factors may need to be incorporated to enhance the model's predictive capability for engagement in *Table 7*.

Table 7.
Construct Cross Validated Redundancy (Q^2).

Constructs	**SSE**	**SSO**	**1-SSE/SSO**
Quality Education	3,060.000	2,370.431	0.225
Student Engagement	8,262.000	7,303.835	0.116

Note: SSO - Systematic Sources of Output; SSE - Systematic Sources of Error.

Table 8.
Goodness of Fit of The Model.

Item	**Saturated Model**	**Estimated Model**
SRMR	0.080	0.080
d_ULS	5.840	5.840
d_G	7.093	7.093
Chi-Square	7,998.354	7,998.354
NFI	0.577	0.577

The SRMR values for both the saturated and estimated models were 0.080, falling below the recommended threshold of 0.10. This indicates that the model used in the study demonstrates an acceptable level of fit [25]. An overview of the structural model indicators is presented in Table 8.

4.3. Hypothesis Testing

Table 9 shows for the first hypothesis (H1), which posited that digital literacy has a positively significant influence on quality education in universities of Cambodia, the results show a path coefficient of 0.294 with a standard error of 0.053. The corresponding t-value is 5.523, and the p-value is 0.000. This indicates a significant and positive relationship, confirming that students with higher digital literacy tend to perceive and experience higher levels of educational quality.

The second hypothesis (H2) proposed that digital literacy has a positively significant influence on student engagement. The analysis yielded a path coefficient of 0.430 and a standard error of 0.046, with a t-value of 9.363 and a p-value of 0.000. These results provide strong support for the hypothesis, suggesting that students with greater digital competencies are more likely to be actively engaged in academic activities and learning processes.

The third hypothesis (H3) examined the relationship between student engagement and quality education. The results indicate a path coefficient of 0.380 with a standard error of 0.053, a t-value of 7.126, and a p-value of 0.000. This statistically significant finding supports the notion that students who

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are more engaged tend to perceive their education as higher in quality, likely due to increased participation, interaction, and learning satisfaction.

Table 9.
Direct Effect Hypotheses Testing.

Hypothesis	*Coef.*	*Se*	*T value*	*P values*	*Decision*
Digital Literacy -> Quality Education	0.294	0.053	5.523	0.000	*Supported*
Digital Literacy -> Student Engagement	0.430	0.046	9.363	0.000	*Supported*
Student Engagement -> Quality Education	0.380	0.053	7.126	0.000	*Supported*

Note: Coef. = Coefficient; se = standard error.

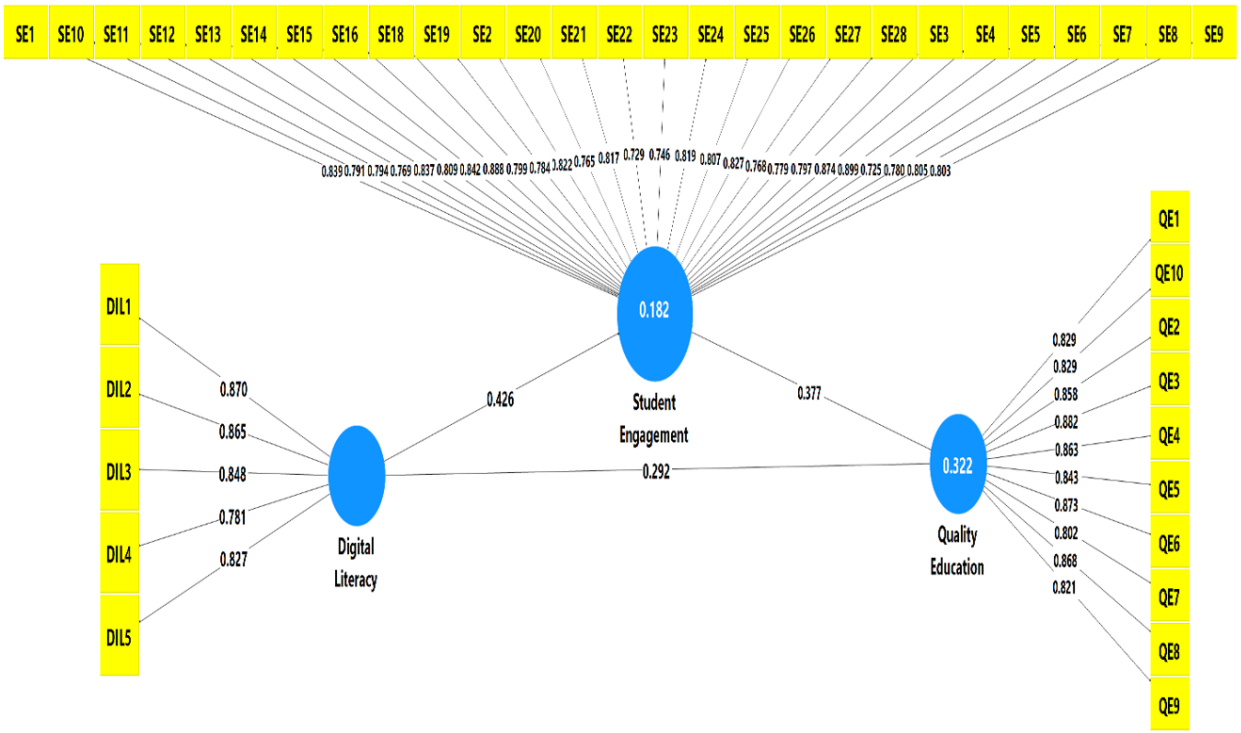

Figure 2.
Path Model Significant.

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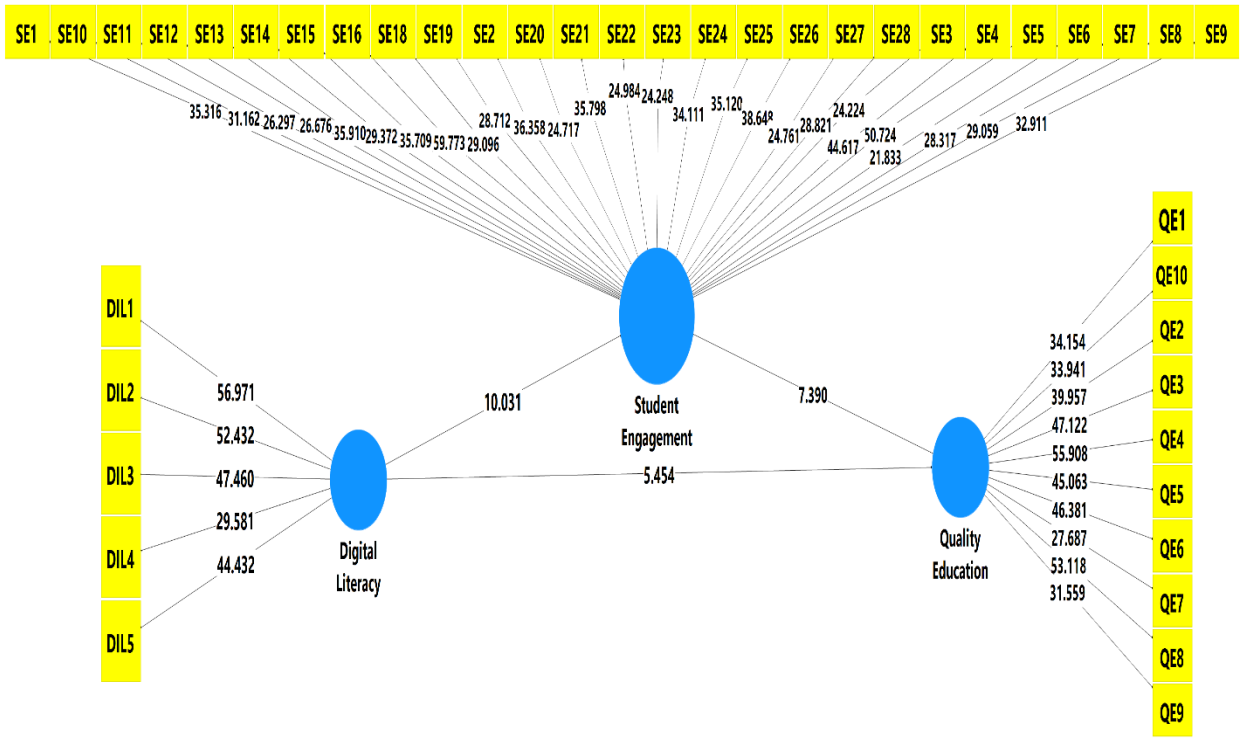

Figure 3.
Path Model Results of Mediation.

Table 10 shows mediation analysis showed that student engagement significantly mediates the relationship between digital literacy and quality education in Cambodian universities. The indirect effect was 0.163 and a standard error of 0.028, with a t-value of 5.666 and a p-value of 0.000. This confirms that digital literacy positively influences quality education through increased student engagement. Thus, Hypothesis 4 is supported.

Table 10.
Indirect Effect Hypotheses Testing.

Hypothesis	Coef.	Se	T value	P values	Decision
Digital Literacy -> Student Engagement -> Quality Education	0.163	0.028	5.666	0.000	Supported

Note: Coef. = Coefficient; se = standard error.

5. Discussion

This study examined the relationships between teaching methods, student engagement, and students' academic performance in Cambodian higher education. Using Partial Least Squares Structural Equation Modeling (PLS-SEM), all four hypotheses (H1–H4) were statistically supported, indicating both direct and indirect influences of teaching practices on academic outcomes.

The findings of this study provide strong evidence that digital literacy has a significant positive influence on quality education in universities of Cambodia, as indicated by the path coefficient of 0.294 (SE = 0.053, t = 5.523, p = 0.000). This result aligns with prior research emphasizing the crucial role of digital literacy in enhancing academic performance and educational quality. For instance, [29] demonstrated that digital literacy positively affects students' academic outcomes at the higher education level in Pakistan, suggesting that digital competencies are vital for navigating and leveraging educational technologies effectively. Similarly, [30] highlighted that digital literacy contributes significantly to realizing learning quality by enabling students and educators to utilize digital tools

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optimally within educational units. Moreover, [31] identified digital literacy as a strong predictor of favorable attitudes toward computer-supported education, which in turn fosters a more engaging and effective learning environment. Collectively, these studies corroborate the present findings and underscore the importance of developing digital literacy skills to improve the overall quality of education. In the context of Cambodian higher education, enhancing digital literacy can empower students to access diverse learning resources, participate actively in digital learning environments, and thus experience a higher standard of education.

The findings confirm that digital literacy has a strong and positive effect on student engagement indicated by the path coefficient of 0.430 (SE = 0.046, t = 9.363, p = 0.000). This supports previous research demonstrating that students with higher digital competencies are more actively involved in academic activities and learning processes. For example, Börekci and Çelik [32] highlight digital literacy as key to students' engagement with AI technologies, while McGuinness and Fulton [33] show how digital skills enhance participation in blended learning environments. Similarly, Kristanto, et al. [34] emphasizes that digital literacy facilitates knowledge acquisition in seamless learning contexts. These studies, together with the present results, underscore the critical role of digital literacy in fostering active and meaningful student engagement in higher education.

The results show a significant positive relationship between student engagement and quality education indicated by the path coefficient of 0.380 (SE = 0.053, t = 7.126, p = 0.000), confirming that higher levels of engagement are associated with improved perceptions of educational quality. This aligns with prior research emphasizing that engaged students experience greater satisfaction, participation, and interaction, which contribute to their overall educational experience. For example, Tahir and Fatima. [35] highlight how student engagement positively influences the quality of higher education, while Thornberg, et al. [36] emphasize the importance of teacher–student relationships in fostering engagement and academic success. Similarly, Xia, et al. [37] found that engagement significantly impacts student satisfaction in medical education. Together, these studies support the current findings and underscore the critical role of student engagement in enhancing educational quality.

The mediation analysis reveals that student engagement significantly mediates the relationship between digital literacy and quality education in Cambodian universities, indicated by the path coefficient of 0.163 (SE = 0.028, t = 5.666, p = 0.000). This finding supports the idea that digital literacy enhances quality education primarily by increasing student engagement. Consistent with this, Huang [38] highlights student engagement as a key mediator between teaching quality and academic performance, while Widowati, et al. [39] emphasize the combined role of digital literacy and engagement in improving student outcomes. These results underscore the importance of fostering digital skills to boost engagement, which in turn enhances educational quality.

6. Conclusion

The study demonstrates that the measurement model is reliable and valid, with strong internal consistency, convergent validity, and discriminant validity across all constructs. The structural model shows that digital literacy and student-engagement significantly explain the variance in quality education, with student-engagement having a stronger effect. Predictive relevance values indicate the model moderately predicts quality education and student engagement outcomes. Overall, the model fits the data well, confirming the robustness of the relationships between digital literacy, student-engagement, and quality education in Cambodian universities.

This study confirms that digital literacy plays a crucial role in enhancing quality education in Cambodian universities. Digital literacy positively influences both quality education (H1) and student engagement (H2), while student engagement itself significantly impacts quality education (H3). Moreover, student engagement mediates the relationship between digital literacy and quality education (H4), highlighting its vital role as a pathway through which digital skills translate into better

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educational outcomes. These findings emphasize the need for higher education institutions to prioritize digital literacy development and foster student engagement to improve overall educational quality.

This study has some limitations. First, the sample was limited to universities in Cambodia, which may affect the generalizability of the findings to other contexts. Second, the cross-sectional design limits the ability to draw causal inferences. Future research could employ longitudinal or experimental designs to better establish causality. Additionally, exploring other potential mediators or moderators, such as teaching quality or technological infrastructure, would provide a more comprehensive understanding of the relationships studied. Expanding the study to different countries and educational levels would also enhance the applicability of the results.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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