Modeling the Influence of Digital Literacy and ICT Competency on Perceived Educational Quality in Cambodian Public Universities: A Structural Equation Modeling Approach

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ABSTRACT

This study investigates the influence of digital literacy and ICT competency on perceived educational quality in Cambodian public universities using a structural equation modeling (SEM) approach. A quantitative research design was employed, with data collected through 306 valid survey responses from students across five public universities. Measurement and structural models were assessed using SmartPLS 3.0, confirming strong reliability, validity, and model fit. The findings reveal that both digital literacy and ICT competency have significant positive effects on educational quality, with digital literacy exerting a stronger impact. Specifically, digital literacy demonstrated a moderate effect size ($f^2 = 0.239$), while ICT competency showed a smaller yet meaningful effect ($f^2 = 0.079$). Together, the predictors explained 26.4% of the variance in perceived educational quality. These results underscore the importance of prioritizing digital literacy development alongside ICT competency to enhance student engagement, teaching effectiveness, and overall educational outcomes. The study contributes empirical evidence from the Cambodian higher education context and offers practical insights for policymakers and university leaders to strengthen digital integration strategies. Limitations include the study's focus on selected universities and its cross-sectional design; future research should adopt longitudinal approaches and broader samples to capture long-term impacts.

Keywords: Technology Integration, Digital Literacy, ICT Competency, Digital Infrastructure, Cambodian Universities

INTRODUCTION

Technology integration has become a catalyst for innovation and efficiency in higher education, offering new pathways to enhance teaching, learning, and institutional development. As universities worldwide transition from traditional pedagogies to digitally enriched environments, digital literacy and ICT competency have emerged as critical foundations for achieving quality education. These competencies empower students and educators to effectively engage with digital platforms, fostering interactive, student-centered learning experiences. In the Cambodian context, while considerable investments have been made to support ICT adoption, disparities in digital skills and infrastructure continue to challenge consistent educational improvement. The shift toward technology-driven instruction demands not only access to digital tools but also the ability to critically navigate, apply, and adapt them within evolving academic settings. This study aims to explore how digital literacy and ICT competency influence education quality in Cambodian universities, with particular attention to student engagement, skill development, and pedagogical transformation. The findings are expected to inform more inclusive and sustainable strategies for enhancing educational outcomes through technology.

The integration of digital technologies into higher education has fundamentally reshaped pedagogical practices, positioning digital literacy and ICT competency as essential drivers of quality education. In university settings, these competencies go beyond technical proficiency, encompassing the critical ability to access, evaluate, and apply digital tools for communication, problem-solving, and independent learning.

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Globally, digital platforms such as learning management systems, video conferencing tools, and online collaborative spaces have transformed the learning environment, enabling more interactive and student-centered approaches. In Cambodia, significant strides have been made through national policies aimed at advancing digital infrastructure and equipping institutions with ICT resources. However, gaps persist in the practical implementation of these tools, particularly in terms of user readiness and effective pedagogical integration. Despite the increased availability of technology, the impact of digital tools on student outcomes remains contested. While studies have linked ICT integration to enhanced critical thinking and engagement (Chhom & Kep, 2022; Jing & Abbas Ali, 2024),others caution against overreliance, citing challenges such as digital distraction and reduced interpersonal interaction (A Erkan, 2019). These contradictory findings underscore the importance of contextualized, evidence-based approaches in measuring the educational value of technology. Crucially, digital literacy and ICT competence among educators and students serve as mediating factors in determining whether technology acts as a facilitator or barrier to learning. For Cambodian universities, building digital capabilities must be accompanied by pedagogical innovation and student-centered practices. This study investigates the role of ICT competency and digital literacy in shaping education quality, focusing on student engagement as a potential mediating mechanism within the Cambodian higher education context.

LITERATURE REVIEW

Digital literacy is a vital element in the effective integration of technology within higher education, supporting improvements in teaching quality, student performance, and institutional efficiency. In Cambodia, national Information and Communication Technology for Education (ICT4E) initiatives emphasize digital literacy as essential for embedding technology in academic and administrative processes. Those hindering digital integration in Cambodian universities, where inclusive access and support are essential for quality education (SU & Ali, 2024). More than basic computer skills, digital literacy entails the ability to critically engage with digital tools for communication, problem-solving, and independent learning. Purposeful use of platforms such as cloud services and virtual learning environments fosters interactive, flexible, and student-centered education. However, developing digital literacy requires sustained institutional support, continuous training, and adaptability to evolving pedagogical practices. Educators with strong digital literacy can move beyond traditional instruction toward innovative, blended approaches that enhance student engagement and learning outcomes. As highlighted by (Iwadi et al., 2024; Khlaif et al., 2022; S Mardiana, 2020)aligning digital tools with educational goals and embracing technological change are critical for building resilient and future-ready higher education systems. Integrating digital literacy and ICT competence into teacher education has become a key driver in enhancing educational quality and nurturing essential 21st-century skills. In Cambodia, the Ministry of Education, Youth, and Sport (MoEYS) has initiated comprehensive efforts to promote digital literacy, including equipping all Teacher Education Colleges with technological resources and offering extensive ICT training for teacher educators. These initiatives represent a strategic commitment to embedding ICT across the educational system to improve instructional effectiveness, foster autonomous learning, and support long-term educational development (MoEYS Cambodia, 2024). Teachers' attitudes toward ICT play a crucial role in determining the success of digital tool adoption in classrooms. Research indicates that educators who possess both technological competence and a positive outlook on ICT are more inclined to integrate digital literacy into their teaching practices, thereby encouraging innovation in pedagogy (Teo, 2008). In teacher education, digital literacy goes beyond fundamental technical skills to include the strategic use of multimedia, collaborative platforms, and digital assessment tools that enable more interactive and customized learning experiences. Such comprehensive integration helps address diverse learner needs while enhancing student engagement, creativity, and critical thinking. Educators with strong ICT skills are better positioned to create learning environments enriched with technology that align with evolving educational expectations and workforce requirements. As such, developing both digital literacy and constructive attitudes toward ICT among educators is vital for improving instructional quality and preparing students for success in an increasingly digital world (Peng & Ali, 2025).

ICT competency has emerged as a key determinant in the pursuit of enhanced education quality, particularly within developing education systems such as Cambodia’s. Defined as the ability to effectively utilize digital tools for communication, learning, and problem-solving, ICT competence plays a dual role—both technical and psychological—in influencing how educators and students interact with digital learning environments. In

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teacher education, studies have revealed that while Cambodian educators generally exhibit positive attitudes toward ICT, their actual competence remains moderate, suggesting a critical need for targeted capacity building (Ravy Hun & S Kinya, 2019). Positive perceptions toward technology have been shown to correlate with higher levels of ICT proficiency, underscoring the role of motivation and institutional support in fostering digital competence. Beyond individual skills, the quality of education is significantly shaped by how ICT is integrated into pedagogical frameworks. Research highlights that effective technology integration, underpinned by ICT competence, enhances quality education (Hanaysha et al., 2023; Jing & DA Ali, 2024). However, this relationship is not automatic; the impact of ICT tools depends largely on their alignment with instructional objectives and the capacity of users to navigate digital platforms confidently. Merely providing access to digital infrastructure is insufficient without concurrent efforts to strengthen users' digital capabilities and pedagogical adaptability. In this context, ICT competency becomes a strategic asset in promoting inclusive, student-centered learning environments that reflect the demands of 21st-century education. Developing ICT skills among both students and educators is therefore central to achieving sustainable improvements in education quality in Cambodia and similar settings.

Hypotheses and Theoretical Framework

H1: Digital literacy positively and significantly influences the perceived quality of education in Cambodian public universities.

H2: ICT competency positively and significantly influences the perceived quality of education in Cambodian public universities.

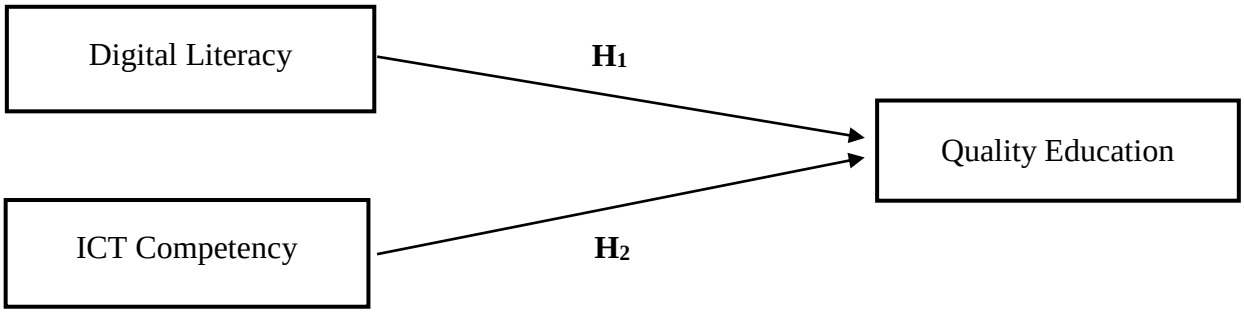

Figure 1: Theoretical Framework

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. Quantitative research is a scientific strategy that involves experiments or systematic approaches to identify control samples and evaluate individual activities (Hoy & Adams, 2015). Additionally, Lawrence Neuman, (2014) defines a population as a broad group of individuals or cases from which a sample is selected for the purpose of generalizing. In line with this, the current study focuses on students from specific public universities in Cambodia. These public universities were chosen for this study for several key reasons. Furthermore, as highlighted by Additionally,(Krejcie & DW Morgan, 1970) 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 0.715 to 0.878, thereby exceeding the commonly accepted threshold of 0.70 (JC Nunnally, 1978). 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

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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 constructs in the study were assessed using a five-point Likert scale, with response options ranging from 1 (strongly disagree) to 5 (strongly agree)(R Likert, 1932). The questionnaire was divided into four sections. Items addressing Digital literacy were designed to reflect the technological context, drawing on established frameworks. ICT competency 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 (Hair et al., 2017) 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.

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**	

RESULT

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 (Hair et al., 2017). All constructs demonstrated strong internal consistency (α and CR > 0.78) and convergent validity (AVE > 0.70). Items with loadings between 0.70 and 0.90 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
Digital Literacy	DIL1	0.877	0.894	0.922	0.704
	DIL2	0.874			
	DIL3	0.845			
	DIL4	0.780			
	DIL5	0.814			
ICT Competency	ITC1	0.869	0.930	0.943	0.704
	ITC2	0.839			
	ITC3	0.878			
	ITC4	0.846			
	ITC5	0.784			
	ITC6	0.832			
	ITC7	0.821			
Quality Education	QE1	0.831	0.956	0.962	0.717
	QE10	0.828			
	QE2	0.860			
	QE3	0.883			
	QE4	0.863			
	QE5	0.843			
	QE6	0.870			
	QE7	0.798			
	QE8	0.869			
	QE9	0.818			

In Table 3, discriminant validity was established using the Fornell–Larcker criterion, confirming that each construct is empirically distinct. The square roots of the Average Variance Extracted (AVE) for Digital Literacy (0.839), ITC Competency (0.839), and Quality Education (0.847) were all greater than their corresponding inter-construct correlations. This meets the standard set by (Fornell & Larcker, 1981) and supports the discriminant validity and robustness of the measurement model (Hair et al., 2017).

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Table 3**:** Latent Variable Correlations (Fornel-Larcker Criterion)

Constructs	DIL	ITC	QE
Digital Literacy (DIL)	0.839		
ICT Competency (ITC)	0.129	0.839	
Quality Education (QE)	0.454	0.297	0.847

Table 4, discriminant validity was further supported using the Heterotrait-Monotrait Ratio (HTMT), with all values below the 0.90 threshold (Henseler et al., 2016). Specifically, the values for DIL–ITC (0.141), DIL–QE (0.487), and ITC–QE (0.303) 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	ITC	QE
Digital Literacy (DIL)			
ICT Competency (ITC)	0.141		
Quality Education (QE)	0.487	0.303	

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 outlined by Chin (1998), R^2 values greater than 0.67 signify strong explanatory power, values ranging from 0.33 to 0.67 indicate a moderate level, values between 0.19 and 0.33 are viewed as weak, and those below 0.19 are considered inadequate. As presented in Table 5, an R^2 of 0.264 indicates that 26.4% of the variability in Quality Education can be explained by the predictors included in the regression model. This suggests a moderate effect size, depending on the context and field (e.g., in social sciences, this might be considered acceptable; in physics or engineering, it would be low). An adjusted R^2 of 0.259 implies that after adjusting for the number of predictors, 25.9% of the variance in Quality Education is accounted for. The small drop from 0.264 to 0.259 suggests that the included predictors have some explanatory power and are not just inflating the R^2 through overfitting.

Table 5: Coefficient of Determination (R Square)

Constructs	R-square	R-square adjusted
Quality Education	0.264	0.259

Additionally, f^2 effect sizes were assessed to determine the extent to which each exogenous variable influences the R^2 values of the endogenous constructs. According to Cohen, (1988), f^2 values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects, respectively. Table 6 reveals that digital literacy has a moderate effect size of 0.239 on quality education, indicating a meaningful and statistically relevant influence. This suggests that as digital literacy among students or educators increases, the perceived or actual quality of education improves in a measurable way. Such a finding highlights the importance of digital competence not just as a technical skill, but as a foundational component of modern educational environments that enhances teaching and learning. In contrast, ICT competency shows a smaller effect size of 0.079, reflecting a comparatively limited influence on quality education. While still statistically relevant, its weaker effect implies that technical proficiency with ICT tools alone may not strongly drive educational quality unless integrated

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meaningfully into pedagogical practice. These results suggest that while both digital literacy and ICT competency are important, emphasis should be placed more heavily on developing digital literacy in order to achieve greater educational impact.

Table 6: Effect Sizes (f^2) Analaysis

Quality Education	Effect Size	Decisions
Digital Literacy	0.239	Moderate
ITC Competency	0.079	Small

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 (Henseler & Sarstedt, 2013). The construct Quality Education shows an SSE (sum of squared errors) of 3060.000 and an SSO (sum of squares total) of 2498.167, yielding a 1–SSE/SSO value of 0.184. This value represents the explained variance in Student Engagement by the model, equivalent to an R^2 of 0.184, or 18.4% in Table 7.

Table 7: Construct Cross Validated Redundancy (Q2)

Constructs	SSE	SSO	1-SSE/SSO
Quality Education	3060.000	2498.167	0.184

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

Therefore, the SRMR values for both the saturated and estimated models are 0.061, which falls below the recommended threshold of 0.10. This indicates that the model applied in this study demonstrates a good fit (Henseler & Sarstedt, 2013; Hu et al.,1999). A summary of the structural model indicators is presented in Table 8.

Table 8: Goodness of Fit of The Model

Item	Saturated Model	Estimated Model
SRMR	0.061	0.061
d_ULS	0.952	0.952
d_G	0.661	0.661
Chi-Square	1,141.254	1,141.254
NFI	0.813	0.813

Hypothesis Testing

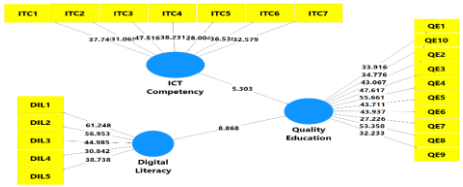

Figure 2: Path Model Significant

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Table 9 shows, the statistical findings demonstrate that Digital Literacy has a positively significant influence on Quality Education within Cambodian universities. The path coefficient of 0.423, coupled with a standard error of 0.048, t-value of 8.868, and p-value of 0.000, indicates a strong and statistically significant relationship. This suggests that as digital literacy improves among educators and students, the perceived and actual quality of education correspondingly increases. The strength of the coefficient also reflects a moderate to strong effect size, underscoring digital literacy as a critical driver in educational quality. This result supports the hypothesis and aligns well with existing literature. (Abbas et al., 2019) reported that digital literacy has a positive effect on quality education at the higher education level, emphasizing its relevance in supporting learning outcomes. Similarly, (Firmannandya et al., 2023) argue that digital literacy is a foundational component in achieving high-quality learning within educational institutions, pointing to its role in shaping pedagogical innovation and student engagement. Yeşilyurt & Vezne, (2023) further highlight that digital, technological, and internet literacy significantly predict positive attitudes toward using computer-supported education, reinforcing the broader educational value of digital

The analysis shows that ICT Competency has a significant positive impact on Quality Education in Cambodian universities, with a path coefficient of 0.243, a t-value of 5.303, and a p-value of 0.000. This indicates that improved ICT skills among students and educators contribute meaningfully to better educational outcomes. This finding aligns with previous studies. (Tokareva et al., 2021) emphasized ICT competency as key to effective implementation in higher education, while (Saravanakumar, 2018) confirmed that ICT competency enhance learning quality. These results suggest that strengthening ICT competency is essential for advancing education quality in the Cambodian context.

Table 9: Direct Effect Hypotheses Testing

Hypothesis	Coef.	Se	T value	P values	Decision
Digital Literacy -> Quality Education	0.423	0.048	8.868	0.000	Supported
ITC Competency -> Quality Education	0.243	0.046	5.303	0.000	Supported

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

CONCLUSION

The study confirms strong reliability and validity of the constructs, with all measures meeting established thresholds for internal consistency and discriminant validity. The structural model shows moderate explanatory power, explaining 26.4% of the variance in Quality education, which is acceptable in social science research. Digital Literacy has a moderate, significant positive effect on Quality Education, emphasizing its vital role in improving educational outcomes. ICT Competency also positively influences Quality Education but with a smaller effect size, indicating it is important but less impactful than digital literacy. The model fit indices support the robustness of these findings. Overall, these results suggest prioritizing digital literacy development alongside ICT competency to enhance the quality of education and student engagement in Cambodian universities.

Both hypotheses are supported by the data. H1 is confirmed as Digital Literacy has a significant and positive effect on Quality Education in Cambodian universities, highlighting its critical role in improving educational outcomes. Similarly, H2 is supported by the finding that ICT Competency also positively and significantly influences Quality Education, though with a somewhat smaller effect size. Together, these results emphasize the importance of developing both digital literacy and ICT skills to enhance the education quality of higher education in Cambodia.

This study is limited by its focus on a few Cambodian universities, which may reduce generalizability. The cross-sectional design also restricts causal inferences. Future research should use longitudinal designs, include

more diverse samples, and investigate additional factors like institutional support or teaching methods to better understand how digital literacy and ICT competency affect education quality.

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