Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10, 50-65
2025
Publisher: Learning Gate
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

Investigating the role of student engagement in the relationship between ICT accessibility and educational quality in Cambodian universities

Samean Phon[1*], Dhakir Abbas Ali[2]
[1,2]School of Business and Management, Lincoln University College, Selangor, Malaysia; phon@lincoln.edu.my (S.P.) drdhakir@lincoln.edu.my (D.A.A.).

Abstract: This study investigates the mediating role of student engagement in the relationship between Information and Communication Technology (ICT) accessibility and educational quality in Cambodian universities. Grounded in established educational theories, the research employed a quantitative method using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 3.0. Data were collected via 346 distributed questionnaires, of which 306 valid responses were analyzed from five public universities. The measurement model demonstrated excellent reliability and validity, with Cronbach's alpha and composite reliability values exceeding 0.719 to 0.905, and average variance extracted (AVE) values above 0.640. Structural model results revealed that ICT accessibility does not directly impact educational quality ($\beta = 0.002$, $p = 0.955$), thus not supporting H1. However, ICT accessibility significantly influences student engagement ($\beta = 0.487$, $p = 0.000$), and student engagement has a strong positive effect on educational quality ($\beta = 0.500$, $p = 0.000$), supporting H2 and H3. Importantly, mediation analysis confirmed that student engagement significantly mediates the relationship between ICT accessibility and educational quality ($\beta = 0.244$, $p = 0.000$), supporting H4. Effect size (f^2) results indicated moderate impacts from ICT accessibility on student engagement ($f^2 = 0.304$) and from student engagement on educational quality ($f^2 = 0.255$), whereas ICT accessibility had no direct effect on quality education ($f^2 = 0.000$). Predictive relevance (Q^2) values of 0.173 (quality education) and 0.145 (student engagement) confirmed the model's robustness. The findings underscore the importance of fostering student engagement to maximize the educational benefits of ICT integration in Cambodian higher education.

Keywords: *Cambodian higher education, Educational quality, ICT accessibility, Student engagement, Technology integration.*

1. Introduction

The integration of technology has become a driving force in transforming modern education, revolutionizing teaching methods, and reshaping how students engage with learning. In Cambodia's higher education system, the adoption of Information and Communication Technology (ICT) has been accelerating, backed by substantial investments from government entities and academic institutions. Despite these progressive efforts to digitize learning environments, the direct influence of technology integration on student engagement and educational quality remains insufficiently understood. This study explores the mediating role of student engagement in the relationship between technology integration and quality education among Cambodian university students. Student engagement, comprising cognitive, emotional, and behavioral dimensions, is examined in the context of how digital learning tools impact student motivation, participation, and skills development. The global shift toward digital learning, intensified by the COVID-19 pandemic and wider socio-technological changes, has challenged traditional instructional methods. Yet, questions persist regarding the long-term

© 2025 by the authors; licensee Learning Gate
Received: 30 July 2025 / Revised: 16 September 2025 / Accepted: 19 September 2025 / Published: 3 October 2025
* Correspondence: phon@lincoln.edu.my

effectiveness of digital tools: do they truly enhance sustained student engagement, or are they temporary distractions? By reviewing current literature and analyzing empirical data, this research evaluates the contribution of ICT to educational quality through learner-centered approaches. It also examines the current landscape, advantages, and obstacles of technology use in Cambodian universities. The study aims to provide valuable guidance for educators, policymakers, and institutional leaders striving to improve quality education. Ultimately, it emphasizes the importance of aligning technological implementation with engagement-driven strategies to ensure that digital transformation supports deeper learning, enhances academic success, and broadens equitable access to quality education.

The integration of technology into education has become a transformative force worldwide, reshaping the ways teaching and learning are delivered. Particularly in the context of higher education, Information and Communication Technology (ICT) has become increasingly essential in promoting inclusive, innovative, and effective academic environments. In Cambodia, where the education sector is undergoing reform to meet the demands of the global knowledge economy and sustainable development goals, ICT accessibility has emerged as a vital component in modernizing universities and enhancing education quality. ICT accessibility refers to the availability and usability of digital tools and resources such as computers, smartphones, internet connectivity, and educational software. In the Cambodian context, various government initiatives, including the Ministry of Education, Youth, and Sport's (MoEYS) Education Strategic Plan (2019–2023) and ICT in Education Policy, have aimed to improve access to digital technologies across universities. This includes the distribution of computers to schools, promotion of internet infrastructure, and development of digital management systems such as the Higher Education Information Management System (HEMIS). These efforts are designed to foster a "smart classroom" environment where students and educators can leverage digital tools for teaching, learning, and administrative functions. Despite significant strides in expanding ICT infrastructure, the mere presence of technology does not automatically lead to improved education outcomes. The difficulties of adopting digital technology in Cambodian universities underscore the importance of providing equal access to enhance the overall quality of education [1]. This is where student engagement plays a crucial mediating role. High levels of engagement have been associated with improved academic performance, greater motivation, and enhanced critical thinking and problem-solving skills.

In Cambodia, where challenges such as limited digital literacy, socioeconomic disparities, and rural-urban divides persist, student engagement becomes even more critical in determining whether ICT tools are effectively utilized. Simply providing access to digital tools is not sufficient if students lack the motivation, support, or skills to integrate these technologies into their learning processes. For example, although video conferencing tools like Zoom and platforms like Google Meet became widely used during the COVID-19 pandemic, their impact on learning was highly dependent on students' active participation and interaction with both peers and instructors. Empirical studies confirm that when students are engaged, the impact of ICT accessibility on education quality is significantly enhanced.. Chhom and Kep [2] found that technology integration, when supported by institutional structures and active student involvement, improves teaching methods, promotes collaboration, and fosters deeper learning. Similarly, Amaniampong and Hartmann [3] and Iwadi et al. [4] reported that Generation Z learners increasingly rely on digital platforms like YouTube for educational purposes, indicating a shift in learning preferences toward more interactive and technology-enhanced formats. Moreover, student engagement is not only influenced by the availability of ICT tools but also by institutional efforts to cultivate a supportive digital learning environment [5]. Faculty mentoring, group projects, and interactive pedagogical strategies are all instrumental in encouraging students to take ownership of their learning using technology. Engaged students are more likely to explore digital resources beyond the classroom, engage in knowledge sharing, and develop 21st-century competencies that align with both national education goals and global labor market expectations. However, challenges remain. Concerns about digital distractions, screen fatigue, and unequal access to devices and internet services

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

have prompted debates about the overall impact of technology on student learning. In some cases, excessive reliance on digital tools without proper pedagogical integration has led to decreased classroom interaction and reduced concentration. This highlights the importance of strategic ICT implementation that aligns with student needs and promotes purposeful engagement rather than passive technology use. This study is structured around the following guiding research questions:

RQ1: Does ICT accessibility significantly influence the quality of education in Cambodian universities?

RQ2: How does ICT accessibility impact student self-engagement in Cambodian higher education institutions?

RQ3: To what extent does student self-engagement affect the quality of education in Cambodian universities?

RQ4: Does student self-engagement mediate the relationship between ICT accessibility and quality education in Cambodian universities?

The primary objective of this research is to investigate the mediating role of student engagement in the relationship between Information and Communication Technology (ICT) accessibility and educational quality within Cambodian higher education institutions. Furthermore, the study aims to assess the contextual challenges and opportunities related to ICT integration in Cambodia's higher education system, including disparities in digital readiness and institutional capacity. Through a combination of empirical analysis and theoretical grounding, the research intends to provide actionable insights for policymakers, educators, and institutional leaders to align digital transformation with engagement-centered pedagogical strategies, ultimately supporting inclusive, equitable, and high-quality education.

2. Literature Review

Technology integration in education refers to the purposeful and systematic application of digital tools and platforms to enhance teaching, learning, and institutional processes. Central to this concept is Information and Communication Technology (ICT) accessibility, which encompasses not only the availability of technological resources but also the capacity of educational systems to ensure equitable, reliable, and effective access for all stakeholders. ICT accessibility enables students to engage with digital learning materials, communicate with instructors, and participate in collaborative activities, thereby contributing to improved academic outcomes and more inclusive educational environments. In the Cambodian higher education context, ICT accessibility plays a pivotal role in transforming traditional pedagogical models by fostering digital participation and innovation across both the higher education (HE) and technical and vocational education and training (TVET) sub-sectors. The integration of ICT is multifaceted, involving both infrastructural development and strategic pedagogical alignment. While hardware availability and internet connectivity form the foundational layer, the broader process includes adapting teaching practices and institutional frameworks to harness ICT's full potential. Khlaif and Salha [6] emphasize that technology integration must go beyond device usage to align with educational goals and promote student-centered learning. From a systemic perspective, Sam [7] argues that ICT integration should be viewed as a continuous, adaptive process influenced by national policy, institutional leadership, and faculty readiness. In resource-constrained environments such as Cambodia, improving ICT accessibility requires sustained investment, capacity building, and equity-driven policies to bridge digital divides and ensure that technology adoption leads to meaningful educational transformation.

The notion of quality education has been examined from various perspectives, with researchers underscoring its complex and multidimensional character. According to The World Bank [8], quality education extends beyond mere access to schooling; it involves equipping learners with vital skills, knowledge, and competencies required for meaningful engagement in society and the labor market [9]. This view aligns with the broader global understanding that education should prepare individuals for meaningful, real-world engagement, nurturing responsible citizens who can contribute positively to

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

their communities. Tawil and Locatelli [10] further emphasized that quality education is transformative, empowering individuals to engage with and address societal challenges. Quality education, according to González García et al. [11], also incorporates environmental and social dimensions, underscoring its role in addressing global issues and promoting sustainable development. This aligns with the principles outlined by UNESCO's Education for Sustainable Development (ESD) movement, which views education as a tool to advance the Sustainable Development Goals. Furthermore, scholars like Kushnir and Nunes [12] argue that quality education should focus not only on economic productivity but on nurturing critical capabilities such as empathy, creativity, and critical thinking that allow individuals to lead fulfilling lives. These perspectives underscore the importance of holistic, inclusive approaches to education that emphasize both academic and personal development, preparing individuals not only for work but for life in a rapidly changing world. Thus, quality education is inherently linked to the development of both cognitive and emotional capabilities necessary for meaningful societal participation.

Student engagement is widely acknowledged as a pivotal mediating factor linking technology integration to academic achievement. It encompasses the levels of attention, curiosity, and commitment students bring to their learning and is typically categorized into cognitive, emotional, and behavioral domains. Engaged students are more likely to stay motivated, perform well academically, and cultivate key 21st-century competencies. Digital literacy is fundamental in fostering such engagement by enabling students to access interactive platforms, collaborate effectively, and engage in problem-solving activities [13]. In Cambodia's higher education sector, digital literacy offers both promise and obstacles. Government initiatives, such as implementing cloud-based education systems and distributing digital devices to disadvantaged students, reflect a strong commitment to digitalization. Nonetheless, persistent challenges such as digital inequality, insufficiently trained staff, and varied student preparedness limit the full impact of these efforts. Empirical studies specifically examining the mediating role of student engagement in Cambodia remain limited, despite the global recognition of its importance in enhancing educational quality. Literature suggests that student engagement may act as a crucial link through which digital literacy affects learning outcomes. Engagement not only indicates students' motivation and active involvement but also reflects the success of teaching methods and institutional support mechanisms [14, 15]. While digital tools can enrich learning by encouraging curiosity, collaboration, and critical thinking, their mere presence is insufficient. Without adequate digital competencies, students may become overwhelmed or disengaged. Therefore, building digital skills must go hand in hand with creating supportive environments that actively cultivate meaningful student engagement.

2.1. ICT Accessibility and Education Quality

Quality education is universally acknowledged as a fundamental driver of national development and human empowerment [16]. As digital transformation reshapes educational landscapes, the accessibility and effective use of Information and Communication Technology (ICT) have emerged as critical components in delivering inclusive and high-quality education. However, empirical evidence reveals that ICT accessibility alone does not guarantee educational improvement, particularly in contexts marked by infrastructural limitations, socio-economic disparities, and digital exclusion. Khalid and Pedersen [17] in their systematic review, they categorize digital exclusion in higher education into three dimensions: social exclusion, digital exclusion, and accessibility. These factors interact to shape the extent to which learners can meaningfully engage with technology-enhanced learning environments, particularly those from marginalized backgrounds or with disabilities. Moreover, Eligi and Mwantimwa [18] demonstrate how ICT accessibility enhances autonomous, collaborative, and participatory learning for students with visual impairments. Yet, their study also underscores the persistent challenges in implementation, such as a shortage of trained personnel, inadequate specialized equipment, and weak institutional support systems. These findings highlight the dual necessity of both accessible infrastructure and capacity development to ensure equitable participation. In this regard, ICT should not only be viewed as a

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

medium for content delivery but as a transformative tool that requires alignment with pedagogical strategies and learner needs. Therefore, addressing ICT accessibility holistically is essential to advancing inclusive and sustainable educational outcomes. Drawing from the theoretical insights and empirical evidence presented, the following hypotheses are proposed:

H_1: ICT accessibility has a positive influence on the quality of education in universities in Cambodia.

2.2. ICT Accessibility on Student Engagement

Student engagement is a critical component of effective learning and is significantly influenced by the accessibility and integration of Information and Communication Technology (ICT) within educational environments. In technology-enhanced classrooms, students demonstrate higher levels of cognitive, emotional, and behavioral engagement, actively participating in learning activities, expressing positive attitudes, and investing greater effort in understanding course content. The availability of accessible ICT infrastructure, such as digital devices, software applications, and online platforms, facilitates a more engaging, cooperative, and inclusive educational setting, thereby enhancing student satisfaction and boosting academic achievement [19]. Engagement is further enhanced when digital tools are aligned with pedagogical goals and are user-friendly, intuitive, and responsive to diverse learner needs. Technology-assisted facilities, such as virtual classrooms, video conferencing systems, and online collaboration tools, support student-centered learning by promoting participation, flexibility, and self-directed learning. These resources not only contribute to deeper learning and retention but also increase motivation and enable students to take ownership of their educational journey. Notably, the impact of ICT accessibility extends beyond the general student populations. Research by Ntshwarang et al. [20] shows that students with disabilities report higher levels of satisfaction with ICT tools, especially when technologies are tailored to accommodate diverse learning needs, thereby contributing to more equitable educational outcomes. Overall, the effective integration of accessible ICT in higher education enhances student engagement, supports inclusive teaching practices, and elevates the overall quality of the learning experience. It underscores the need for institutions to invest in accessible digital infrastructure and support systems that cater to a wide range of learners. Building on the theoretical perspectives and empirical evidence reviewed, the following hypotheses are suggested:

H_2: ICT accessibility has a positive influence on self-engagement in universities of Cambodia.

2.3. Effect of Student Engagement and Education Quality

Extensive empirical studies have consistently shown that integrating technology into education positively influences student engagement across various learning environments. For instance, a meta-analysis by Tahir and Fatima [21], which examined data from different countries and educational levels, found a strong positive link between the use of digital technologies and heightened student engagement, motivation, and participation. Tools such as interactive platforms, multimedia content, and collaborative technologies were particularly effective in enriching learning by encouraging active involvement and sustained interest. The study also emphasized the role of interactivity and easy access to information as critical factors in driving engagement, while acknowledging that students' responses to technology-enhanced learning vary based on cultural and contextual differences. Nevertheless, most global research tends to neglect region-specific contexts like Cambodia's higher education sector. This represents a significant research gap, as the success of technology integration is not universally applicable and must be tailored to the local educational culture, technological infrastructure, and students' specific needs. Martinez and Lee [22] highlighted several challenges associated with digital transformation in education, including disparities in access to technology, differing levels of digital literacy, and the risk of distraction. Their review advocated for equity-focused policies and professional development for educators to ensure that technological adoption genuinely promotes inclusive and effective student engagement. These insights highlight the importance of localized strategies when implementing educational technology, particularly in underexplored contexts such as Cambodia, where

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

unlocking the full potential of digital tools depends on overcoming infrastructure barriers and aligning innovations with local pedagogical practices. Drawing upon the established theoretical framework and supported by relevant empirical evidence, this study formulates the following hypotheses:

H_3: Student engagement has a positive influence on the quality of education in universities of Cambodia.

2.4. Student Engagement, ICT Accessibilities and Education Quality

Access to Information and Communication Technology (ICT) has become a critical driver in advancing educational quality, particularly in developing countries where traditional learning resources may be scarce. ICT accessibility, encompassing infrastructure, digital tools, and supportive environments, directly influences how students engage with the learning process. When adequately implemented, ICT facilitates interactive, student-centered learning that fosters participation, collaboration, and academic success. According to Rashid and Asghar [23], the Campus-Class-Technology (CCT) theory suggests that student engagement and educational quality are influenced by the combined effects of technological infrastructure, the learning environment within the classroom, and the level of support provided by the institution. Their model illustrates how accessible ICT resources enable students to become more autonomous learners, thereby contributing to improved educational outcomes. However, the benefits of ICT accessibility are not uniform. Challenges such as the digital divide, limited infrastructure, and uneven technological literacy continue to hinder equitable access, particularly in underserved communities. Research by Zhang et al. [24] highlights that while technology holds transformative potential, successful implementation requires context-specific strategies that account for infrastructural and socio-economic disparities. In developing countries, where students often face barriers related to connectivity and affordability, tailored interventions that expand ICT accessibility are essential for bridging educational gaps. Ensuring inclusive access to ICT not only enhances student engagement but also supports broader educational objectives, including equity, quality, and lifelong learning. Therefore, integrating ICT into education systems must go beyond physical access to include the development of digital competencies and the creation of enabling environments that sustain active and meaningful student engagement. Drawing on the established theoretical foundation and supporting empirical findings, this study formulates the following hypotheses.

H_4: Student engagement has a positive mediating influence on the relationship between ICT accessibility and quality education in universities of Cambodia.

2.5. Hypotheses and Theoretical Framework

- H_1: ICT accessibility has a positive influence on quality education in universities of Cambodia.
- H_2: ICT accessibility has a positive influence on self-engagement in universities in Cambodia.
- H_3: Student engagement has a positive influence on quality education in universities of Cambodia.
- H_4: Student engagement has a positive mediating influence on the relationship between ICT accessibility and quality education in universities in Cambodia.

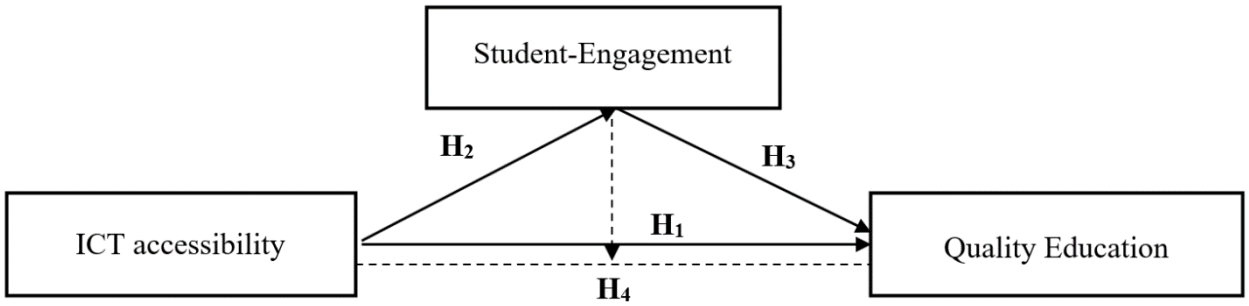

Figure 1.
Theoretical Framework.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

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. Quantitative research is a scientific strategy that involves experiments or systematic approaches to identify control samples and evaluate individual activities [25]. Moreover, given the relevance of population in any research, it would include all the conceivable elements that comprise the study analysis from which the researcher seeks to draw specific conclusions [26]. Consequently, the present research focuses on students from 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 [27] 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 conducted 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 [28]. Following the pilot validation, hard copies of the finalized questionnaires were distributed to students at five selected public universities in Cambodia to ensure efficient and effective data collection. In total, 346 hard-copy questionnaires were distributed to students across these institutions. 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 Likert [29] 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 engagement 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 [30]. 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**	

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

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 [30]. All constructs demonstrated strong internal consistency (α and CR > 0.919) and convergent validity (AVE > 0.640). Items with loadings between 0.719 and 0.905 were retained in the model.

Table 2.
Construct Reliability and Validity.

Construct	Items	Loadings	Cronbach Alpha	Composite Reliability	Average Variance Extracted
ICT Accessibility	ITA1	0.817	0.919	0.934	0.640
	ITA2	0.785			
	ITA3	0.801			
	ITA4	0.814			
	ITA5	0.882			
	ITA6	0.785			
	ITA7	0.772			
	ITA8	0.736			
Quality Education	QE1	0.834	0.956	0.962	0.717
	QE10	0.823			
	QE2	0.861			
	QE3	0.882			
	QE4	0.868			
	QE5	0.848			
	QE6	0.870			
	QE7	0.796			
	QE8	0.863			
	QE9	0.815			
Student Engagement	SE1	0.851	0.979	0.980	0.649
	SE10	0.788			
	SE11	0.805			
	SE12	0.777			
	SE13	0.843			
	SE14	0.815			
	SE15	0.854			
	SE16	0.894			
	SE18	0.799			
	SE19	0.782			
	SE2	0.831			
	SE20	0.772			
	SE21	0.805			
	SE22	0.719			
	SE23	0.738			
	SE24	0.805			
	SE25	0.792			
	SE26	0.814			
	SE27	0.752			
	SE28	0.764			
	SE3	0.807			
	SE4	0.879			
	SE5	0.905			
	SE6	0.728			
	SE7	0.780			
	SE8	0.816			
	SE9	0.795			

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

Discriminant validity was confirmed using the Fornell–Larcker criterion, as shown in *Table 3*, demonstrating that each construct is empirically distinct. The square roots of the AVE for ICT Accessibility (0.800), Student Engagement (0.805), and Quality Education (0.847) all exceeded their correlations with other constructs, satisfying the threshold recommended by Fornell and Larcker [31]. These findings support the measurement model's discriminant validity and overall reliability, consistent with [30].

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

Constructs	ITA	QE	SE
ICT Accessibility (ITA)	0.800		
Quality Education (QE)	0.244	0.847	
Student Engagement (SE)	0.483	0.501	0.805

Table 4, discriminant validity was further supported using the Heterotrait-Monotrait Ratio (HTMT), with all values below the 0.90 threshold [32]. Specifically, the values for ITA–QE (0.259), ITA–SE (0.491), 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	ITA	QE	SE
ICT Accessibility (ITA)			
Quality Education (QE)	0.259		
Student Engagement (SE)	0.491	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 Chin [33], the R-squared value for Quality Education is 0.251, indicating that 25.1% of the variance in the dependent variable is explained by this construct. The adjusted R-squared value of 0.246 suggests a minimal adjustment for the number of predictors, confirming the model's robustness. Similarly, Student Engagement has an R-squared of 0.233, meaning it explains 23.3% of the variance, with an adjusted R-squared of 0.230. These results suggest that both Quality Education and Student Engagement moderately contribute to explaining the outcome, with Quality Education having a slightly stronger influence in *Table 5*.

Table 5.
Coefficient of Determination (R Square).

Constructs	R-square	R-square adjusted
Quality Education	0.251	0.246
Student Engagement	0.233	0.230

The f^2 effect size analysis, based on Cohen [34] thresholds, reveals varied impacts of the exogenous variables on the endogenous constructs. ICT Accessibility has an effect size of 0.000 on Quality Education, indicating no direct meaningful influence. However, Student Engagement exhibits a moderate effect size of 0.255 on Quality Education, underscoring its significant role in improving educational quality. Additionally, ICT Accessibility shows a moderate effect size of 0.304 on Student Engagement, suggesting that increased access to ICT moderately boosts student engagement. These results emphasize the indirect but crucial role of ICT in enhancing Quality Education through its positive effect on student engagement, as summarized in *Table 6*.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

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

Quality Education	**Effect Size**	**Decisions**
ICT Accessibility	0.000	None
Student-Engagement	0.255	Moderate
Sefl-Engagement	**Effect Size**	**Decisions**
ICT Accessibility	0.304	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 [35]. The predictive relevance (Q^2) values, represented by 1–SSE/SSO, are 0.173 for Quality Education and 0.145 for Student Engagement. These values indicate acceptable predictive relevance, as both exceed the threshold of 0.10, suggesting that the model has meaningful predictive power for both constructs in *Table 7*.

Table 7.
Construct Cross-Validated Redundancy (Q2).

Constructs	***SSE***	***SSO***	***1-SSE/SSO***
Quality Education	3,060.000	2,530.515	0.173
Student Engagement	8,262.000	7,060.851	0.145

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

The SRMR values for both the saturated and estimated models were 0.084, falling below the recommended threshold of 0.10. This indicates that the model used in the study demonstrates an acceptable level of fit [30]. An overview of the structural model indicators is presented in Table 8.

Table 8.
Goodness of Fit of The Model.

Item	***Saturated Model***	***Estimated Model***
SRMR	0.084	0.084
d_ULS	7.296	7.296
d_G	7.404	7.404
Chi-Square	8,524.377	8,524.377
NFI	0.575	0.575

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

4.3. Hypothesis Testing

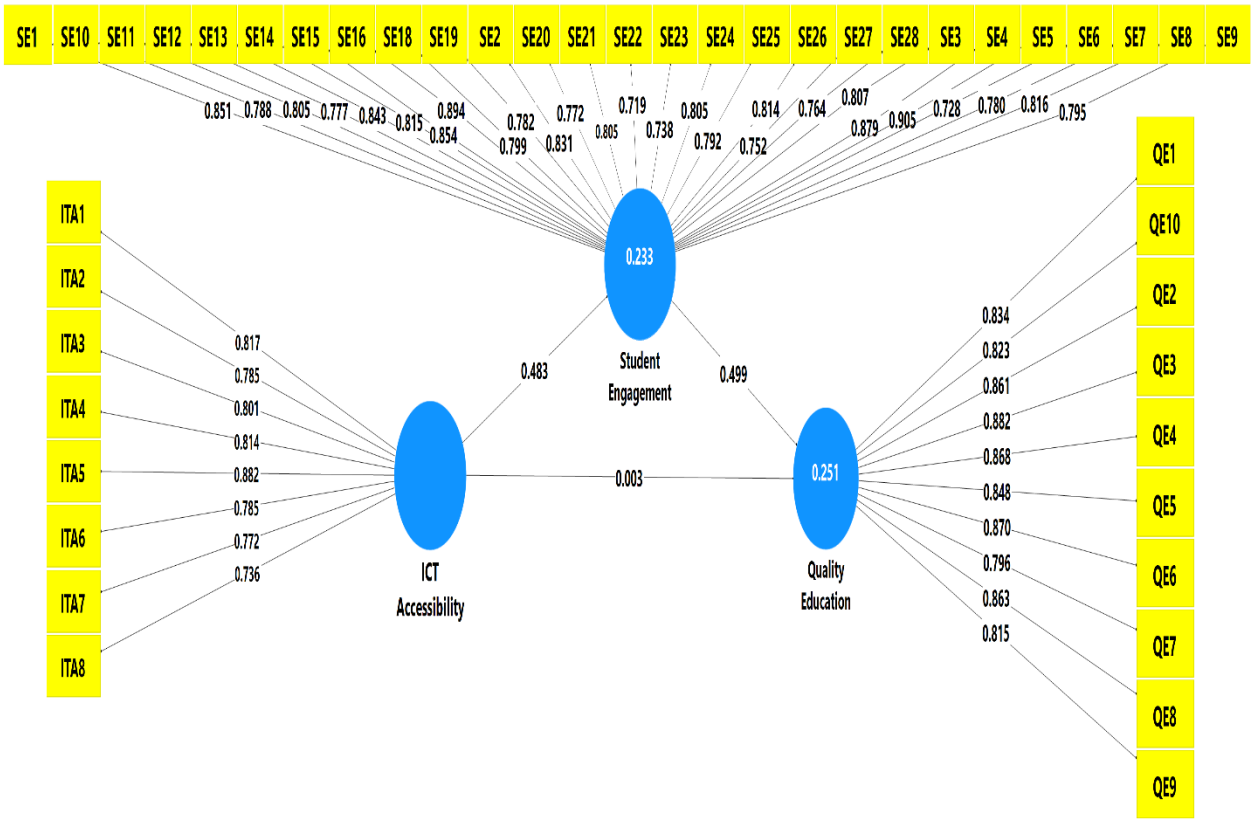

Figure 2.
Path Model Significant.

Table 9 shows the results of the structural model, providing mixed support for the proposed hypotheses. H1 is not supported, as the path coefficient between ICT Accessibility and Quality Education is very low (β = 0.002, t-test = 0.057, p = 0.955), indicating no significant effect.

In contrast, H2 is strongly supported (β = 0.487, t-test = 9.805, p = 0.000), confirming that ICT accessibility has a significant positive influence on student engagement.

H3 is also supported (β = 0.500, t-test = 9.192, p = 0.000), demonstrating that student engagement significantly and positively impacts quality education.

These findings suggest that, while ICT accessibility does not directly influence quality education, it contributes indirectly through its substantial effect on student engagement.

Table 9.
Direct Effect Hypotheses Testing.

Hypothesis	Coef.	Se	T value	P values	Decision
ICT Accessibility -> Quality Education	0.002	0.056	0.057	0.955	Not supported
ICT Accessibility -> Student Engagement	0.487	0.049	9.805	0.000	Supported
Student Engagement -> Quality Education	0.500	0.054	9.192	0.000	Supported

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

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

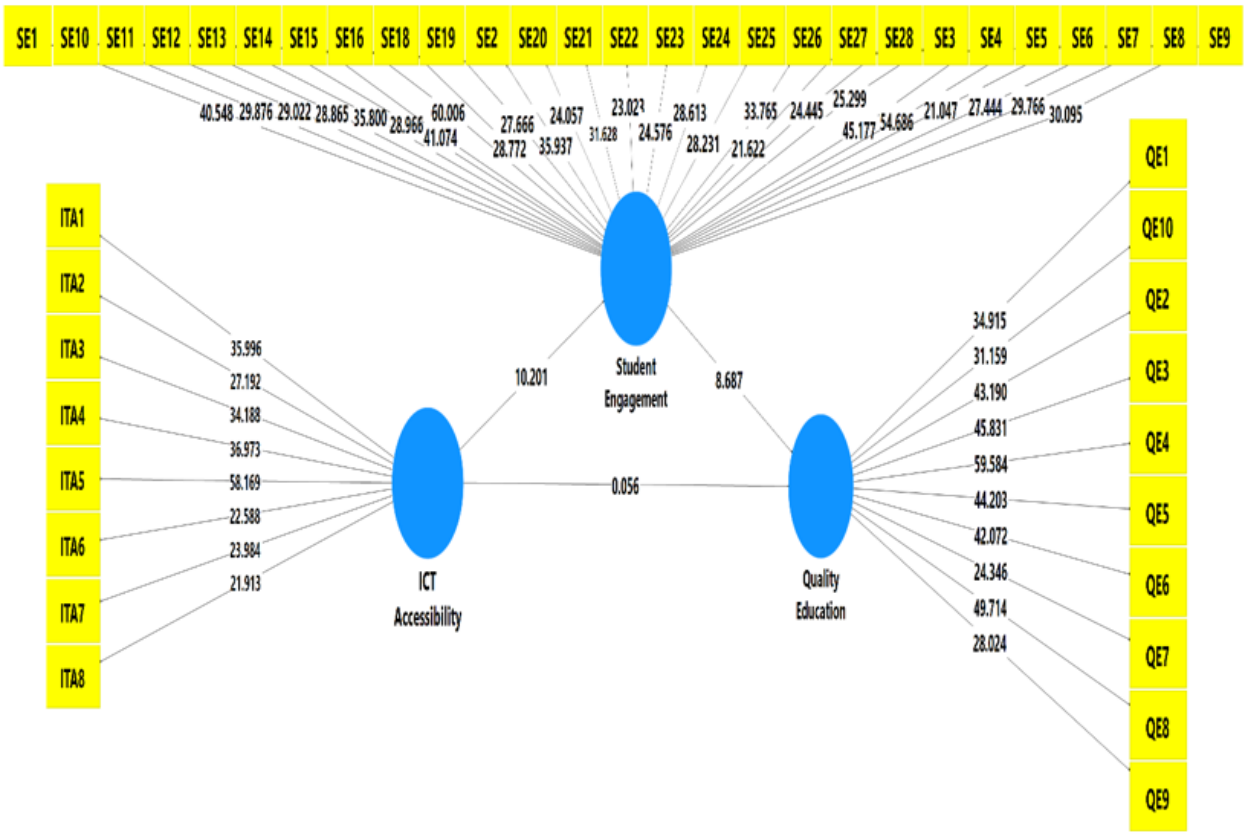

Figure 3.
Path Model Results of Mediation.

Table 10 shows that the mediation analysis supports H4, indicating that Student Engagement significantly mediates the relationship between ICT Accessibility and Quality Education (β = 0.244, p = 0.000). Despite the absence of a significant direct effect from ICT Accessibility to Quality Education, the strong indirect path through Student Engagement highlights its crucial mediating role. H4 is also supported (β = 0.244, t-test=6.353, p = 0.000), suggesting that ICT Accessibility enhances Quality Education primarily by fostering greater Student Engagement in Cambodian universities.

Table 10.
Indirect Effect Hypotheses Testing

Hypothesis	Coef.	Se	T value	P values	Decision
ICT Accessibility -> Student Engagement -> Quality Education	0.244	0.038	6.353	0.000	Supported

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

5. Discussion

This study examined the relationships between teaching methods, self-regulation, 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: three hypotheses and one hypothesis were not supported, indicating both direct and indirect influences of teaching practices on academic outcomes.

The structural model offers the proposed hypotheses. H1 is not supported, as ICT Accessibility shows no significant direct effect on Quality Education (β = 0.002, p = 0.955). This finding aligns with

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

Bindu [36], who noted that ICT alone may not directly enhance educational outcomes without supportive pedagogical strategies. Similarly, Amutha [37] emphasized that ICT's role in improving education quality depends on how effectively it is integrated into teaching and learning processes.

H2 is strongly supported, with results showing a significant positive influence of ICT Accessibility on Student Engagement ($\beta = 0.487$, $p = 0.000$). This aligns with prior literature, emphasizing technology's pivotal role in enhancing student involvement. D'Angelo [38] highlights that well-integrated technological tools can significantly boost student engagement and academic success by creating interactive and learner-centered environments. Similarly, Pandita and Kiran [19] assert that the interface between technology and student engagement is a key determinant of sustainable student satisfaction, particularly in higher education contexts. Furthermore, Roopa and Rajesh [39] emphasize that ICT fosters more active learning and achievement, reinforcing its role in transforming student engagement. These studies collectively support the finding that ICT accessibility serves as a vital enabler of student engagement in the Cambodian university setting.

H3 is supported, with Student Engagement demonstrating a strong and significant positive influence on Quality Education ($\beta = 0.500$, $p = 0.000$). This finding is well-supported by existing literature. Senior et al. [40] emphasize that student engagement is central to enhancing the quality of undergraduate learning, noting that motivated and actively involved students contribute more meaningfully to their educational experiences. Similarly, Tahir and Fatima [21] argue that student engagement, along with strong student-faculty relationships and loyalty, is a critical driver of higher education quality. Further reinforce this relationship, showing that the quality of teacher–student interactions significantly shapes students' engagement levels, which in turn impacts their learning outcomes. Collectively, these studies support the conclusion that fostering student engagement is essential to improving the overall quality of education, consistent with the present study's findings in the context of Cambodian universities.

The mediation analysis supports H4, demonstrating that Student Engagement significantly mediates the relationship between ICT Accessibility and Quality Education ($\beta = 0.244$, $p = 0.000$). Although ICT Accessibility does not have a direct significant effect on Quality Education, its strong indirect effect through Student Engagement underscores the importance of engagement as a key mechanism in this relationship. This finding is supported by Li and Zhu [41], who showed that cognitive-motivational engagement in ICT use mediates the relationship between ICT access and academic achievement across diverse global contexts. Similarly, Panigrahi et al. [42] emphasized that student engagement plays a critical mediating role in the effectiveness of e-learning, reinforcing that technological tools alone are insufficient without active student participation. In the context of Cambodian universities, these results suggest that ICT resources improve educational quality primarily by enhancing how students interact, engage, and learn through digital platforms.

6. Conclusion

The constructs demonstrated strong reliability and validity (α and CR > 0.719; AVE > 0.640), with good model fit (SRMR = 0.084). Predictive relevance (Q^2) and effect sizes (f^2) confirmed the model's strength and practical impact. Findings highlight Student Engagement as a key mediator between ICT Accessibility and Quality Education in Cambodian universities.

This study examined the relationships between ICT Accessibility, Student Engagement, and Quality Education in Cambodian universities. The findings reveal that ICT Accessibility does not have a direct significant impact on Quality Education (H1 not supported). However, ICT Accessibility positively influences Student Engagement (H2 supported), which in turn significantly enhances Quality Education (H3 supported). Importantly, Student Engagement mediates the relationship between ICT Accessibility and Quality Education (H4 supported), highlighting its pivotal role as the mechanism through which ICT access translates into improved educational quality. These results underscore the

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate

importance of fostering active student engagement to fully leverage ICT resources in higher education settings.

This study has several limitations that offer directions for future research. First, the cross-sectional design limits the ability to infer causality between ICT accessibility, student engagement, and quality education. Longitudinal studies are needed to explore these dynamics over time. Second, the data were collected from universities in Cambodia, which may restrict the generalizability of the findings to other cultural or educational contexts. Future research should examine these relationships in diverse geographic and institutional settings. Additionally, while this study focused on student engagement as a mediator, other potential mediators or moderators, such as teaching quality, digital literacy, or institutional support, warrant investigation to provide a more comprehensive understanding of how ICT influences educational outcomes.

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.

Copyright:

© 2025 by the authors. This open-access article is distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

References

[1] X. SU and D. A. Ali, "Education level and experience moderates the effects of gender discrimination on employee compensation at Taizhou universities," *Frontiers in Health Informatics*, vol. 13, no. 8, p. 3501, 2024.

[2] C. Chhom and B. Kep, "Students' engagement and English performance: A case of undergraduate students in the University of Cambodia," *Cambodian Journal of Humanities and Social Sciences*, vol. 1, no. 1, pp. 16-35, 2022.

[3] A. Amaniampong and M. D. Hartmann, "Factors affecting technology integration in colleges of education," *International Journal of Studies in Education and Science*, vol. 4, no. 2, pp. 176-194, 2023.

[4] I. Iwadi, D. Ali, and M. Jabari, "Artificial intelligence techniques and their role in enhancing the competitive advantage of Palestinian schools," *Journal of Palestine Ahliya University for Research and Studies*, vol. 3, no. 2, pp. 120–135, 2024.

[5] T. Jing and D. A. Ali, "The influence of CRM and organizational agility on career outcomes: A study in Jiangxi higher education institutions," *Globus Journal of Progressive Education*, vol. 14, no. 1, pp. 121–125, 2024.

[6] Z. N. Khlaif and S. Salha, "Exploring the factors influencing mobile technology integration in higher education," *Technology, Pedagogy and Education*, vol. 31, no. 3, pp. 347-362, 2022. https://doi.org/10.1080/1475939X.2022.2052949

[7] R. Sam, "Challenges and opportunities of educational technology integration in Cambodian higher education institutions: A literature review," *Available at SSRN 4849873*, 2024.

[8] The World Bank, "World development report2018," 2018. https://openknowledge.worldbank.org/server/api/core/bitstreams/7c836e00-a608-5a5b-b4f1-63b4507d2126/content

[9] E. Unterhalter, "The many meanings of quality education: Politics of targets and indicators in SDG 4," *Global Policy*, vol. 10, pp. 39-51, 2019. https://doi.org/10.1111/1758-5899.12591

[10] S. Tawil and R. Locatelli, "Rethinking education: Towards a global common good. Dostupné z," 2015. https://www.researchgate.net/profile/Sobhi-Tawil-2/publication/321289639_Rethinking_Education_Towards_a_Global_Common_Good/links/5a1940e6a6fdcc50ade7fd81/Rethinking-Education-Towards-a-Global-Common-Good

[11] E. González García, E. Colomo Magaña, and A. Cívico Ariza, "Quality education as a sustainable development goal in the context of 2030 agenda: Bibliometric approach," *Sustainability*, vol. 12, no. 15, p. 5884, 2020. https://doi.org/10.3390/su12155884

[12] I. Kushnir and A. Nunes, "Education and the UN development goals projects (MDGs and SDGs): Definitions, links, operationalisations," *Journal of Research in International Education*, vol. 21, no. 1, pp. 3-21, 2022. https://doi.org/10.1177/14752409221088942

[13] G. El-Sayad, N. H. Md Saad, and R. Thurasamy, "How higher education students in Egypt perceived online learning engagement and satisfaction during the COVID-19 pandemic," *Journal of Computers in Education*, vol. 8, pp. 527-550, 2021. https://doi.org/10.1007/s40692-021-00191-y
[14] T. Jing and D. A. Ali, "Exploring the relationship between faculty engagement and institutional performance: A case study approach in Jiangxi's universities," *Sciences of Conservation and Archaeology*, vol. 36, no. 3, pp. 486-491, 2024.
[15] Z. Peng and D. A. Ali, "Leadership and career planning in higher education: A critical review of their impact on student success," *Cosmos: An International Journal of Management*, vol. 14, no. 2, pp. 1–10, 2025.
[16] L. Sovanak, L. Vouchsieng, and M. Navy, "The challenges of higher education for rural students in urban universities in Cambodia. In UC Working Paper Series," 2017. http://uc.edu.kh/userfiles/image/2017/Working%20Paper%20Series%20Volume%201%20Issue%201.pdf#page=99
[17] M. S. Khalid and M. J. L. Pedersen, "Digital exclusion in higher education contexts: A systematic literature review," *Procedia-Social and Behavioral Sciences*, vol. 228, pp. 614-621, 2016. https://doi.org/10.1016/j.sbspro.2016.07.094
[18] I. Eligi and K. Mwantimwa, "ICT accessibility and usability to support learning of visually-impaired students in Tanzania," *International Journal of Education and Development using ICT*, vol. 13, no. 2, pp. 87-102, 2017.
[19] A. Pandita and R. Kiran, "The technology interface and student engagement are significant stimuli in sustainable student satisfaction," *Sustainability*, vol. 15, no. 10, p. 7923, 2023. https://doi.org/10.3390/su15107923
[20] P. N. Ntshwarang, T. Malinga, and N. Losike-Sedimo, "eLearning tools at the University of Botswana: Relevance and use under COVID-19 crisis," *Higher Education for the Future*, vol. 8, no. 1, pp. 142-154, 2021. https://doi.org/10.1177/2347631120986281
[21] I. Tahir and N. Fatima, "The impact of student engagement, quality of student faculty relationship and student loyalty on quality of higher education: A systematic literature review," *World Journal of Advanced Research and Reviews*, vol. 20, no. 2, pp. 741-755, 2023.
[22] A. Martinez and S. Lee, "Cross-cultural virtual negotiations: The role of technology in bridging differences," *International Business Review*, vol. 31, pp. 101–119, 2022.
[23] T. Rashid and H. M. Asghar, "Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations," *Computers in human behavior*, vol. 63, pp. 604-612, 2016. https://doi.org/10.1016/j.chb.2016.05.084
[24] X. Zhang, W. Qian, and C. Chen, "The effect of digital technology usage on higher vocational student satisfaction: The mediating role of learning experience and learning engagement," *Frontiers in Education*, vol. 9, 2024. https://doi.org/10.3389/feduc.2024.1508119
[25] W. Hoy and C. Adams, *Quantitative research in education: A primer*. Thousand Oaks, CA: SAGE Publications, 2015.
[26] M. Blanche, M. Blanche, K. Durrheim, and D. Painter, *Research in practice: Applied methods for the social sciences*, 2nd ed. Cape Town, South Africa: Juta and Company Ltd, 2006.
[27] R. V. Krejcie and D. W. Morgan, "Determining sample size for research activities," *Educational and Psychological Measurement*, vol. 30, no. 3, pp. 607-610, 1970. https://doi.org/10.1177/001316447003000308
[28] J. Nunnally, *An overview of psychological measurement*. New York: McGraw-Hill, 1978.
[29] R. Likert, "A technique for the measurement of attitudes," *Archives of Psychology*, vol. 22, pp. 140-155, 1932.
[30] J. F. Hair, G. T. M. Hult, C. M. Ringle, and M. Sarstedt, *A primer on partial least squares structural equation modeling (PLS-SEM)*, 2nd ed. Thousand Oaks, CA: Sage, 2017.
[31] C. Fornell and D. F. Larcker, "Structural equation models with unobservable variables and measurement error: Algebra and statistics," *Journal of Marketing Research*, vol. 18, no. 3, pp. 382–388, 1981. https://doi.org/10.1177/002224378101800313
[32] J. Henseler, *Partial least squares path modeling. In Advanced methods for modeling markets*. Cham: Springer International Publishing, 2017.
[33] W. W. Chin, "Commentary: Issues and opinion on structural equation modeling," *MIS Quarterly*, vol. 22, no. 1, pp. vii-xvi, 1998.
[34] J. Cohen, *Statistical power analysis for the behavioral sciences*, 2nd ed. New York: Routledge, 1988.
[35] J. Henseler and M. Sarstedt, "Goodness-of-fit indices for partial least squares path modeling," *Computational statistics*, vol. 28, pp. 565-580, 2013. https://doi.org/10.1007/s00180-012-0317-1
[36] C. Bindu, "Impact of ICT on teaching and learning: A literature review," *International Journal of Management and Commerce Innovations*, vol. 4, no. 1, pp. 24-31, 2016.
[37] Amutha, "The role and impact of ICT in improving the quality of education," *SSRN*, 2020. https://doi.org/10.2139/ssrn.3585228
[38] C. D'Angelo, "The impact of technology: Student engagement and success. Technology and the Curriculum: Summer 2018," 2018. https://pressbooks.pub/techandcurriculum/chapter/engagement-and-success/
[39] S. Roopa and K. Rajesh, "Revolutionizing learning: The role of ICT in enhancing student engagement and achievement. | EBSCOhost," 2024. https://openurl.ebsco.com/EPDB%3Agcd%3A2%3A12206098/detailv2?sid=ebsco%3Aplink%3Ascholar&id=ebsco%3Agcd%3A180918492&crl=c&link_origin=scholar.google.com

© 2025 by the authors; licensee Learning Gate

[40] R. M. Senior, P. Bartholomew, A. Soor, D. Shepperd, N. Bartholomew, and C. Senior, "'The rules of engagement': Student engagement and motivation to improve the quality of undergraduate learning," *Frontiers in Education*, vol. 3, 2018. https://doi.org/10.3389/feduc.2018.00032

[41] S. Li and J. Zhu, "Cognitive-motivational engagement in ICT mediates the effect of ICT use on academic achievements: Evidence from 52 countries," *Computers & Education*, vol. 21, no. 1, p. 204, 2023.

[42] R. Panigrahi, P. R. Srivastava, and D. Sharma, "Online learning: Adoption, continuance, and learning outcome—A review of literature," *International Journal of Information Management*, vol. 43, pp. 1-14, 2018. https://doi.org/10.1016/j.ijinfomgt.2018.05.005

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 10: 50-65, 2025
DOI: 10.55214/2576-8484.v9i10.10342
© 2025 by the authors; licensee Learning Gate