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The influence of ICT accessibilities on learning outcomes in Cambodian public higher education institutions: The mediating role of self-efficacy

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Abstract: The integration of Information and Communication Technology (ICT) in education has become a key strategy to enhance teaching quality and student performance. This study explores the mediating role of self-efficacy in the relationship between ICT accessibility and learning outcomes in Cambodian public higher education. Data were collected from 326 students across three public universities using structured questionnaires. Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to assess the measurement and structural models. The measurement model demonstrated strong reliability and validity (Cronbach's α and CR > 0.90, AVE > 0.60). The structural model explained 24.4% of the variance in learning outcomes and 14.9% in self-efficacy. Findings revealed that ICT accessibility significantly influences both learning outcomes (β = 0.287, p = 0.000) and self-efficacy (β = 0.389, p = 0.000). Self-efficacy also exerted a positive effect on learning outcomes (β = 0.307, p = 0.000) and mediated the relationship between ICT accessibility and learning outcomes (β = 0.119, p = 0.000). Effect size and model fit indices confirmed the robustness of the results. The study highlights that improving ICT infrastructure must be complemented by strategies to strengthen students' self-efficacy to optimize educational achievement.

Keywords: *Cambodia, Higher education, ICT accessibility, Learning outcomes, Self-efficacy.*

1. Introduction

Technology has evolved rapidly, becoming a vital force in reshaping teaching and learning in the 21st century. The integration of ICT has transformed educational environments globally, influencing how institutions plan, deliver, and enhance academic programs. In response to these advancements, Cambodian higher education institutions, with strong support from the government, have begun embracing ICT to improve both the quality and accessibility of education. As this transformation continues, it is crucial to explore the dynamic interplay between ICT, self-efficacy, and student learning outcomes in Cambodian universities. While there is a growing body of international research on these topics, limited attention has been given to how self-efficacy may mediate the relationship between ICT accessibility and learning outcomes within Cambodia's context. Understanding this mediating role could provide valuable insights into how students' confidence in using technology affects their academic success. This study aims to fill this gap by examining how ICT accessibility influences learning outcomes and whether self-efficacy plays a significant mediating role. The research begins by discussing the global relevance of ICT in education and its specific importance in Cambodian higher education. It also outlines the current state of ICT integration in Cambodia, along with the challenges and opportunities it presents. Key objectives, research questions, and the study's significance are clearly presented, targeting educators, institutions, policymakers, and researchers. Definitions of core terms, study scope, and structural organization are also addressed to guide readers through the research process and its anticipated contributions.

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ICT has rapidly transformed the educational landscape by enhancing access to data, enabling communication across individuals, institutions, and countries, and improving instructional delivery. Tools such as the internet, computers, software, and mobile technologies have redefined how educational systems operate globally. This transformation became especially evident during the COVID-19 pandemic, where widespread school closures necessitated a shift to online learning, highlighting both the critical importance and challenges of ICT accessibility. ICT accessibility involves the availability and ease of use of essential technological infrastructure, including internet services, digital devices, and online learning platforms. In Cambodia, initiatives such as the EduTech Roadmap have been introduced to improve ICT infrastructure within the education sector. This roadmap outlines a phased approach, beginning with basic necessities like electricity, devices, and internet access, followed by the implementation of system management tools and interactive digital resources [1]. Ultimately, it aims to build capacity through the promotion of digital literacy and the training of educators in hybrid teaching methods [2]. These strategic stages reflect Cambodia's ongoing efforts to align its higher education system with international standards and enhance the quality of teaching and learning. Nevertheless, access to technology alone does not lead to better educational outcomes. Effective ICT integration also relies on students' psychological preparedness, particularly their self-efficacy, the confidence in their ability to learn and successfully complete tasks using technology. Bandura [3] self-efficacy theory suggests that students with strong belief in their technological abilities are more likely to set ambitious goals, stay motivated, and overcome academic obstacles. This heightened self-efficacy promotes more active engagement with ICT tools, which can subsequently lead to improved academic achievement.

In Cambodian higher education, where socioeconomic and cultural contexts often influence students' access to resources and confidence levels, self-efficacy plays a critical mediating role between ICT accessibility and learning outcomes. Students with strong self-efficacy are more likely to use ICT tools effectively for research, collaboration, and self-directed learning, ultimately achieving better academic results. Conversely, those lacking confidence may struggle to leverage available technologies, regardless of infrastructure improvements. Thus, understanding the interplay between ICT accessibility and self-efficacy is essential for maximizing the benefits of technology in learning environments. Despite the global emphasis on technology-enhanced learning, there is limited research on how these dynamics operate in Cambodia. Most existing studies do not fully address how self-efficacy mediates the relationship between ICT and educational outcomes in this context. Given the increasing pressure on higher education institutions to improve quality, equity, and employability, exploring this relationship is both timely and necessary [4]. Learning outcomes, including academic achievement, cognitive development, and critical thinking, are not only indicators of educational effectiveness but also have long-term implications for national development. This study seeks to bridge this research gap by investigating the impact of ICT accessibility on learning outcomes in Cambodian public universities, with a particular focus on the mediating role of self-efficacy. By doing so, the goal is to offer practical guidance for policymakers, educators, and institutions in creating focused strategies that promote effective technology use while also enhancing students' confidence and skills in digital learning environment. This study is structured around the following guiding research questions:

RQ1: To what extent does ICT accessibility influence learning outcomes in Cambodian public higher education institutions?

RQ2: How does ICT accessibility affect students' self-efficacy in Cambodian public higher education?

RQ3: What is the relationship between students' self-efficacy and their learning outcomes in Cambodian public higher education?

RQ4: Does self-efficacy mediate the relationship between ICT accessibility and learning outcomes in Cambodian public higher education?

The primary objective of this PhD research is to investigate the mediating role of self-efficacy in the relationship between ICT accessibility and learning outcomes among students in Cambodian public higher education institutions. Specifically, the study aims to examine how varying levels of access to

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ICT resources affect students' academic performance and cognitive development, and to what extent students' belief in their own technological and learning capabilities influences this relationship. By exploring this mediating effect, the research seeks to provide a deeper understanding of the psychological and infrastructural factors that jointly contribute to improved learning outcomes, offering practical insights for educators, institutional leaders, and policymakers to enhance digital learning environments in Cambodia's higher education sector.

2. Literature Review

ICT accessibility plays a pivotal role in fostering inclusive, equitable, and effective educational environments in higher education. As technology continues to redefine the landscape of teaching and learning, ensuring that ICT tools are both available and usable by all students regardless of their physical, cognitive, or socioeconomic backgrounds has become essential. ICT accessibility extends beyond the physical provision of digital devices and infrastructure to encompass inclusive design practices that accommodate diverse learner needs. This includes ensuring compatibility with assistive technologies, adopting universal design principles, and creating digital content that adheres to accessibility standards such as the Web Content Accessibility Guidelines (WCAG). As noted by Alhassan and Adam [5] integrating accessibility features like alternative text, captions, and keyboard navigation significantly enhances the learning experience for students with impairments, while simultaneously benefiting the broader student population. Moreover, ICT accessibility must be approached as a systemic and collaborative effort within tertiary institutions. This involves cross-functional coordination among IT departments, disability services, academic staff, and students to identify and address barriers to digital engagement. Fernández-Gutiérrez, et al. [6] emphasize that a culture of awareness and continuous training among faculty and staff is crucial for maintaining inclusive digital learning ecosystems. Without accessibility, ICT adoption may inadvertently deepen educational inequalities rather than mitigate them. Therefore, ICT accessibility should be considered a fundamental pillar of digital transformation strategies in higher education, particularly in developing contexts where disparities in infrastructure, digital literacy, and policy implementation are more pronounced.

Self-efficacy, a central construct within social cognitive theory, refers to an individual's belief in their ability to execute tasks and achieve specific outcomes [3]. In the context of higher education, academic self-efficacy plays a pivotal role in shaping students' motivation, learning behaviors, and overall academic performance. Students with high self-efficacy demonstrate greater confidence in planning, organizing, and executing academic tasks, even in the face of adversity. They tend to be more resilient, engage more deeply with learning materials, and are proactive in seeking support and resources to enhance their academic experience. Conversely, low self-efficacy often correlates with hesitation, reduced effort, and a diminished sense of academic commitment, which can negatively affect performance and persistence. According to Schunk and DiBenedetto [7] academic self-efficacy significantly predicts learning outcomes by influencing students' goal setting, effort regulation, and adaptive learning strategies. These beliefs not only shape learners' expectations of success but also guide their responses to academic challenges. Similarly, Oriol-Granado, et al. [8] argue that self-efficacy encompasses not only students' confidence in managing academic demands but also their ability to identify and respond constructively to opportunities and barriers within the learning environment. High academic self-efficacy enhances students' willingness to engage with complex tasks, encourages persistence, and promotes a more active, strategic approach to learning. As such, fostering self-efficacy is vital for educational systems aiming to support student success, especially in contexts where learners must navigate evolving technological and instructional modalities. Empowering students through self-efficacy enhancement initiatives can lead to more equitable, engaged, and high-performing academic communities [9].

Learning outcomes are foundational components in the design and evaluation of educational programs, providing a clear articulation of what students are expected to know, do, and value upon the completion of a learning process. More than just broad educational goals, learning outcomes serve as

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measurable indicators that guide instructional strategies and assessment methods are the need for collaborative efforts between academic leaders, career services, and students to foster a supportive environment that promotes success [10]. According to Yusop, et al. [11] learning outcomes encompass cognitive, affective, and psychomotor domains are reflecting what learners should know, the skills they should acquire, and the values they should develop. These outcomes are often framed in explicit, measurable terms that align with the intended curriculum, ensuring that both students and instructors have a shared understanding of the educational objectives. Parsons, et al. [12] further emphasize the utility of learning outcomes as critical tools for educational navigation, likening them to a GPS system that ensures instructional alignment and student progression. By clearly defining the destination of learning, these outcomes help educators select appropriate content, teaching methodologies, and evaluation criteria. Moreover, they empower learners by setting transparent expectations and fostering self-directed learning. In curriculum development, well-defined learning outcomes facilitate consistency across modules and enable institutions to benchmark academic programs, assess quality, and ensure the relevance of instruction to real-world applications. Overall, learning outcomes are more than pedagogical formalities; they represent essential markers of academic quality, learner achievement, and institutional accountability in higher education, serving as both a roadmap for educators and a success metric for students.

2.1. ICT Accessibility and Learning Outcome

The development and accessibility of Information and Communication Technologies (ICTs) have become a global priority, as they play a crucial role in enhancing teaching and learning processes. While ICT integration has the potential to positively influence educational outcomes, its impact remains complex and context dependent. For instance, Okoye, et al. [13] found that the availability of ICT resources significantly influenced teachers' integration of technology in higher education, ultimately improving student learning outcomes. Kulal, et al. [14] reported that, despite the presence of ICT infrastructure in some public universities, its utilization in teaching was minimal and largely due to educators' limited capacity and reluctance to adopt digital tools. This disparity in ICT impact is further reflected in global assessments. While ICT access and usage can support innovative and independent learning, particularly when used effectively outside the classroom, its use within school environments often presents mixed results. In several developing countries, excessive or unfocused ICT use at school has been linked to lower academic performance, suggesting that the quality, purpose, and pedagogical integration of technology are more critical than mere access. These findings highlight the importance of ensuring that ICT use is paired with appropriate. Based on the theoretical and empirical foundations discussed, it is hypothesized that:

H_1: ICT Accessibilities has a positively significant influence on Cambodian Public Higher Education Learning Outcomes.

2.2. ICT Accessibility and Self-Efficacy

ICT accessibility has become a global imperative, driven by its transformative potential to enhance educational quality and bridge equity gaps. As emphasized by UNESCO [15] the development and inclusive accessibility of ICTs are critical for modern education systems, particularly in low- and middle-income countries. However, the link between ICT access and learning outcomes is multifaceted and influenced by the specific context in which it occurs. For instance, Okoye, et al. [13] demonstrated that the availability of ICT resources significantly influenced teachers' ability to integrate technology into instruction, ultimately impacting student performance in higher education institutions across Latin America. This suggests that ICT infrastructure alone is insufficient without the pedagogical capacity and institutional readiness to leverage it effectively. Furthermore, Putri, et al. [16] examined the interplay between technology use in educational settings and students' self-efficacy, concluding that technological engagement positively correlates with learners' confidence in managing their own learning processes. These findings collectively emphasize that effective ICT integration requires a

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holistic approach, encompassing infrastructure, educator capacity, and student agency. In the Cambodian higher education context, where digital transformation is still emerging, these insights underscore the need for not just improving ICT availability, but also ensuring its pedagogically meaningful use. Drawing from the theoretical insights and empirical evidence presented, the following hypotheses are proposed:

H_2: ICT Accessibilities has a positively significant influence on self-efficacy in Cambodia Public Higher Education.

2.3. Self-Efficacy and Learning Outcome

Self-efficacy is a crucial factor influencing students' academic involvement and success in higher education. Rooted in Bandura's social cognitive theory, self-efficacy refers to an individual's belief in their capability to execute tasks and achieve goals [3]. In academic contexts, students with high self-efficacy are more likely to approach learning challenges with confidence, resilience, and strategic effort, thereby enhancing their overall performance and motivation. Such students tend to set ambitious goals, persist through difficulties, and adopt effective learning strategies that promote cognitive engagement and academic success. Empirical evidence supports this link, showing that students' academic self-efficacy significantly predicts their ability to regulate learning, manage time, and maintain a positive academic orientation [17]. Recent studies further reinforce the mediating role of self-efficacy in the relationship between technology use and academic outcomes. For instance, Özer and Akçayoğlu [18] found that academic self-efficacy significantly strengthens the positive effects of ICT use on learning performance. Their study revealed that professional and purposeful engagement with digital tools was more predictive of academic achievement when students believed in their capability to use these tools effectively. Thus, ICT self-efficacy is what students' perceived competence in using technology that emerges as a crucial determinant of both the frequency and quality of ICT use in educational contexts. Building on the theoretical framework and supporting empirical findings, the study puts forward the following hypotheses:

H_3: *Self-efficacy has a positively significant influence on Cambodian Public Higher Education Learning Outcomes.*

2.4. Self-Efficacy, ICT Accessibilities and Learning Outcome

The integration of ICT in higher education has reshaped how students engage with learning, influencing both their self-efficacy and academic outcomes. Access to ICT tools facilitates opportunities for students to control their learning processes, encouraging goal setting, progress monitoring, and autonomous knowledge construction that all of which are fundamental to the development of self-efficacy. When students perceive themselves as capable of using technology to complete academic tasks, their confidence grows, fostering deeper engagement and improved learning outcomes. According to Ibrahim and Aldawsari [19] ICT self-efficacy defined as learners' belief in their ability to effectively use digital tools for academic purposes that plays a mediating role between ICT use and academic performance. Students with high ICT self-efficacy are not only more comfortable navigating digital platforms, but also more proactive in using these tools to enhance understanding and collaborate meaningfully. Moreover, the extent of ICT accessibility directly impacts students' ability to participate in self-regulated and technology-enhanced learning. Zakir, et al. [20] observed that students with greater exposure to digital learning environments report higher academic self-efficacy, which in turn leads to more positive educational outcomes. They argue that the psychological confidence fostered through digital engagement reinforces persistence, adaptability, and motivation. As such, meaningful access to ICT is not merely a technological concern, but a pedagogical imperative that shapes students' belief in their academic capabilities. These findings suggest that institutions must prioritize both access and support structures to maximize the educational benefits of ICT and foster sustainable student success.

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H_4: *Self-efficacy has a positively significant mediating influence on the relationship between ICT accessibilities* and Cambodian Public Higher Education Learning Outcomes.

2.5. Hypotheses and Theoretical Framework

H_1: ICT Accessibilities has a positively significant influence on Cambodian Public Higher Education Learning Outcomes.

H_2: ICT Accessibilities has a positively significant influence on self-efficacy in Cambodia Public Higher Education.

H_3: Self-efficacy has a positively significant influence on Cambodian Public Higher Education Learning Outcomes.

H_4: Self-efficacy has a positively significant mediating influence on the relationship between ICT accessibilities and Cambodian Public Higher Education Learning Outcomes.

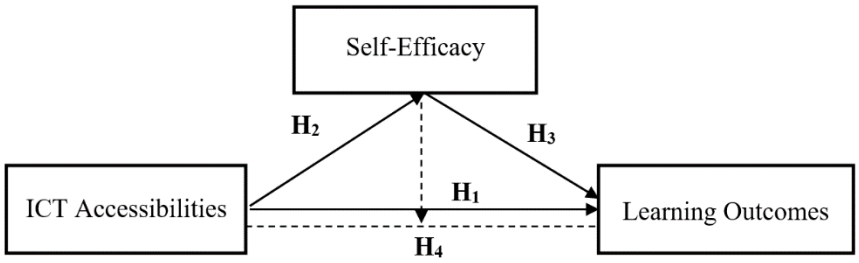

Figure 1.
Theoretical Framework.

3. Methodology

According to Mishra and Alok [21] qualitative research methods, such as interviews, observations, and content analysis, allow for rich, context-specific data collection, enabling researchers to uncover underlying meanings, perspectives, and themes. Moreover, the population of study is defined as a group of elements sharing the same affinity or sentiment [22]. 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, Krejcie and Morgan [23] observed that the growing need for research has spurred efforts to identify an effective approach for determining the sample size necessary to accurately represent the population being studied.

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 0.713 to 0.900, thereby exceeding the commonly accepted threshold of 0.70 [24]. Following the pilot validation, hard copies of the finalized questionnaires were distributed to students at selected 3 public universities in Cambodia to ensure efficient and effective data collection. In total, 384 hard-copy questionnaires were distributed to academic staff across selected public and private higher education institutions in Cambodia. This effort yielded 348 returned surveys, representing a response rate of approximately 90.6%. Upon screening the responses, 58 questionnaires were excluded due to substantial incomplete data. Consequently, 326 fully completed and valid questionnaires were retained for subsequent analysis. Thus, the overall response rate was 84.9%, 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). The questionnaire was divided into four sections. Items addressing ICT Accessibilities were designed to reflect the technological context, drawing on established frameworks. Self-efficacy measures were adapted from previously validated

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scales, while learning outcomes 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.

Table 1.
The demographic characteristics of the respondents

Factors	Classification	Repetition	Proportion
Gender	Male	155	47.5
	Female	171	52.5
Age	<20yrs	109	33.4
	20-22yrs	121	37.1
	23-25yrs	86	26.4
	25yrs >	10	3.1
Institutions	National University of Management	96	29.4
	Royal University of Phnom Penh	197	60.4
	National University of Battambang	33	10.1
N		**326**	

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 > 0.90) 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
ICT Accessibilities	IA1	0.910	0.960	0.965	0.678
	IA10	0.859			
	IA11	0.747			
	IA15	0.842			
	IA16	0.809			
	IA18	0.903			
	IA2	0.794			
	IA3	0.835			
	IA4	0.716			
	IA6	0.827			
	IA7	0.754			
	IA8	0.862			
	IA9	0.826			
Learning Outcomes	LO1	0.941	0.946	0.957	0.760
	LO2	0.911			
	LO3	0.806			
	LO4	0.772			
	LO5	0.805			
	LO6	0.932			
	LO7	0.918			
Self-Efficacy	SE1	0.795	0.959	0.965	0.734
	SE10	0.742			
	SE2	0.885			
	SE3	0.914			
	SE4	0.923			
	SE5	0.896			
	SE6	0.833			
	SE7	0.923			
	SE8	0.835			
	SE9	0.801			

Table 3 illustrates that discriminant validity was established through the Fornell–Larcker criterion, confirming that each construct is empirically unique. The square roots of the AVE values for ICT Accessibility (0.824), Self-Efficacy (0.857), and Learning Outcomes (0.872) all exceeded their respective correlations with other constructs, meeting the threshold recommended by Fornell and Larcker [26]. These findings validate the discriminant validity and further strengthen the reliability of the measurement model [25].

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

Constructs	IA	LO	SE
ICT Accessibility (IA)	0.824		
Learning Outcomes (LO)	0.401	0.872	
Self-Efficacy (SE)	0.386	0.421	0.857

Table 4, discriminant validity was further supported using the Heterotrait-Monotrait Ratio (HTMT), with all values below the 0.90 threshold [25]. Specifically, the values for IA–LO (0.418), IA–SE (0.398), and SE–LO (0.439) 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	IA	LO	SE
ICT Accessibility (IA)			
Learning Outcomes (LO)	0.418		
Self-Efficacy (SE)	0.398	0.439	

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 [27] the coefficient of determination (R^2) and the adjusted R^2 were used to evaluate the explanatory power of the regression models for each construct. For Learning Outcomes, the model explained approximately 24.4% of the variance ($R^2 = 0.244$), with an adjusted R^2 of 0.239, indicating a moderate explanatory power. For Self-Efficacy, the model accounted for 14.9% of the variance ($R^2 = 0.149$), with an adjusted R^2 of 0.146, suggesting a relatively weaker explanatory contribution. These findings indicate that the predictors in the model explain a greater proportion of variance in Learning Outcomes compared to Self-Efficacy in *Table 5*.

Table 5.
Coefficient of Determination (R Square).

Constructs	R-square	R-square adjusted
Learning Outcomes	0.244	0.239
Self-Efficacy	0.149	0.146

Additionally, the f^2 effect sizes were computed to assess how much each exogenous variable contributed to the R^2 of the endogenous constructs. According to Cohen [28] effect sizes of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively. The f^2 effect size analysis reveals that ICT accessibility has a small impact on students' performance ($f^2 = 0.088$), while self-efficacy demonstrates a small effect ($f^2 = 0.110$) on students' performance. Additionally, ICT accessibility exerts a moderate effect on self-efficacy ($f^2 = 0.175$), indicating that improved access to digital tools contributes meaningfully to enhancing learners' belief in their academic capabilities in *Table 6*.

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

Learning Outcomes	Effect Size	Decisions
ICT Assessibility	0.088	Small
Self-Efficacy	0.110	Small
Sefl-Efficacy	Effect Size	Decisions
ICT Assessibility	0.175	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 [29]. The Q^2 value for Learning Outcomes was 0.181, calculated from a sum of squares of errors (SSE) of 2,282.000 and a sum of squares of observations (SSO) of 1,867.965. This value exceeds the minimum threshold of 0.00 and suggests that the model exhibits medium predictive relevance for the construct [25]. In practical terms, this indicates that the predictors in the model are moderately effective in forecasting students' learning outcomes. For Self-Efficacy, the Q^2 value was 0.106, derived from an SSE of 3,260.000 and an SSO of 2,915.884. This value also indicates small to moderate predictive relevance, suggesting that the model has a meaningful yet more limited capability in explaining the variance in students' self-efficacy levels in *Table 7*.

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Table 7.
Construct Cross Validated Redundancy (Q2).

Constructs	SSE	SSO	1-SSE/SSO
Learning Outcomes	2,282.000	1,867.965	0.181
Self-Efficacy	3,260.000	2,915.884	0.106

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

Therefore, the SRMR values for both the saturated model and the estimated model are 0.078, which is below the recommended threshold of 0.10. This indicates that the model employed in this study demonstrates a good fit [25]. 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	0.078	0.078
d_ULS	2.863	2.863
d_G	8.644	8.644
Chi-Square	8114.357	8114.357
NFI	0.538	0.538

4.3. Hypothesis Testing

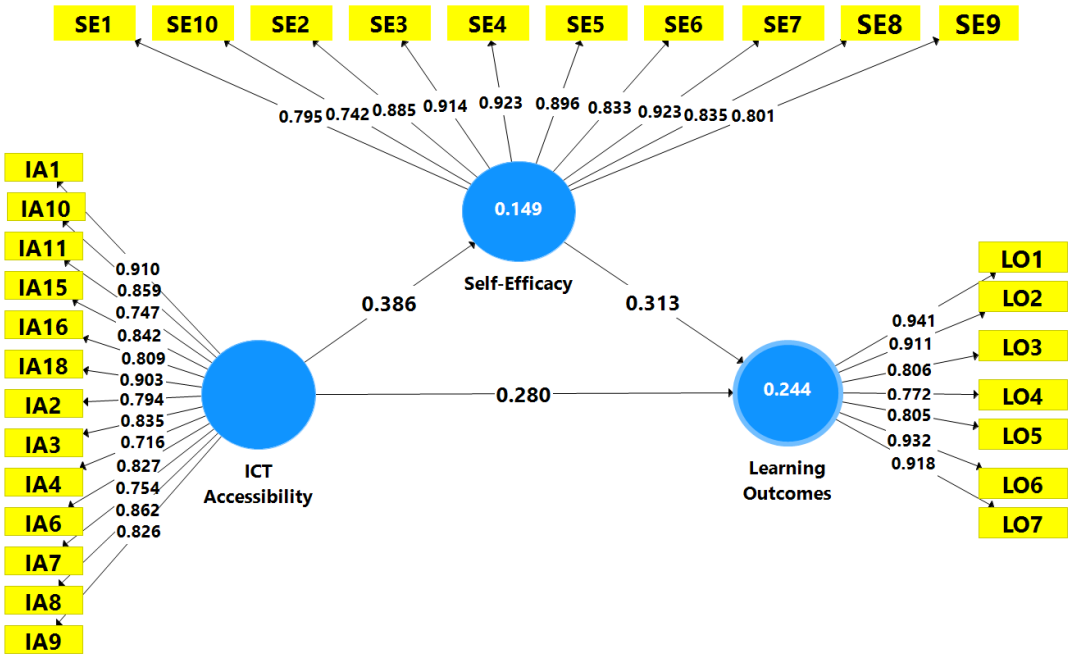

Figure 2.
Path Model Significant.

Table 9 shows H1: ICT accessibility has a significant positive effect on learning outcomes (β = 0.287, t = 5.494, p = 0.000), supporting the hypothesis that improved access to ICT resources enhances student academic performance in Cambodian public higher education.

H2: ICT accessibility significantly influences self-efficacy (β = 0.389, t = 8.410, p = 0.000), indicating that greater ICT access contributes to increased students' belief in their academic capabilities.

H3: Self-efficacy exerts a significant positive effect on learning outcomes (β = 0.307, t = 5.636, p = 0.000), corroborating its role as a critical psychological determinant of academic success.

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Table 9.
Direct Effect Hypotheses Testing.

Hypothesis	Coef.	Se	T value	P values	Decision
ICT Accessibility -> Learning Outcomes	0.287	0.051	5.494	0.000	Supported
ICT Accessibility -> Self-Efficacy	0.389	0.046	8.410	0.000	Supported
Self-Efficacy -> Learning Outcomes	0.307	0.055	5.636	0.000	Supported

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

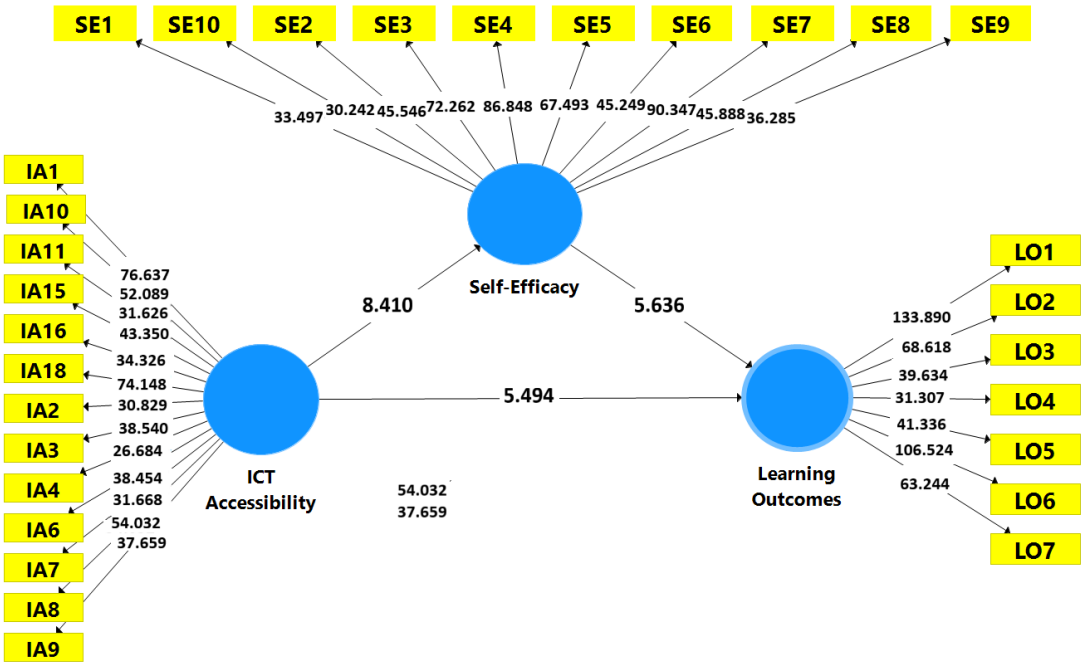

Figure 3.
Path Model Results of Mediation

Table 10 shows the analysis revealed that the indirect path from ICT Accessibility and Self-Efficacy and Learning Outcomes is statistically significant ($\beta = 0.119$, $SE = 0.025$, $t = 4.836$, $p = 0.000$). This confirms that Self-Efficacy significantly mediates the relationship between ICT accessibility and learning outcomes.

Table 10.
Indirect Effect Hypotheses Testing.

Hypothesis	Coef.	Se	T value	P values	Decision
ICT Accessibility -> Self-Efficacy -> Learning Outcomes	0.119	0.025	4.836	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, indicating both direct and indirect influences of teaching practices on academic outcomes.

This study confirms that ICT accessibility significantly influences learning outcomes in Cambodian public higher education ($\beta = 0.287$, $t = 5.494$, $p = 0.001$), supporting H1. This finding aligns with [13], who emphasized that digital access enhances engagement and academic performance when effectively integrated into instruction. Similarly, Kulal, et al. [14] found that equitable ICT access promotes

inclusion and improves learning outcomes, particularly in distance education settings. In the Cambodian context, these results suggest that investments in ICT infrastructure, alongside policies to ensure equitable access, can directly contribute to improved student performance.

The findings show that ICT accessibility significantly influences self-efficacy ($\beta = 0.389$, $t = 8.410$, $p = 0.000$), supporting H2. This suggests that increased access to digital tools strengthens students' confidence in their academic abilities. Peciuliauskiene, et al. [30] highlight that ICT self-efficacy is closely tied to digital literacy and access, particularly in teacher training contexts. Similarly, Putri, et al. [16] found a strong link between technology use and student self-efficacy, noting that consistent digital engagement enhances learners' autonomy and motivation. These results reinforce the importance of equitable ICT access not only for academic performance but also for building students' psychological readiness to learn.

The results indicate that self-efficacy has a significant positive effect on learning outcomes ($\beta = 0.307$, $t = 5.636$, $p < 0.001$), supporting H3. This reinforces the role of self-efficacy as a key psychological predictor of academic success. Özer and Akçayoğlu [18] found that higher self-efficacy contributes to better academic performance by enhancing learners' self-regulation and reducing anxiety. Meng and Zhang [17] also demonstrated that academic self-efficacy improves achievement through increased engagement. Additionally, AL-Qadri, et al. [31] emphasized that self-efficacy positively influences learning outcomes, particularly when linked with academic commitment and self-assessment. Together, these findings highlight self-efficacy as essential for fostering sustained academic achievement in higher education contexts.

The study confirms that Self-Efficacy significantly mediates the relationship between ICT Accessibility and Learning Outcomes ($\beta = 0.119$, SE = 0.025, t = 4.836, $p < 0.001$). This suggests that access to technology alone does not ensure improved academic performance—students' belief in their ability to use ICT effectively is crucial. This aligns with Rorimpandey and Midun [32] who found that self-efficacy enhances the impact of hybrid learning strategies, and with Bećirović, et al. [33] who showed that e-learning self-efficacy is a key predictor of academic achievement. Thus, boosting students' self-efficacy should be a priority alongside improving ICT infrastructure.

6. Conclusion

The measurement model demonstrates strong reliability and validity, with high internal consistency, convergent validity, and robust discriminant validity confirmed through multiple criteria (Fornell–Larcker, HTMT). The structural model shows moderate explanatory power for Learning Outcomes ($R^2 = 0.244$) and lower for Self-Efficacy ($R^2 = 0.149$). Effect size analysis reveals that ICT accessibility has a small to moderate influence on performance and self-efficacy. Predictive relevance is supported by Q^2 values above threshold, and SRMR values below 0.08 confirm good model fit. Overall, the model is both statistically sound and practically meaningful. This study confirms that ICT accessibility positively impacts both learning outcomes and self-efficacy in Cambodian public higher education. Self-efficacy also significantly enhances learning outcomes and mediates the ICT–performance link, emphasizing that digital access alone is insufficient—students' confidence in using technology is essential. These findings highlight the dual importance of investing in ICT infrastructure and fostering students' self-efficacy to drive academic success.

This study focused only on Cambodian public universities, limiting broader generalization. Its cross-sectional design restricts causal conclusions, and self-reported data may introduce bias. Future research should use longitudinal designs, include diverse contexts, and explore additional factors like digital literacy or motivation. Qualitative approaches could also deepen understanding of ICT's impact on learning.

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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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