

Digital Transformation in Cambodian Higher Education and Its Impact on Teaching and Learning Outcomes

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ABSTRACT

This study investigates the impact of digital transformation (DT) on teaching and learning outcomes in higher education institutions (HEIs) in Cambodia. This research examines the implementation, challenges, and effects of DT initiatives using a survey questionnaire distributed to management, academic, and support personnel and students from public and private HEIs. The findings reveal widespread implementation of DT in Cambodian HEIs, with a high level of perceived effectiveness. The positive correlation between DT and improved teaching and learning outcomes, such as student satisfaction, academic performance, and educator effectiveness, supports the hypothesis that DT enhances the quality and delivery of higher education in Cambodia. However, the study also identifies several challenges, including financial constraints, digital literacy, technological infrastructure, institutional leadership support, and resistance to change. Addressing these barriers through targeted strategies and investments is crucial for the successful and sustainable adoption of digital technologies in Cambodian higher education. Additionally, the study confirms the moderating effects of technological readiness, educator competencies, student digital skills, and leadership styles on the relationship between DT and teaching and learning outcomes. Among these factors, student digital skills emerged as the strongest moderator, emphasizing the importance of enhancing digital literacy among students to maximize the benefits of DT.

Keywords: Digital transformation; Higher education; Teaching and learning outcomes; Cambodia

INTRODUCTION

The global trend towards digital transformation has significantly influenced the integration of digital technologies into teaching and learning processes in Cambodian higher education (DT). This shift towards digitalization has been accelerated by the COVID-19 pandemic, highlighting the potential benefits of digital technologies in the education sector (Heng & Doeur, 2022). The implementation of DT in higher education institutions (HEIs) is driven by the need to adapt to technological advancements brought about by the Fourth Industrial Revolution (Alenezi, 2023).

Digital technologies have disrupted traditional teaching and learning models by introducing tools such as learning management systems (LMS), data analytics, online learning, and artificial intelligence (AI). These tools enhance pedagogy, student experience, and educator roles but also present challenges related to justice, ethics, and human relations (Qolamani & Mohammed, 2023). Therefore,

DT in higher education requires not only adopting new technologies but also developing the competencies of educators and students to thrive in a digital education landscape (Mamaeva et al., 2020). Leadership plays a crucial role in facilitating DT, with specific leadership styles, mainly transactional leadership, increasing student engagement in digitally transformed learning environments (Niță & Guțu, 2023).

Learners' digital competencies are critical for developing higher education teaching. Students' self-assessment of their digital competencies highlights the need for technology-supported teaching and learning processes, presenting challenges and opportunities for HEIs (Kamsker et al., 2020). In higher vocational education, DT requires a new teaching mode that includes diversified teaching resources, personalized learning experiences, and interactive learning environments to improve students' learning effects and teachers' teaching quality (Xu, 2023).

Students' perceptions of DT in university teaching are

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crucial for managing cultural change in higher education. The COVID-19 pandemic has prompted a reevaluation of digital education, focusing on resources, professional collaboration, digital pedagogy, and student empowerment, which are vital for developing competencies in future educators (Díaz-Noguera et al., 2020).

DT has significantly impacted teaching and learning outcomes in higher education across various contexts. One notable effect is the shift towards student-centered learning, where digital tools and big data analytics enable more personalized and adaptive learning experiences (Park, 2020). Additionally, integrating digital technologies has led to more dynamic and interactive learning environments, facilitating blended learning and enhancing the overall learning experience (Bui & Nguyen, 2023; Qolamani & Mohammed, 2023).

Despite existing literature on DT in Cambodian higher education, research gaps need to be filled. Specifically, more quantitative research needs to be done into the factors that influence the relationship between DT and teaching and learning outcomes in Cambodian higher education (Shenkoya & Kim, 2023). Additionally, the potential negative consequences of DT for education have not been thoroughly investigated (Shenkoya & Kim, 2023).

To address these research gaps, this study investigates the impact of DT on teaching and learning outcomes in higher education in Cambodia. Survey questionnaires were administered to collect data from stakeholders, including students, academic staff, management, and support staff at public and private HEIs in Cambodia. The collected data were analyzed using descriptive and inferential statistics. The results aim to contribute to the existing literature on DT in Cambodian higher education by providing empirical evidence on its implementation, challenges, and impact on teaching and learning outcomes. The findings will be valuable to policymakers, educators, and stakeholders, aiding in developing effective strategies to promote and support digitalization in Cambodian higher education.

The following section presents the literature review, conceptual framework, and study hypotheses. Section four outlines the research methodology. The fifth section presents and discusses the research findings, and the final section offers concluding remarks.

LITERATURE REVIEW

DT in higher education involves the comprehensive integration of digital technologies into all aspects of HEIs, fundamentally altering their operations, education delivery, and stakeholder interactions. Driven by advancements in the Fourth Industrial Revolution, this transformation encompasses curriculum development, teaching methodologies, administrative processes, and student engagement (Benavides et al., 2020; Shenkoya & Kim, 2023; Alenezi, 2023). HEIs are adopting digital tools and platforms to enhance learning experiences and operational efficiencies, such as online courses, digital learning environments, and data analytics, to support decision-making and improve student outcomes (Shenkoya & Kim, 2023; Abad-Segura et al., 2020). This transformation contributes to sustainable curriculums and practices, promotes innovation, and helps institutions keep pace with technological changes (Shenkoya & Kim, 2023; Abad-Segura et al., 2020).

Implementing DT in HEIs necessitates strategic planning and management. HEIs must develop models and frameworks to effectively integrate digital technologies, build competitive advantages, and meet evolving stakeholder expectations (Mohamed Hashim et al., 2022; Valdés et al., 2021; Bisri et al., 2023). This transformation drives changes in HEIs' business models, requiring innovation and adaptation to the new digital landscape, addressing tensions, and leveraging opportunities presented by digital technologies (Rof et al., 2020). Executive leadership strongly influences effective implementation, which must overcome barriers and maintain a consistent approach (Bisri et al., 2023).

DT presents various challenges for HEIs, including environmental, strategic, organizational, technological, people-related, and cultural barriers (Gkrimpizi et al., 2023; Gkrimpizi & Peristeras, 2022; Rima Aditya et al., 2021). Additional obstacles include digital divides, insufficient preparation for a technology-rich society, and potential conflicts between academic and professional roles (Akour & Alenezi, 2022). Overcoming these challenges requires technological innovations, effective communication, and transforming traditional culture (Díaz-García et al., 2023). Cultural and mental shifts are essential to support technological advancements and ensure a smooth transition to a digitally enabled educational environment (Akhmetshin et al., 2020; Bucăța et al., 2022).

Several key factors influence DT in higher education, including technological readiness, educator competencies, and student digital skills. Robust digital infrastructure

and regulatory frameworks are crucial for a seamless transition from traditional to digital learning environments (Larionov et al., 2021). Universities must ensure that students and educators are well-equipped with the necessary technological tools and resources (Latifah et al., 2022). Educators must develop digital competencies to meet the digital economy's demands and effectively support students in a digital learning environment (Larionov et al., 2021; Latifah et al., 2022). Students must also possess the necessary digital competencies to engage effectively with digital learning platforms and tools, including basic digital literacy, navigating online learning environments, and using digital tools for communication and collaboration. Factors such as socio-economic background, prior training in ICT, and attitudes towards digital technologies can influence students' digital skills (Litiņa & Miltuze, 2023). While students may possess high levels of 21st-century competencies, their readiness for e-learning might be moderate, indicating a need for further development of digital skills (Elçiçek & Erdemci, 2021).

The DT of higher education has influenced teaching and learning outcomes in various ways. The integration of ICT in educational practices has been shown to improve student engagement, particularly in mathematics and science (Valverde-Berrocoso et al., 2022). Using digital technologies in class encourages students to engage in more constructive and interactive activities, positively associated with learning outcomes (Wekerle et al., 2022). Transactional leadership within a digitally transformed environment significantly enhances student engagement (Niță & Guțu, 2023).

The impact of DT on academic performance has been mixed. While some studies report slight performance improvement attributed to the use of ICT, others show positive results in specific curricular areas (Valverde-Berrocoso et al., 2022). Adopting digital learning platforms, blended learning models, and online assessment tools has reshaped traditional teaching methods and influenced student achievement by facilitating personalized and interactive learning experiences (Kumar & Priyanka, 2023). Additionally, using big data and advanced technologies in higher education has been linked to better meeting students' needs and improving learning outcomes (Park, 2020).

Student satisfaction is another critical outcome influenced by DT. The quality of online learning, particularly during the COVID-19 pandemic, has been

a focal point of research. Teacher quality, technical service quality, and overall service quality significantly impact student satisfaction (Jiménez-Bucarey et al., 2021). In Bangladesh, DT activities in private universities have positively influenced student satisfaction and retention (Forid et al., 2022). Furthermore, a systematic review of digital strategies in education underscores the importance of a well-implemented DT for improving educational outcomes and student satisfaction (Bui & Nguyen, 2023). In Cambodian higher education, DT has garnered significant research attention. Studies emphasize the importance of ICT models, emerging technologies, learning theories, professionalizing teachers, and leveraging existing resources (Antepli et al., 2019; Donaher & Wu, 2020). The Cambodian government's vision and initiatives, such as the EduTech roadmap, focus on promoting innovation and entrepreneurship through technology-enhanced learning (Hul, 2022).

Shenkoya and Kim (2023) expanded the literature by examining the effects of DT on higher education in Cambodia by combining a systematic literature review and bibliometric analysis. Their study found that DT in Cambodian higher education has led to the development of sustainable curriculums, digitalization of education, enhancement of innovation, and improved student performance. They also identified future trends, including the advancement of "Education 4.0," increased use of gamification, datafication in decision-making, and AI/augmented intelligence integration. However, the study noted a need for more quantitative research on the relationship between DT and higher education teaching and learning outcomes. Additionally, their study did not consider the negative impacts of DT on education.

Despite the existing literature on DT in Cambodian higher education, a research gap needs to be filled. Specifically, there needs to be more quantitative research that analyzes various factors that may affect the relationship between DT and teaching and learning outcomes in higher education. This lack of quantitative research limits our understanding of DT's specific impacts and effectiveness in Cambodian HEIs. Additionally, the negative impacts of DT on education have yet to be thoroughly examined. By addressing these research gaps, this study can provide more comprehensive insights into the effects of DT in Cambodian higher education and inform strategies and policies to maximize its benefits while mitigating potential drawbacks.

CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

Figure 1 presents the conceptual framework that serves as a roadmap for this study. DT is the independent variable driving changes in teaching and learning approaches and outcomes in HEIs. DT encompasses adopting and integrating digital technologies, such as LMS, data analytics, online learning, and AI, into the educational process (Benavides et al., 2020; Shenkoya & Kim, 2023; Alenezi, 2023).

The successful implementation of DT in HEIs depends on various moderating variables identified in the literature. Technological readiness, including robust digital infrastructure and regulatory frameworks, is crucial for a seamless transition to digital learning environments (Larionov et al., 2021). Educator competencies, such as developing digital skills and pedagogical knowledge to support students in a digital learning environment effectively, also play a crucial role (Larionov et al., 2021; Latifah et al., 2022). Similarly, student digital skills, including basic digital literacy, the ability to navigate online learning platforms, and skills for using digital tools for communication and collaboration, are essential for engaging with technology-enhanced learning (Litiņa & Miltuze, 2023; Elçiçek & Erdemci, 2021).

The literature also highlights the importance of leadership styles in promoting student engagement and enhancing learning outcomes in digitally transformed environments. Transactional leadership has significantly enhanced student engagement (Niță & Guțu, 2023). Additionally, effective leadership is crucial for overcoming barriers and maintaining a consistent approach to DT (Bisri et al., 2023).

Integrating digital technologies in educational practices has improved student engagement, particularly in mathematics and science (Valverde-Berrocoso et al., 2022; Wekerle et al., 2022). However, the impact of DT on academic performance has been mixed, with some studies reporting little improvement and others showing positive results in specific curricular areas (Valverde-Berrocoso et al., 2022). Adopting digital learning platforms, blended learning models, and online assessment tools has reshaped traditional teaching methods and influenced student achievement by facilitating personalized and interactive learning experiences (Kumar & Priyanka, 2023; Park, 2020).

Student satisfaction is another critical outcome influenced by DT. Factors such as teacher quality, technical service quality, and overall service quality significantly impact student satisfaction with online

and technology-enhanced learning (Jiménez-Bucarey et al., 2021; Forid et al., 2022; Bui & Nguyen, 2023).

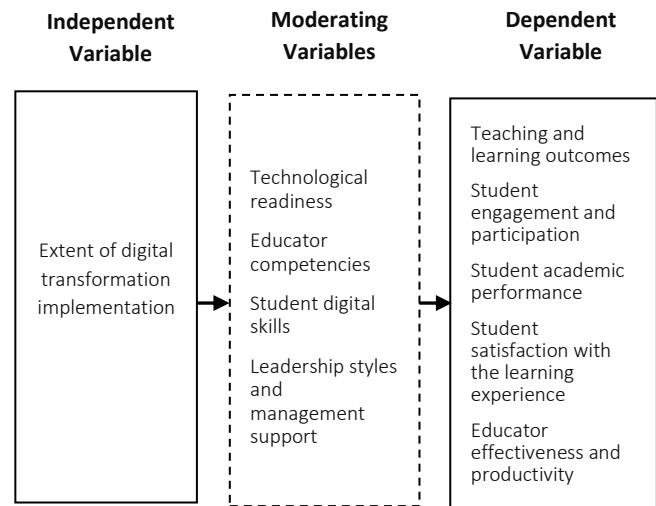


Figure 1. Conceptual Framework

Source: Constructed by the authors

Based on the above conceptual framework, the study intends to test the following hypotheses:

H1: The level of DT implementation in Cambodian HEIs is positively correlated with improved teaching and learning outcomes.

H2: Technological readiness, educator competencies, student digital skills, and leadership styles moderate the relationship between DT and teaching and learning outcomes.

METHODOLOGY

This study employed online surveys to gather data regarding the extent of DT implementation, challenges faced, and perceived impact on teaching and learning outcomes in Cambodian HEIs. The survey questions were developed based on insights from previous studies (Shenkoya & Kim, 2023; Heng & Doeur, 2022; Hul, 2022).

The target population for this study includes academic staff, management, and support personnel, as well as students from public and private HEIs in Cambodia. However, due to data limitations, the actual population size is unknown. The researchers used Zikmund's (2003) methodology to determine a suitable sample size for indeterminate population sizes. Conventional survey research aims for a 95% confidence level and a 5% margin of error (Story et al., 2019; Zikmund, 2003). Using this approach, the minimum required sample size was calculated as follows:

$$n = \frac{(z^2 pq)}{e^2}$$

Where (n) is the sample size, (z) is the z-score for a 95% confidence level (1.96), (p) is the estimated proportion of the population with the characteristic of interest (set to 0.5 for a conservative approach), ($q = 1 - p$), and (e) is the desired margin of error (5%). Substituting these values, the minimum sample size required is 385 respondents.

The study surveyed 981 respondents, including 54 academic staff, 159 management personnel, 117 support staff, and 651 students. This diverse representation ensures comprehensive insights from different stakeholders in Cambodian higher education. Academic staff are likely to focus on the impact of DT on teaching, management personnel on strategic implementation, support staff on operational challenges, and students on the effects of their learning experiences.

The data were collected using a Google Forms questionnaire sent directly to the target respondents. The survey instrument was divided into several sections, covering respondent profiles, DT implementation, impact on teaching and learning outcomes, challenges and barriers, perceived benefits and drawbacks, and moderating factors.

The gathered data were analyzed using appropriate statistical techniques, including descriptive and inferential statistics.

FINDINGS AND DISCUSSION

As shown in Table 1, the respondents are well-represented across different roles within HEIs, with a significant portion being students (38%). This is crucial for understanding the impact of DT on teaching and learning outcomes, as students are the primary beneficiaries. The inclusion of academic staff (25%), management (13%), and support staff (25%) provides a comprehensive perspective on the implementation and adoption of DT across various stakeholders.

Most respondents (83%) are from private institutions, which could influence the findings related to DT, as private institutions may have different resources, priorities, and constraints compared to public institutions (17%).

The range of service years among the respondents indicates a mix of experience levels, from those with less than one year (8%) to those with more than ten years (19%) in the education sector. This diversity can

provide insights from both newer and more seasoned individuals, offering a well-rounded perspective on the challenges and opportunities of DT. The largest group of respondents (35%) has 4-6 years of service, representing mid-career individuals with a significant understanding of the education sector.

The respondents' educational backgrounds are predominantly at the bachelor's (48%) and master's (31%) levels, with a smaller proportion holding doctoral degrees (17%). This distribution offers a comprehensive view of how DT is perceived across different educational attainments, from those with more technical and specialized knowledge (doctoral) to those with a more general understanding of the education sector (bachelor's and master's).

Table 1. Respondents' Profile

Characteristic	Percentage
<i>Position</i>	
Academic staff	25%
Management	12%
Support staff (lecturer's assistant, IT staff, librarian, etc.)	25%
Students	38%
Total	100%
<i>Types of HEIs</i>	
Private	83%
Public	17%
Total	100%
<i>Years of Service</i>	
1-3 years	29%
4-6 years	35%
7-10 years	8%
Less than 1 year	8%
More than 10 years	19%
Total	100.00%
<i>Education Level</i>	
Bachelor's degree	48%
Doctoral degree	17%
High school	4%
Master's degree	31%
Total	100%

Source: Survey results

As shown in Table 2, the extent of implementation and overall effectiveness of DT in Cambodian HEIs varies across different groups within the institution. Respondents were asked to rate the extent of implementation and overall effectiveness of DT in their respective HEIs on a scale of 1 to 5.

Academic staff rated the extent of DT implementation at

4.33, indicating a high level of integration into their work environment. Management rated it slightly lower at 4.00, reflecting robust implementation but suggesting some areas for improvement in their adoption or perception of DT. Support staff rated the highest at 4.67, showing they feel the DT initiatives are thoroughly implemented, likely due to their direct involvement in the technical and operational aspects. Students rated the extent of DT implementation at 4.28, which is high but slightly lower than other groups, suggesting that while they recognize the presence of DT initiatives, they may not feel as fully integrated or impactful as other groups.

Regarding the overall effectiveness of DT, academic staff rated it at 4.33, indicating they find the DT initiatives highly effective in enhancing their teaching and learning processes. Management also rated it at 4.33, showing they perceive the DT initiatives as effective in achieving institutional goals and improving operations. Support staff's rating of 4.33 is consistent with other groups, suggesting they find the DT initiatives effective in their roles. However, students rated the overall effectiveness at 3.94, the lowest among all groups. This indicates that students feel the DT initiatives are less effective than other groups, highlighting a potential area for improvement in how DT impacts their learning experience.

Table 2. Extent of DT Implementation and Overall Effectiveness

Stakeholder	Extent of DT implementation	Overall effectiveness of DT
Academic staff	4.33	4.33
Management	4.00	4.33
Support staff	4.67	4.33
Students	4.28	3.94
Overall	4.35	4.19

Source: Survey results

Furthermore, the survey results revealed the digital tools utilized by all Cambodian HEI stakeholders, including LMS, video conferencing platforms, and online assessment and feedback tools. Many stakeholders cited using mobile learning apps and collaborative platforms like Google Workspace and Microsoft 365. A few respondents mentioned emerging technologies such as virtual reality (VR) and augmented reality (AR). Although not widely adopted, VR/AR's potential for immersive learning experiences is recognized. Adopting these technologies will likely depend on cost, equipment availability, and the creation of relevant educational content.

Table 3 highlights the diverse challenges encountered by Cambodian HEIs when implementing their DT initiatives. The survey results identify several

challenges faced by Cambodian HEIs in implementing DT for teaching and learning, including technological infrastructure (C1), digital literacy and competencies of faculty and staff (C2), digital literacy and competencies of students (C3), availability of financial resources (C4), institutional leadership and management support (C5), and resistance to change and cultural barriers (C6). These challenges are rated on a scale of 1 to 5, with 1 being "not a challenge at all" and 5 being "a major challenge."

Table 3. Challenges and Barriers of Digital Transformation in Cambodian HEIs

Stakeholder	C1	C2	C3	C4	C5	C6
Academic staff	3.08	2.67	2.58	2.64	2.30	2.17
Management	3.17	3.17	3.00	3.00	2.17	2.83
Support staff	2.65	3.00	2.83	3.12	2.76	2.59
Students	3.25	3.17	3.64	3.36	2.91	2.82
Overall	2.98	2.98	2.98	3.04	2.61	2.57

Source: Survey results

Technological infrastructure (C1) is perceived as a moderate challenge across all groups, with students rating it the highest at 3.25. Academic staff and management also see it as a significant challenge, with ratings of 3.08 and 3.17, respectively. Support staff rate it slightly lower at 2.65, indicating some variability in perceptions of technological readiness.

Regarding digital literacy and competencies of faculty and staff (C2), management and students both rate this challenge at 3.17, suggesting a recognition of the need for improved digital skills among faculty and staff. Academic staff rate it lower at 2.67, indicating they may feel more confident in their digital competencies.

Concerning digital literacy and competencies of students (C3), students rate this as the highest challenge at 3.64, indicating significant awareness of their limitations in digital skills. Support staff and management also recognize this challenge, with ratings of 2.83 and 3.00, respectively.

Regarding the availability of financial resources (C4), students rate this challenge the highest at 3.36, reflecting their perception of financial constraints impacting DT initiatives. Support staff and management also see financial resources as significant challenges, with ratings of 3.12 and 3.00, respectively. Academic staff rate it slightly lower at 2.64.

Institutional leadership and management support (C5) are perceived as less of a challenge overall, with

academic staff rating it the lowest at 2.30. Students rate it higher at 2.91, suggesting some dissatisfaction with leadership support. Support staff and management rate it at 2.76 and 2.17, respectively.

Management perceives resistance to change and cultural barriers (C6) as more significant challenges, with a rating of 2.83. Students and support staff also recognize this challenge, with ratings of 2.82 and 2.59, respectively. Academic staff rate it the lowest at 2.17, indicating they may be more open to change.

Table 4 presents DT's perceived benefits and drawbacks in Cambodian HEIs based on existing literature. The benefits include improved student engagement and motivation (B1), enhanced quality of teaching and learning (B2), and better access to educational resources and information (B3). The drawbacks include increased workload and stress for faculty and staff (D1), the creation of a digital divide and inequalities among students (D2), and compromised personal touch and face-to-face interaction in teaching and learning (D3). Respondents were asked to rate each benefit/drawback on a scale of 1 to 5, with one being "Strongly disagree" and five being "Strongly agree."

Regarding the perceived benefits, the survey results reveal a strong consensus among stakeholders on the positive impact of DT. Academic and support staff rated the enhanced student engagement and motivation (B1) highly, with an average rating of 4.48, indicating strong agreement. However, management and students showed slightly lower levels of agreement, rating it at 3.83 and 3.94, respectively.

Similarly, the study found a strong consensus on the improved quality of teaching and learning (B2). Academic staff, support staff, and students all rated this aspect very highly, with an average rating of 4.53, reflecting strong agreement. Management also acknowledged the benefits, though to a lesser degree, with a rating of 3.83.

The most remarkable finding was the stakeholders' overwhelming agreement on the improved access to educational resources and information (B3). Academic staff, in particular, rated this benefit the highest at 4.83, followed by students (4.56), support staff (4.50), and management (4.33), indicating a shared perception of enhanced access.

Table 4. Perceived Benefits and Drawbacks of Digital Transformation in Cambodian HEIs

Stakeholder	B1	B2	B3	D1	D2	D3
Academic staff	4.42	4.50	4.83	2.75	2.83	2.92
Management	3.83	3.83	4.33	2.83	2.67	3.17
Support staff	4.55	4.58	4.50	2.83	2.73	3.25
Students	3.94	4.50	4.56	3.19	3.12	3.38
Overall	4.19	4.44	4.58	2.93	2.89	3.20

Source: Survey results

In contrast, the perceived drawbacks of DT were viewed with more moderate concerns. Academic staff, management, and support staff rated the increased workload and stress for faculty and staff (D1) at an average of 2.80, suggesting a moderate level of concern. Students, however, expressed greater concern, rating it at 3.19.

Regarding creating a digital divide and inequalities among students (D2), the stakeholders again expressed moderate concern, with average ratings of 2.74. Students indicated a slightly higher level of concern at 3.12.

The most significant drawback identified was the compromised personal touch and face-to-face interaction in teaching and learning (D3). Support staff and students rated this aspect the highest, at 3.25 and 3.38, respectively, reflecting moderate to high concern. Management and academic staff also expressed notable concern, with ratings of 3.17 and 2.92, respectively.

The correlation results presented in Table 5 provide insights into the relationships between the study's independent variable (extent of DT implementation) and dependent variables (student engagement and participation [Y1], student academic performance [Y2], student satisfaction with the learning experience [Y3], educator effectiveness and productivity [Y4], and the overall impact of DT on teaching and learning outcomes [Y5]). The correlation coefficients between the extent of DT implementation (X) and the dependent variables (Y1 - Y5) are positive, indicating a positive relationship between these variables.

The strongest positive correlation (0.213936) is found between DT implementation and student satisfaction with the learning experience (Y3). This indicates that while there is a positive relationship, it is relatively weak. When digital tools and technologies are effectively integrated into the learning environment, students are more satisfied with their overall learning experience. Enhancing the quality and accessibility of digital resources can further increase student satisfaction.

A positive relationship (0.177853) between DT

implementation and educator effectiveness and productivity (Y4) suggests that digital tools and technologies help educators become more effective and productive. Although this correlation is weak, providing ongoing training and support for educators can enhance this positive impact.

The correlation for student academic performance (Y2) is also positive (0.147481), indicating that digital initiatives positively impact academic outcomes, though the effect is not very strong. Continued focus on integrating digital resources and personalized learning approaches can help improve academic performance.

In contrast, the correlation between student engagement and participation (Y1) is the weakest among the outcomes (0.114785), indicating a relatively modest positive relationship with the extent of DT implementation. This implies that while DT efforts contribute to increased engagement and participation, the effect is relatively modest. Enhancing digital tools and interactive platforms could further boost student involvement.

The overall impact on teaching and learning outcomes (Y5) shows a weak positive correlation (0.161999) with the extent of DT implementation. This suggests that while DT efforts generally improve teaching and learning outcomes, the effect is not strong. Continued investment in digital initiatives and addressing barriers can maximize the overall impact.

Table 5. Correlation Results

	Y1	Y2	Y3	Y4	Y5
X	0.114785	0.147481	0.213936	0.177853	0.161999
M1	0.219189	0.174972	0.129904	0.142573	0.101706
M2	0.215199	0.209203	0.063161	0.089151	0.114405
M3	0.311469	0.307001	0.196688	0.247640	0.149278
M4	0.212617	0.321999	0.239983	0.261601	0.098571

Source: Authors' calculations

The moderating effects of technological readiness (M1), educator competency with digital tools (M2), student digital skills (M3), and leadership styles and management support (M4) were also analyzed, as these factors can influence the relationship between DT implementation and the observed teaching and learning outcomes.

The correlation coefficients between the moderating variables (M1 – M4) and the dependent variables (Y1 – Y5) are positive, indicating a positive relationship between these variables. The magnitudes of the correlation coefficients vary, with some being stronger than others.

Student digital skills (M3) show the strongest correlations with student engagement and participation (Y1, $r = 0.311469$), student academic performance (Y2, $r = 0.307001$), and educator effectiveness and productivity (Y4, $r = 0.247640$). This suggests that enhancing students' digital literacy and competencies can significantly improve their learning experiences and academic performance. Initiatives focused on developing students' digital skills should be a priority in DT strategies.

Leadership styles and management support (M4) also show strong correlations with student academic performance (Y2, $r = 0.321999$) and educator effectiveness and productivity (Y4, $r = 0.261601$). This indicates that effective leadership can be crucial in championing the DT agenda, securing necessary resources, and fostering a culture of innovation and continuous improvement.

In contrast, the correlations for technological readiness (M1) and educator competency with digital tools (M2) are relatively weak. This implies that while these factors are important, their direct influence on teaching and learning outcomes is more limited. Having the necessary technology or providing training to educators may not be enough to drive significant improvements in outcomes. Other factors, such as pedagogical approaches, learning design, and integrating digital tools into the curriculum, may play a more crucial role.

The weak correlation between leadership styles and management support with the overall impact of DT on teaching and learning outcomes (Y5, $r = 0.098571$) indicates that these factors, while important for creating an enabling environment for DT, have a less pronounced direct impact on outcomes.

The study investigated two hypotheses related to the impact of DT on teaching and learning outcomes in Cambodian HEIs.

H1 states that the level of DT implementation in Cambodian HEIs is positively correlated with improved teaching and learning outcomes. The correlation results support this hypothesis, showing positive relationships between DT implementation and various outcomes, including student engagement and participation (0.114785), academic performance (0.147481), satisfaction with the learning experience (0.213936), educator effectiveness and productivity (0.177853), and the overall impact on teaching and learning (0.161999). Though relatively weak, these correlations indicate that DT initiatives are positively associated with improved teaching and learning outcomes, particularly

in terms of student satisfaction and educator productivity.

These findings align with existing literature on the impact of DT in higher education. Studies have shown that integrating ICT into educational practices can improve student engagement, especially in mathematics and science (Valverde-Berrocoso et al., 2022; Wekerle et al., 2022). Using digital technologies in the classroom encourages students to engage in more constructive and interactive activities, positively associated with learning outcomes (Wekerle et al., 2022). Additionally, adopting digital learning platforms, blended learning models, and online assessment tools has been linked to improved student achievement by facilitating personalized and interactive learning experiences (Kumar & Priyanka, 2023).

The positive correlation between DT implementation and student satisfaction (0.213936) aligns with previous studies. Researchers have highlighted the importance of teacher quality, technical service quality, and overall service quality in influencing student satisfaction, particularly in online learning during the COVID-19 pandemic (Jiménez-Bucarey et al., 2021). Studies in Bangladesh have also found that DT activities in private universities positively influence student satisfaction and retention (Forid et al., 2022). Furthermore, a systematic review of digital strategies in education underscores the importance of well-implemented DT for improving educational outcomes and student satisfaction (Bui & Nguyen, 2023).

The positive correlation between DT implementation and educator effectiveness and productivity (0.177853) contributes to the existing literature on the impact of DT in higher education. Researchers have highlighted the importance of transactional leadership within a digitally transformed environment in significantly enhancing student engagement (Niță & Guțu, 2023), closely related to educator effectiveness and productivity.

H2 states that technological readiness, educator competencies, student digital skills, and leadership styles moderate the relationship between DT and teaching and learning outcomes. The findings support this hypothesis, with student digital skills (0.149278) showing the strongest moderating effect, followed by educator competency with digital tools (0.114405), technological readiness (0.101706), and leadership styles and management support (0.098571). These

results indicate that these factors moderate the relationship between DT and teaching and learning outcomes, with student digital skills particularly influential.

The literature review underscores the importance of these factors in successfully implementing DT in higher education. Researchers have emphasized the crucial role of robust digital infrastructure, regulatory frameworks, and well-equipped students and educators in facilitating the transition to digital learning environments (Larionov et al., 2021; Latifah et al., 2022). Additionally, the literature highlights the significance of leadership and management support in driving effective DT (Bisri et al., 2023). The findings of this study align with these insights and provide empirical evidence on the moderating effects of these factors in the context of Cambodian higher education.

CONCLUSION

This study investigates the impact of DT on teaching and learning outcomes in HEIs in Cambodia. The findings provide valuable empirical evidence on the implementation, challenges, and impact of DT initiatives in the context of Cambodian higher education.

The results indicate that Cambodian HEIs have widely implemented DT initiatives with a high perceived effectiveness. This suggests a strong commitment to integrating digital tools and technologies across various aspects of HEI operations, including teaching, learning, and administrative processes. The positive correlation between the extent of DT implementation and improved teaching and learning outcomes, such as student satisfaction, academic performance, and educator effectiveness, supports the first hypothesis (H1). This underscores the potential of DT to enhance the quality and delivery of higher education in Cambodia.

The study also identified several challenges HEIs face in implementing DT, including financial constraints, digital literacy and competencies of faculty, staff, and students, technological infrastructure, institutional leadership support, and resistance to change. Addressing these barriers through targeted strategies and investments will be crucial for the successful and sustainable adoption of digital technologies in Cambodian higher education.

Furthermore, the findings confirm the moderating effects of technological readiness, educator competencies, student digital skills, and leadership styles on the relationship between DT and teaching and learning outcomes, as hypothesized (H2). Among these

factors, student digital skills emerged as the strongest moderator, highlighting the importance of enhancing digital literacy and competencies among students to maximize the benefits of DT. Ensuring adequate support and training for educators and students to develop their digital capabilities will be essential for realizing the full potential of DT in Cambodian HEIs.

This study has limitations. Though representative of different stakeholder groups, the data were primarily from private HEIs, which may not fully capture the experiences of public HEIs in Cambodia. Future research should aim for a balanced representation of both public and private HEIs to understand better the actual state of DT in Cambodian higher education and its impact on teaching and learning outcomes. Additionally, in-depth case studies of successful DT initiatives could highlight best practices, critical success factors, and effective implementation strategies. Comparative studies between HEIs with varying levels of DT maturity could provide deeper insights into the conditions and factors that enable or hinder the successful integration of digital technologies in Cambodian higher education.

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