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Modeling Digital Transformation in Higher Education: A Cipp-based Evaluation of Smart Learning Environments in Resource-constrained Contexts

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Research Article

Keywords: Digital transformation, Smart learning environments, Higher education, CIPP model, Technology-enhanced learning, Resource-constrained contexts

Posted Date: April 9th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9356259/v1

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Additional Declarations: No competing interests reported.

Abstract

The transformation of higher education into smart digital learning environments has become a global priority, yet empirical evidence from resource-constrained contexts remains limited. This study models digital transformation as a nonlinear and context-dependent process by integrating the Context–Input–Process–Product (CIPP) evaluation framework with diffusion of innovation theory. Focusing on public universities in Tanzania under the Higher Education for Economic Transformation (HEET) project, the study examines how infrastructure, institutional readiness, and pedagogical practices interact to shape transformation outcomes. A convergent mixed-methods design was employed, drawing on data from 732 participants, including academic staff, students, and institutional leaders across five universities. Quantitative data were analysed using descriptive and inferential statistics, while qualitative data were examined through thematic analysis. The findings show that large-scale investments significantly improve infrastructure, connectivity, and access, creating enabling conditions for digital transformation. However, persistent misalignment between technological inputs and pedagogical practices constrains the effective use of smart learning environments. Institutional differences were statistically significant, indicating that transformation outcomes are mediated by organisational readiness, leadership, and implementation processes. This study contributes to the literature by advancing a context-sensitive model of digital transformation that highlights the interaction between infrastructure, pedagogical integration, and institutional capacity. It demonstrates that infrastructure alone is insufficient to drive pedagogical change and that transformation unfolds through complex, interdependent processes. The findings offer practical and transferable insights for policymakers and higher education institutions seeking to design integrated, sustainable, and inclusive digital transformation strategies in developing contexts.

1. Introduction

The global digital transformation of higher education has accelerated, driven by the need for flexible, inclusive, and technology-enhanced learning environments (Aithal et al., 2025; Yadav, 2026; Suntharalingam, 2026). Smart digital learning environments characterised by the integration of digital infrastructure, data-driven systems, and student-centred pedagogies are increasingly seen as essential for improving learning outcomes and institutional resilience (Batsurovska et al., 2025; Dudar et al., 2025). While significant progress has been made in high-income contexts, the dynamics of digital transformation in resource-constrained higher education systems remain underexplored. Prior research has focused primarily on infrastructure and access, often assuming that investment in digital tools improves learning outcomes(Arifudin, 2025). However, emerging evidence indicates that transformation depends not only on technology but also on alignment among infrastructure, pedagogical practices, and institutional readiness.

This gap is particularly pronounced in Sub-Saharan Africa, where digital transformation initiatives frequently produce uneven outcomes despite substantial investment (Astuti & Ayinde, 2025; Naatu et al., 2025). Universities in the region continue to face challenges, including limited information and

communication technology (ICT) infrastructure, unreliable internet connectivity, inadequate digital learning facilities, and insufficient staff readiness to support technology-integrated pedagogy. These constraints hinder the effective utilisation of digital learning environments and slow the transition from traditional classrooms to smart digital spaces (Mhlanga, 2024; Mhlongo et al., 2023).

In Tanzania, efforts to strengthen smart digital learning environments have intensified over time. Since independence, the government of the United Republic of Tanzania has implemented various policies and institutional reforms to expand access to higher education and improve quality. Regulatory frameworks developed by the Tanzania Commission for Universities, alongside national policies such as the Education and Training Policy of 2014 (revised 2023) and the National Digital Education Strategy (2024–2030), emphasise the integration of digital technologies into teaching and learning. These initiatives have been complemented by investments in physical and digital infrastructure, including lecture halls, laboratories, and ICT facilities (MoEST, 2024), thereby emphasising the integration of digital technologies into teaching and learning.

Despite these efforts, challenges related to infrastructure limitations, uneven resource distribution, and low levels of pedagogical integration persist (Adam et al., 2026; Ndibalema, 2025; Shao et al., 2026). Universities often struggle not only with access to digital technologies but also with effectively integrating them into teaching practices (Ambele et al., 2025; Mtebe et al., 2025). These findings indicate that smart digital learning environments in higher education extend beyond infrastructure provision and require alignment among technological resources, pedagogical practices, and institutional support systems.

To address these challenges, the Government of Tanzania, in collaboration with the World Bank, launched the Higher Education for Economic Transformation (HEET) project. The project aims to strengthen learning environments by investing in physical and digital infrastructure while also aligning academic programs with labour market demands (URT, 2021). Although the project represents a significant national intervention, systematic evidence on the transformation of smart digital learning environments at the institutional level remains limited. The existing study (Mwaitete, 2024) predominantly assesses broader development outcomes, such as employment creation, rather than focusing on the HEET project's core objectives, and provides limited insight into the transformation of the learning environment. Similarly, project implementation reports highlight progress in key indicators, such as curriculum alignment with labour market needs and access to learning interventions, but also reveal uneven progress across components and gaps in system-level mechanisms, including performance agreements and education management information systems (World Bank, 2023). Therefore, there is a critical need for comprehensive, mixed-method evaluations that simultaneously examine implementation processes, progress indicators, and emerging outcomes to provide a more holistic understanding of the transformation of smart digital learning environments.

This study addresses this gap by applying the CIPP evaluation model to assess the extent to which HEET project interventions have contributed to transforming traditional classrooms into smart digital learning

spaces in Tanzanian public universities. Specifically, the study examines institutional progress and persistent challenges, offering an integrated understanding of how infrastructure, pedagogy, and institutional readiness interact to shape technology-enabled learning environments.

This study makes three key contributions. First, it provides empirical evidence on large-scale digital transformation in higher education within a resource-constrained context, addressing a gap in the current literature. Second, it extends the CIPP evaluation model by integrating Diffusion of Innovation Theory to explain institutional variation in digital adoption. Third, it develops a context-sensitive analytical framework that demonstrates how infrastructure, pedagogical practices, and institutional readiness interact to shape transformation outcomes. These contributions provide transferable insights for both researchers and policymakers in similar contexts.

1.1 Conceptual framework

This study conceptualises the transformation of traditional classrooms into smart digital learning environments as a multidimensional process shaped by the interactions among technological infrastructure, pedagogical practices, and institutional support systems (Astuti & Ayinde, 2025). Rather than viewing digital transformation as a purely technological shift, the study assumes that meaningful change occurs when these elements are systematically aligned to support effective teaching and learning. To guide the analysis, this study adopts the context, input, process, and product (CIPP) evaluation model, which provides a comprehensive framework for assessing educational interventions (Chinenye, 2025; Zhang et al., 2025).

The four core components serve distinct but interrelated purposes. Context evaluation identifies underlying needs and justifies interventions (Stufflebeam, 2000), whereas input evaluation assesses the adequacy of the design and resources. Although the study initially intended to prioritise context and input evaluations within the CIPP framework, these components were less central in practice. They primarily served to provide background and situational analysis. In contrast, implementation and process evaluations were more directly relevant to understanding the progress and challenges of transforming higher education into smart digital learning environments. Thus, the context dimension refers to the institutional needs, challenges, and conditions that necessitate transforming learning environments in Tanzanian public universities. This includes infrastructure gaps, limitations in traditional pedagogical approaches, and the growing demand for technology-enhanced learning. The input dimension focuses on the resources provided through the HEET project, including physical infrastructure, digital technologies and academic staff capacity. This dimension reflects the extent to which universities are equipped to support smart digital learning environments.

The process dimension examines how these inputs are utilised in practice, particularly in relation to teaching and learning. It captures the extent to which academic staff integrate digital technologies into pedagogical practices, adopt student-centred approaches, and engage with digital platforms. This dimension was critical, as the effectiveness of technology depends largely on its implementation rather

than its mere availability (Islam et al., 2022). The product dimension represents the intermediate outcomes of the transformation process, including improved teaching practices, enhanced student engagement, increased access to learning resources, and the development of inclusive learning environments. These intermediate outcomes reflect the extent to which smart digital learning environments contribute to meaningful educational improvement.

To strengthen the analytical framework, this study draws on diffusion of innovation (DOI) theory, which explains how new technologies are adopted and institutionalised within organisations (Mexhuani, 2025; Wang et al., 2023). This theory suggests that the adoption of digital learning technologies depends on factors such as perceived usefulness, institutional support, and users' readiness (Abulail et al., 2025; Luo & Tang, 2026; Maharani et al., 2025). In this study, diffusion processes were reflected in how universities adopted, adapted, and integrated HEET-supported technologies into teaching and learning practices.

By integrating the CIPP model with diffusion-of-innovation perspectives, the framework enables the study to assess not only whether digital transformation has occurred but also how and why variations exist across institutions. Specifically, the framework guides data collection by structuring variables around context, input, processes, outcomes, and data analysis and by linking quantitative indicators and qualitative themes to CIPP dimensions. Interpretation explains institutional differences through variations in readiness, resource utilisation, and adoption processes. Thus, the transformation of traditional classrooms into smart digital spaces is understood as a dynamic, context-dependent process shaped by the alignment of institutional readiness, available resources, implementation practices, and resulting outcomes.

1.2. Empirical Literature Review

Empirical studies on smart digital learning environments in higher education have consistently highlighted their potential to enhance student engagement, collaboration, and learning outcomes. However, the extent to which these benefits are realised depends on how effectively technological, pedagogical, and institutional factors are aligned.

1.2.1 Smart Digital Learning Environment and Student Engagement

A substantial body of literature demonstrates that smart digital spaces improve student engagement and learning outcomes. Studies by Dai et al. (2023) and Hsu and Ching (2023) reported increased student motivation, interaction, and participation in technology-enabled learning environments. Similarly, AlAli and Yousef (2024) reported that smart classrooms promote collaboration, particularly in STEM disciplines. However, these positive outcomes are not consistent across contexts. Nguyen et al. (2022) argued that the effectiveness of smart classrooms varies depending on course design, students' prior exposure to digital technologies, and the level of institutional support. This suggests that digital learning environments alone do not guarantee improved outcomes, highlighting the importance of contextual and institutional factors.

1.2.3 Role of Infrastructure in the Smart Digital Learning Environment

Infrastructure is widely recognised as a foundational element of digital transformation in higher education. Studies indicate that access to reliable internet, digital platforms, and well-equipped learning facilities is strongly associated with improved student satisfaction and academic performance (Mohammed et al., 2025; Umar et al., 2023). In the African context, research by Gikandi (2021) and Swai et al. (2022) shows that improvements in ICT infrastructure significantly enhance student engagement and learning experiences. However, most studies focus on isolated infrastructure components and pay little attention to how large-scale institutional investments are coordinated and sustained.

1.2.4 Pedagogical integration and implementation processes

The effectiveness of smart digital learning environments depends on how technologies are integrated into teaching practices. Tadesse et al. (2022) highlight the importance of constructivist and student-centred pedagogies in enhancing engagement in digital environments. Similarly, Huang et al. (2024) show that digital learning interventions improve self-regulation and collaboration when supported by appropriate instructional strategies. Despite these benefits, several studies have identified persistent challenges. Kaeane and Molokomme (2025) reported that limited staff training and inadequate institutional support constrain the effective use of a digital smart learning environment. Nguyen et al. (2024) further reported that disparities in digital skills and access continue to affect learning outcomes. These findings suggest that pedagogical alignment and readiness building are critical for translating technological inputs into meaningful learning experiences.

1.2.5 Institutional Readiness in Smart Digital Learning Environments

Institutional factors, including leadership, policy frameworks, and stakeholder engagement, play crucial roles in shaping the success of digital transformation initiatives. Swai et al. (2022) emphasise that leadership commitment and policy alignment are essential for improving learning environments in Tanzanian institutions. Similarly, Selim et al. (2020) and Rashed et al. (2025) highlight the importance of strategic ICT planning in sustaining digital learning initiatives. These studies collectively demonstrate that infrastructure investments alone are insufficient without strong institutional support mechanisms. Effective digital transformation requires coordinated efforts across multiple levels of the institution.

Generally, the literature demonstrates that smart digital learning environments enhance educational outcomes when supported by adequate infrastructure, effective pedagogical practices, and strong institutional frameworks. However, most studies focus on classroom-level or single-component interventions, with limited attention given to institutional initiatives that integrate infrastructure, pedagogy, and institutional support. There are inadequate comprehensive evaluation frameworks that

systematically assess digital transformation across multiple dimensions, including processes and products. In the context of Tanzanian public universities, empirical evidence on large-scale initiatives, such as the HEET project, remains limited, particularly from mixed-methods and institutional evaluation perspectives. This study addresses these gaps by applying the CIPP evaluation model to assess the extent to which HEET project interventions have contributed to transforming traditional classrooms into smart digital learning environments, with a focus on institutional progress and persistent challenges.

2. Methodology

2.1 Research Design

This study adopts a convergent mixed-methods design in which quantitative and qualitative data are collected concurrently, analysed separately, and integrated during interpretation (Creswell & Creswell, 2023). This design was selected to provide a comprehensive understanding of the HEET project's contribution to transforming traditional classrooms into smart digital spaces. While quantitative data capture the extent of institutional progress, qualitative data provide deeper insights into implementation processes, contextual factors, and challenges. The integration of both datasets allows for triangulation and enhances the validity of the findings.

2.2 Participants

The study was conducted in five public universities in Tanzania that are beneficiaries of the HEET project. These universities reflect variations in institutional size, infrastructure development, and the level of project implementation. The study targeted four key groups: academic staff, third-year undergraduate students, project coordinators, and component leaders (ICT and physical infrastructure). Academic staff were included because of their direct involvement in teaching and in integrating digital technologies. Moreover, third-year students were selected for their sustained exposure to HEET-supported learning environments. Project coordinators and component leaders were included to provide institutional and technical perspectives on project implementation.

2.3 Sampling Procedure and Sample Size

A combination of stratified random and purposive sampling was employed. Simple random sampling was used to select five public universities. A total of 338 academic staff members and 379 third-year undergraduate students were sampled by using stratified proportionate random sampling to ensure representation across universities and sexes. The final sample included 271 academic staff (80.1% response rate) and 329 students (86.8% response rate). Twenty-five key informants, comprising project coordinators and component leaders, were purposively selected for their direct involvement in HEET implementation. Data saturation was reached after 3 project coordinators and 17 component leaders, when no new themes emerged. The sample size was adequate to capture both the breadth (quantitative patterns) and depth (qualitative insights) of institutional transformation processes.

2.4 Data collection

Questionnaires were administered to academic staff and students. The items were rated on a five-point Likert scale (1 = very low extent to 5 = very great extent). The instrument included 10 items covering key dimensions, including digital infrastructure, pedagogical practices, accessibility and inclusivity, and capacity building. A pilot study was conducted to ensure clarity and reliability. Internal consistency was confirmed using Cronbach's alpha: academic staff, $\alpha = 0.81$; students, $\alpha = 0.79$. Both values exceed the recommended threshold of 0.70, indicating acceptable reliability (Hussey et al., 2025). Face-to-face interviews were conducted with project coordinators and component leaders to explore implementation processes, institutional readiness, intermediate outcomes, and challenges. The interviews lasted 40–50 minutes, were audio-recorded with consent, and were conducted in confidential settings to ensure the openness of the responses.

Observations were conducted on both the ongoing and the completed HEET-supported learning infrastructure. The observation guide focused on the availability and quality of the ICT infrastructure, the flexibility of learning spaces, support for technology-enhanced pedagogy, and accessibility and inclusivity. This method enables direct assessment of the operational readiness of smart digital learning environments.

2.5 Data analysis

Data analysis followed the procedures of a convergent mixed-methods design. The first step was quantitative data analysis; all the questionnaires were checked for completeness after data collection. The responses were then coded and entered into SPSS (version 27). The data were cleaned to identify and correct missing values, outliers, and inconsistencies. Descriptive statistics, including mean scores and standard deviation, were computed to summarise the responses. One-way ANOVA was conducted to examine differences across universities. Post hoc comparisons were performed using Tukey's HSD test. Effect sizes (partial η^2) and confidence intervals were used to assess the magnitude of difference. The second step was qualitative data analysis using thematic analysis. The transcripts were coded by using ATLAS.ti. Codes were grouped into themes.

The third step involved integrating the quantitative and qualitative results through analysis. This process used a side-by-side comparison (Creswell & Creswell, 2023): the quantitative results were presented first, followed by qualitative themes that either confirmed, expanded, or explained those results. The fourth step was data interpretation: The integrated results were analysed to determine the extent to which the project has transformed the learning environment into smart digital spaces. The interpretation involved identifying points of convergence and divergence between quantitative and qualitative findings and linking them to the study's purpose. Ethical clearance was obtained before data collection. The participants were informed about the study's purpose, their right to withdraw, and the voluntary nature of participation. Informed consent was obtained from all participants (Cilar Budler & Stiglic, 2025). Confidentiality and anonymity were ensured through the use of pseudonyms and coded identifiers (Adams, 2025).

3. Findings

3.1 Progress in Transforming Higher Education into Smart Digital Learning Environments

To enhance analytical clarity, findings were organised according to CIPP dimensions. The findings indicate that the HEET project has contributed moderately to the transformation of a smart digital learning environment in Tanzanian public universities. Overall, academic staff and students reported improvements across key dimensions, although the extent of progress varied. The data are summarised and presented in Table 1.

Table 1

HEET Project Contributions to Smart Digital Learning Environments (AS n = 271; Ss n = 329)

SN	Στατεμεντσ	Student (mean)	Academic staff (mean)
i.	**Supports the integration of digital technologies (e.g., smart boards, projectors, online platforms) in classrooms.**	**2.54**	**3.01**
ii.	Φacilitates access to reliable internet and Wi-Fi for students and academic staff.	3.31	2.88
iii.	Provides infrastructure enabling interactive, technology-enhanced teaching and learning.	2.59	2.57
iv.	Promotes the use of innovative digital pedagogical approaches.	2.35	2.19
v.	Ensures classrooms are designed to support collaborative, technology-enabled learning.	2.92	2.32
vi.	Provides tools and platforms for virtual learning, online assignments, and digital assessments.	2.57	3.06
vii.	Ensures accessibility for students with disabilities in digital learning environments.	2.92	3.06
viii.	Incorporates inclusive practices in technology-enabled classrooms, including gender considerations.	3.12	3.39
ix.	Supports the use of adaptive learning technologies and interactive simulations in classrooms.	3.12	3.33
x.	Strengthens lecturers' and students' readiness to use digital tools effectively for teaching, learning, and academic management.	3.08	3.26
Source (Author's own work)			

The data in Table 1 indicate that Academic Staff members consider the greatest contributions to digital inclusivity, accessibility, and capacity building. Academic staff recognised improvements in inclusive learning practices, accessibility for students with disabilities, and the use of adaptive learning technologies. Similarly, the students emphasised the need for increased access to reliable internet

connectivity and increased opportunities for engagement through digital platforms. These patterns suggest that the HEET project has been effective at expanding access to digital learning resources and supporting broader participation in technology-enabled education. Students identified reliable internet and Wi-Fi access as the most significant benefit (mean = 3.31), alongside inclusive classroom practices (mean = 3.12) and adaptive learning technologies (mean = 3.12). They also acknowledged improvements in readiness-building for digital tools (mean = 3.08) and in collaborative, technology-enabled classroom design (mean = 2.92). These responses suggest that students observe HEET as enhancing connectivity, interactive learning, and engagement with digital tools.

The data in Table 1 also reveal lower progress in pedagogical transformation and infrastructure integration (students = 2.54; Staff = 3.01) and infrastructure enabling interactive, technology-enhanced teaching (students = 2.59; Staff = 2.57). Both academic staff and students reported limited advancements in the use of innovative digital pedagogical approaches and in the availability of fully interactive smart classroom environments. These findings indicate that while access to technology has improved, its integration into teaching practices remains uneven and still developing. Thus, the results further suggest that the HEET project has made stronger contributions to enabling conditions (access and infrastructure availability) than to transformational intermediate outcomes (pedagogical innovation and interactive learning environments).

3.2 Variations in the transformation of higher education into smart digital learning environments

Academic staff and students' responses to the extent to which the HEET Project contributed to the smart digital learning environment varied across the five sampled universities (n = 05). The mean ratings ranged from 2.36 (University B) to 3.60 (University D), with standard deviations ranging from 0.32 to 0.61, indicating differences in perceived project contributions and response consistency. Preliminary assessment confirmed approximate normality (Shapiro–Wilk W = 0.986, p = 0.279) and homogeneity of variance (Levene's test p = 0.057–0.08), justifying the results of the parametric ANOVA.

A one-way ANOVA tested whether the ratings of academic staff and students differed significantly across universities: H_0: No difference exists in the ratings of staff who contribute to the technology-enabling learning environment across the five universities. The results are summarised and presented in Table 2.

Table 2

One-way ANOVA – HEET Project Contribution to Smart Digital Learning Environments

Source of Variation	Sum of Squares	df	Mean Square	F	P value
Between Groups	19.652	4	4.913	25.59	< 0.001
Within Groups	22.079	115	0.192		
Total	41.732	119			
Source: Author's own work					

The ANOVA results in Table 2 revealed a significant difference, $F(4,115) = 25.59$, $p < 0.001$, leading to rejection of H_0. These findings indicate that the HEET project contributes to a technology-enabling learning environment that varies across institutions. The analysis further reveals statistically significant differences in perceived project contributions across the five universities. These findings indicate that the intermediate outcome of the HEET project is not uniform but varies across institutional contexts and implementation levels.

Post hoc analysis (Tukey HSD) pairwise comparisons revealed significant differences in perceptions

University A was rated higher than University B (MD = 0.71, $p < 0.001$) and lower than University D (MD = − 0.54, $p < 0.001$). Compared with University C (MD = − 0.84, $p < 0.001$), D (MD = − 1.24, $p < 0.001$), and E (MD = − 0.57, $p < 0.001$), University B recorded significantly lower ratings. Universities C and E did not differ significantly ($p > 0.05$). Post hoc comparisons indicate that some universities show significantly greater progress, whereas others lag. These variations suggest differences in institutional readiness, infrastructure development, and the effectiveness of implementation processes. These findings highlight that digital transformation is context-dependent and that similar investments may yield different intermediate outcomes across institutions.

3.4 Qualitative Insights into Progress in Transforming Higher Education into Smart Digital Learning Environments

The qualitative findings provide deeper insights into how the HEET has contributed to institutional transformation. The interview participants consistently reported substantial improvements in physical and digital infrastructure, including the renovation of existing learning spaces, the construction of new learning spaces, the establishment of smart classrooms, and the upgrading of ICT facilities. For example, project leaders described transforming traditional lecture halls into functional smart learning environments and expanding classroom readiness by constructing new buildings. These developments directly address long-standing challenges related to overcrowding and inadequate facilities, as reported below.

With HEET support, a former single hall was renovated into three sections: an editing area and two studio rooms. Additionally, the computer laboratory was upgraded into a smart classroom equipped with ICT facilities for technology-enhanced teaching and learning (ICTL, University B).

Similarly, physical component leaders emphasised that newly constructed buildings accommodate up to 3,000 students and include mini-conference rooms and laboratories, directly addressing classroom shortages, as stated:

Three HEET-funded buildings are under construction in two lots. Lot One includes a 13,000 m² academic block with a basement and three floors, accommodating 3,340 users simultaneously and over 9,000 daily, with classrooms, labs, offices, and conference halls (PCL University A).

In addition, the participants highlighted progress in digital platforms and connectivity. Improvements such as increased internet bandwidth, the integration of virtual learning environments with learning management systems, and expanded access points have enhanced flexibility in teaching and learning. These developments enable both face-to-face and remote participation, supporting blended learning approaches and reporting:

Zoom was integrated with the LMS, enabling blended teaching with remote participation and increasing the number of users. The bandwidth increased from 230 to 550 Mbps, with 35 access points installed. Fibre connectivity improved access, whereas VLE integration with Moodle enhanced features and accessibility to digital learning material (ICTL University A).

Leaders reported implementing student registration systems, e-learning platforms, and faster internet, supported by new servers, confirming quantitative findings on internet access and virtual learning support:

Before the HEET project, ICT systems were absent or outdated. Since implementation, systems have been introduced, including student registration, records management, and e-learning. Internet access improved from limited mobile connectivity to faster TTCL-supported service, alongside three servers and a reliable infrastructure (ICTL University C).

3.5 Capacity Building and Digital Adoption

Another important area of progress was capacity building and digital adoption. The interview data indicate that academic staff and students have gained increased access to digital tools and platforms, enabling more flexible interactions. The availability of LMS, video conferencing tools, and digital content platforms has increased opportunities for online teaching and learning. This suggests that the project has contributed to improving institutional capacity and digital competence, which are essential for sustaining technology-enabled learning environments: *"The learning management system is always available*, allowing *teachers to teach online, interact with students, and discuss topics online. These facilities are accessible to all academic staff whenever needed"* (ICTL University E).

Furthermore, the ICT component leader of University D (ICTLD) described the adoption of video conferencing tools and software to increase teaching and research flexibility, as stated:

We also have a Zoom account and a video conferencing platform provided through the HEET project. We are subscribed to En Vivo, a software tool for qualitative data analysis, which students and staff now use. Academic staff can now conduct sessions outside traditional hours and still communicate with students, as the internal infrastructure supports such flexibility (ICTL University D).

ICTLD's response demonstrates a mature stage of digital adoption, in which institutions improve connectivity and leverage advanced digital tools for teaching, research, and flexible scheduling. Such developments enhance academic productivity and learning flexibility, aligning closely with the goal of digital transformation.

Observations of ongoing and completed physical and ICT infrastructure projects revealed progress in the creation of smart digital learning environments. Renovated and new spaces were evaluated against technological infrastructure, pedagogical support, institutional readiness, and inclusivity, with facilities that incorporated accessibility for students with disabilities, gender-responsive designs, and safe, energy-efficient structures. The classrooms and learning spaces were flexible and supported blended learning, collaborative problem-solving, and student-centred activities. Lecture halls and laboratories enhanced academic and collaborative engagement. ICT infrastructures, including multimedia studios, smart classrooms, online conferencing systems, and digital platforms, were at varying stages of completion and use, providing the backbone for real-time interaction and digital collaboration. These findings indicate that HEET investments are transforming traditional classrooms into smart digital spaces, though some areas require further improvement to optimise teaching and learning fully.

3.6 Persistent Challenges in Transforming Higher Education into Smart Digital Learning Environments

Despite the notable progress achieved through the HEET project, the findings reveal several persistent challenges that continue to constrain the full realisation of smart digital learning environments in Tanzanian public universities.

Limited Pedagogical Integration and Readiness

The findings indicate that although digital infrastructure and tools have improved, their effective integration into pedagogy remains limited. Many academic staff have not fully transitioned from traditional teaching approaches to student-centred, technology-driven pedagogies, indicating a gap between technological provision and actual utilisation. This challenge is closely linked to insufficient and inconsistent readiness-building efforts. Training programs are often too short to equip staff with the necessary competencies to integrate digital tools effectively into teaching:

The greatest challenge is the insufficient time allocated for these training courses. For example, many aspects of this project are new and require expertise. However, people are given only one or two days of

Training. How can you build the readiness of the academic staff in just one day or a week? (SL University E).

In addition, low participation in institutional Training further undermines readiness development:

Poor attendance, especially during in-house Training. You will find that Training is scheduled for three days, but some attend only one or two days, or none at all. You know, for these internal sessions, there is no allowance; just lunch is provided, so that is part of the issue (SL University B)

Moreover, resistance to change and limited exposure to global best practices continue to slow the adoption of innovative teaching approaches. Academic staff, particularly those accustomed to traditional content delivery, often hesitate to integrate student-centred and technology-driven pedagogies. These observations indicate that despite HEET's substantial investment in digital infrastructure, the full transformation into smart learning environments remains constrained by gaps in human readiness, engagement, and pedagogical readiness.

Uneven Infrastructure Development and Resource Constraints

The study further reveals that infrastructure development remains uneven across institutions, contributing to disparities in access to smart digital learning environments. While some universities have made significant progress, others continue to face structural, financial, and procedural barriers. A major constraint relates to delays in funding and procurement processes:

The pace of implementation. There are many processes involved in releasing funds. Therefore, there were issues with the banking process, i.e., the World Bank's procedures, before the funds could be cleared and made available. That was one of the greatest challenges (ICT University A)

The ICT leader at university E also added the following:

The procurement process sometimes takes longer than you expect. You have to advertise the tender, and for this HEET project, you have to, first before you advertise you have to send your request to the World Bank so that you get approval from the World Bank, and after that, you advertise, you open bids, you evaluate those bids, and you know, it takes longer than our normal procurement process (ICT University E)

Financial limitations also restrict the scale of implementation:

Given the budget we have for ICT, it is not enough. We relied on additional HEET project funds to support a range of activities. Thus far, some things will happen, but I think many will not because the budget is low (ICT University C)

In addition, existing physical infrastructure often does not support digital transformation:

Because if we look at the buildings, perhaps they were built using a traditional model that did not support technology, and now you have brought new technology. What challenges have you faced? In some buildings, wiring and cabling are in place, but the infrastructure lacks the necessary data transmission equipment. Yes, but in some buildings, you want to turn them into smart classrooms, but the windows are not supportive (ICT University B)

Implementation Inefficiencies and Sustainability Challenges

These findings demonstrate that institutional progress under the HEET is uneven, with infrastructural and financial constraints limiting equitable access to smart digital learning environments.

The transformation process was also hindered by ongoing implementation inefficiencies and sustainability challenges, with some digital systems and facilities not yet fully operational or optimally utilised.

One key issue is planning and prioritisation:

Another issue concerns specifications, knowing what needs to be done and what should be left out. What must be prioritised to ensure impact? Everyone had their priorities. Even within ICT, there were competing priorities, and deciding which action to take and what to leave out was challenging. For example, you might choose to purchase computers for labs, but then realise there are no computer labs to install them in (ICT University A).

Budget instability due to external economic factors further affects implementation:

The fluctuation of the U.S. dollar versus our Tsh. This budget was set three to four years ago, and the values have changed. If you plan to have, like, two loads of that equipment, you will end up with one load (ICT University E)

In addition, limited technical expertise and project management readiness pose challenges:

We are the ones expected to manage the project. However, the project involves technologies we are not familiar with; we do not know them, and we are supposed to follow up in detail (ICT University A).

The greatest challenge we encountered was a shortage of professionals (ICT University C).

System adoption also remains a concern owing to continued resistance and low readiness:

The challenge is that when you develop a new system, you have to train staff to use it and explain its benefits. Sometimes you can also face resistance from some people, like, 'Why should we use it?' (ICT University A)

Digital literacy remains a major challenge for both staff and students. Some students do not know how to move around those digital platforms; that is the challenge (ICT University E)

These findings suggest that the transition to smart digital learning environments under HEET is still ongoing, with challenges related to coordination, system readiness, and long-term sustainability limiting full implementation and impact.

Generally, the findings demonstrate that while the HEET project has driven substantial institutional progress, persistent challenges related to pedagogical adoption, infrastructure disparities, and implementation inefficiencies continue to shape the pace and depth of transformation. This underscores the complexity of transforming higher education into smart digital learning environments, where technological investments must be matched with human readiness, institutional coordination, and sustainable implementation strategies.

The integration of quantitative and qualitative datasets provides a comprehensive understanding of the HEET project contribution. The quantitative results highlight moderate progress and institutional variation, whereas the qualitative evidence explains these patterns by revealing differences in infrastructure development, institutional readiness, and implementation practices. The integrated findings demonstrate that the HEET project has established a strong foundation for transforming smart digital learning environments, particularly in terms of infrastructure, connectivity, and capacity-building. However, the transition from traditional classrooms to fully functional smart digital spaces remains incomplete, with significant gaps in pedagogical innovation and institutional consistency.

4. Discussion of the findings

The findings of this study provide important insights into how large-scale institutional interventions transform traditional classrooms into smart digital learning spaces. Guided by the CIPP evaluation framework, this study demonstrates that digital transformation in Tanzanian public universities is shaped not only by resource investments but also by the interaction between contextual conditions, implementation processes, and institutional capacities.

The findings advance current understanding by demonstrating that the HEET project has significantly strengthened digital infrastructure, connectivity, and access to learning technologies, confirming that the input dimension of the CIPP model has been effectively addressed. These improvements have expanded access to digital learning resources and enhanced inclusivity, particularly for students requiring flexible learning pathways. These findings align with those of previous studies by Umar et al. (2023) and Mohammed et al. (2025), which identify infrastructure as a foundational enabler of technology-enhanced learning. However, the present study moves beyond this established view by demonstrating that infrastructure alone does not ensure pedagogical transformation. While access to digital tools has improved, their use for innovative pedagogy remains limited. This challenges the implicit assumption in parts of the literature that infrastructure investment is sufficient to drive technological transformation.

These findings indicate a complex, nonlinear transformation between infrastructure investment and pedagogical change. While smart classrooms, connectivity, and digital platforms create enabling conditions, their impact depends on effective integration into teaching. Many academic staff still use

digital tools as a substitute, reflecting a disconnect between technology and pedagogy. Within the CIPP framework, this indicates a process limitation where inputs do not translate into meaningful outcomes. Consistent with Tadesse et al. (2022) and Nguyen et al. (2022), the findings show that large-scale investments alone yield limited change when process factors are weak. From a diffusion of innovation perspective, many staff members remain at early adoption stages, highlighting the need for sustained institutional support.

The findings further demonstrate that digital transformation is highly context-dependent, as reflected in significant variation across universities. Despite operating under a shared national initiative, institutions exhibit different levels of progress in implementing smart learning environments. Within the CIPP model, these differences can be attributed to variations in context (institutional capacity and leadership commitment) and process (implementation effectiveness). While some universities have achieved relatively advanced levels of integration, others remain at early stages. These findings support earlier research by Selim et al. (2020) and Rashed et al. (2025) but also extend it by showing that institutional dynamics mediate the intermediate outcomes of national-level interventions, leading to uneven transformation. In this sense, digital transformation should be understood as a locally negotiated process rather than a uniform intermediate outcome of policy implementation.

The findings also highlight the critical role of capacity building and institutional readiness. Although improvements in digital skills, access to platforms, and technical support indicate progress, these gains have not yet translated into widespread pedagogical innovation. This suggests that current capacity-building efforts may be insufficient in depth, continuity, or alignment with pedagogical goals. Consistent with Kaeane and Molokomme (2025), the results indicate that without sustained professional development and institutional support, digital technologies are unlikely to be effectively integrated into teaching practices.

From a broader perspective, the findings contribute to ongoing debates on digital transformation in higher education, particularly in Sub-Saharan Africa. While previous research has emphasised the role of infrastructure in expanding access (Nguyen et al., 2022; Hsu & Ching, 2023), the present study provides empirical evidence that the key challenge lies not in access but in pedagogical transformation. Furthermore, the observed disparities across institutions reflect a multidimensional digital divide encompassing not only technological access but also differences in pedagogical, institutional, and organisational readiness and support (Gikandi, 2021; Mhlanga, 2024). By applying the CIPP model, this study advances an integrated understanding of digital transformation by highlighting the interplay among infrastructure, pedagogy, and institutional readiness.

4.1 Practical implications of the findings

The findings have several important implications for Policy and practice. First, policymakers should move beyond an infrastructure-centric approach and adopt a more integrated strategy that aligns technological investments with pedagogical reform. This includes embedding clear expectations for

student-centred teaching within digital transformation initiatives. Second, universities should strengthen continuous professional development for academic staff, focusing not only on technical skills but also on pedagogical integration. Training programs should be practice-oriented and aligned with teaching contexts to facilitate meaningful adoption. Given the observed institutional disparities, national initiatives such as the HEET project should incorporate context-sensitive implementation strategies that allow for flexibility while ensuring minimum standards for effective integration.

4.2. Limitations of the Study and Future Research

This study examined the current implementation phase of the HEET project; as a result, it may not reflect the long-term effects of smart digital classroom infrastructure on teaching practices, student engagement, and institutional transformation. Longitudinal studies should be conducted in future research to assess the long-term impact of smart digital classrooms on student learning outcomes. Comparative institutional studies should be explored to identify the factors that influence successful digital transformation.

5. Conclusions of the Study

The findings indicate that the HEET project has made significant progress in transforming higher education into smart digital learning environments, particularly by enhancing digital infrastructure, connectivity, accessibility, and institutional capacity. These improvements have expanded the opportunities for flexible and inclusive learning, demonstrating the value of large-scale national investment. However, the transformation remains uneven across institutions, as the integration of innovative digital pedagogical practices and fully interactive smart classrooms is still limited. This highlights a critical gap between technological provision and pedagogical utilisation. This study demonstrates that digital transformation in higher education is not a linear outcome of technological investment but a complex, context-dependent process shaped by the interaction of infrastructure, institutional readiness, and pedagogical integration. Sustainable transformation, therefore, requires a systemic approach that aligns technological inputs with organisational and pedagogical change.

6. Recommendations

Based on the conclusions, the following recommendations are proposed. Develop integrated digital transformation policies that link infrastructure investment with pedagogical innovation. Provide continuous professional development, including Training and mentorship, to enhance digital teaching competence. Strengthen evaluation frameworks to monitor technological adoption and pedagogical outcomes. Establish leadership strategies with clear guidelines and incentives for innovative teaching practices. Student-centred, interactive pedagogical approaches supported by digital technologies should be promoted.

Declarations

7.1 Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

7.2 Competing interests

The authors declare that they have no competing interests.

7.3 Funding

Not applicable

7.4 Acknowledgements

Not applicable

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