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The Digital Learning Tools and Educational Access in Tanzanian Higher Education: The Mediating Role of Academic Staff Digital Competence in Advancing the Mwalimu Nyerere Legacy in Science and Technology

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Abstract: *This study investigates the growing influence of digital learning tools on educational access to higher education in Tanzania, while incorporating the mediating influence of academic staff's digital competence in championing the legacy of Mwalimu Nyerere's advocacy for science and technology for self-reliance and development of the nation. Despite the growing use of digital platforms to support higher education by universities in Tanzania, issues of infrastructure, user training and readiness amongst academic staff still inhibit the possibility for equitable access to digital educational options. The study adopted the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The study utilized a cross-sectional research design and quantitative approach which utilized survey questionnaire for data collection from academic staff from different institutions. Data was analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) and tested both direct and mediation effects amongst digital learning tools, academic staff digital competence and student educational access. The study findings indicate that digital learning tools positively support access and staff competence. Results also indicate that staff competence has a significant and positive direct effect on access, independently. Mediation analysis suggests that academic staff digital competence only partially mediates the effect of digital learning tools and access. The findings underscore the role of higher education institutions' capacity as a complement to the investment in the institutional infrastructure when turning a positive effect from technology into inclusive learning opportunities. The study findings suggest that while digital tools are important, the needs to invest in a complement in human capacity is significant. From these findings, the study suggest that Nyerere's vision for technological advancement as an effort for equitable advancement can hold true for higher education as well. The findings contribute to the literature by extending UTAUT into the context of African higher education. These findings have informed future considerations for governmental policy, institutional implementation strategies, and professional development for higher education in Tanzania to be inclusive and sustainable in technology change.*

Keywords: Academic Staff, Digital Learning, Digital Competence, Higher Education, Educational Access, Mwalimu Nyerere, Science and Technology

1. INTRODUCTION

Digital learning tools are disruptive in higher education and have altered how knowledge is accessed, shared, and used. There are international trends that show universities are increasingly adopting digital platforms, e-learning systems, and online collaboration tools to enhance teaching and learning (Rafiq et al., 2024). These tools, at least in part, support Sustainable Development Goal (SDG) 4, which promotes inclusive and equitable quality education and lifelong learning opportunities for all. As higher education integrates digital technologies to a greater extent, the need for academic staff with the appropriate skills to use these tools effectively has been increasing substantially (Sormunen et al., 2022). This finding also presents both opportunities for innovation and challenges for developing capacity.

Despite the rapid growth of digital learning globally, access, quality, and utilization varies widely across the world, and it is seen as particularly problematic in developing parts of the world. While digital learning tools have the potential to democratize education, their success often hinges on the digital competence of academic staff (Alenezi, 2023a). It has been argued by scholars that simply creating digital technology is not enough, there is a need to be a focus on faculty competency in order to be able to make effective use of technology in the classroom (Sousa et al., 2022). There are still gaps in context in terms of faculty readiness and this affects students' ability to receive equitable access to purposeful and quality digital learning environments (Neeraj Yadav, 2024). As such, digital

competence develops as a key mediating piece between technology adoption and access to education.

In Tanzania, a variety of higher education institutions are increasingly pursuing digital learning systems, but while there are prospects for improvement, the issues surrounding infrastructure, ongoing training for staff, and digital divide remain significant. Given Tanzania's recognition that education is important as a key driver for development, this context is important. During Tanzania's first president, Mwalimu Julius Kambarage Nyerere's effort to find ways for Tanzania to develop self-reliance, he clearly articulated the importance of education, and made a case for science and technology as an essential component for a sound, equitable, progressive society. The concern for education for self-reliance embedded into digital learning possibilities can be viewed as a way to maintain his legacy in the new knowledge economy, and the rapidly evolving technology economy as a means of education delivery. What is unclear is whether or not the digital competence of academic staff can explain the connection between the use of digital learning tools and access to education in higher education in Tanzania through empirical studies.

The literature suggests that digital learning tools alone cannot ensure equitable educational outcomes without proper facilitation by academic staff (García-Martínez et al., 2020a); (Lindfors et al., 2021a). The digital competencies of teachers are linked with student engagement, learning performance, and the inclusiveness of educational delivery (Basilotta-Gómez-Pablos et al., 2022). A considerable amount of research has been produced in developed contexts, but there are significant gaps regarding how these dynamics have unfolded and are evolving in African higher education systems. Tanzania, with its infrastructural challenges and unequal uptake of technology, offers a unique lens to investigate these issues. In this sense, this research will fill an important gap in the literature on digital competence and educational access in sub-Saharan Africa.

The issue that this study investigates is that although Tanzanian universities are developing digital learning platforms, the digital competence of academic staff have not been sufficiently developed to maximise the potential of these technologies and subsequently, students' access to education through digital platforms remains limited thereby creating inequalities in higher education. If the situation is left uncorrected, a lack of digital competence can affect the country's ability to achieve SDG 4 and limit progress in the advancement of science and technology for sustainable development (Hamadi & El-Den, 2024) which is a threat to the national vision of maintaining Mwalimu Nyerere's legacy of education as a catalyst for self-reliance and technology development. Addressing digital competence among academic staff is necessary for attaining local and national development objectives.

The purpose of this study is to explore how digital learning tools impact access to education in Tanzanian higher education through the mediating role of academic staff's digital competence. Employing Nyerere's philosophy of education and the global SDGs provides a conceptual foundation that links theory to practice. The study will generate new knowledge by clarifying how digital competence mediates the effectiveness of digital learning tools on educational access and also produces evidence as a reference for policy frameworks, institutional-level strategies, and capacity building processes in Tanzanian higher education. In the end, the study provides evidence that technology must be adopted in alignment with faculty competence to maintain the transformative vision of education for national development in Tanzania.

2. Literature Review and Hypotheses Development

2.1 Theoretical Literature Review

(Dwivedi et al., 2019a) proposed the Unified Theory of Acceptance and Use of Technology (UTAUT), which provides a framework to analyze the use of digital learning tools for higher education. The model states the four determinants of technology acceptance are performance expectancy, effort expectancy, social influence, and facilitating conditions; these fit neatly with the variables of this study. From a higher education perspective, the degree of access to digital learning tools is based on their availability and the competent use of them by academic staff (Rafiq et al., 2024); (García-Martínez et al., 2020a). Digital competence is a mediating factor as staff perceptions of ease of use and usefulness determine the initial uptake of digital tools to improve access to available education (Alenezi, 2023a); (Fareen, 2022). UTAUT is a more holistic framework in comparison to other adoption models such as the Technology Acceptance Model (TAM) as it takes multiple views in to account, and is an appropriate framework to explore the mediating role of digital competence to promote equitable access to education and establishing Mwalimu Nyerere's vision in science and technology.

Many researchers have investigated UTAUT in diverse contexts, demonstrating its viability to explain technology acceptance in education and related disciplines. One example is (Alkhuwaylidee, 2019), who utilized an extended model of UTAUT for e-learning. Other researchers who extended UTAUT2 for e-learning adoption in Qatar and the USA were (El-Masri & Tarhini, 2017a). Another, (Alshehri et al., 2012), used UTAUT to look at e-government service adoption suggesting that UTAUT has validity and reliability in across contexts. Reliability and validity is a strength of UTAUT; that it can be used to explain various constructs; and that it can be used in diverse contexts. One of the weaknesses of UTAUT is that it doesn't acknowledge cultural and contextual differences. Another is the absence of personal innovativeness as a measure of technology acceptance (Dwivedi et al., 2019a); (Ali, R. A., & Arshad, M. R. M. (2016). UTAUT is useful for this study because it highlights performance expectancy, institutional support, and the digital competence of the academic staff and how these will contribute to the technology acceptance and effective use of digital tools in Tanzanian higher education (Sormunen et al., 2022); (Dang et al., 2024a). "The theoretical framework also assures that the study will not only examine

the availability of digital tools, but also the human and institutional elements that mediate educational access an approach to digital technology related issues demonstrated by Nyerere (1985): that technology development should be people-centred and to support the national development agenda.

2.2 Digital Learning Tools and Educational Access in Higher Education

Digital learning resources (for example, e-learning platforms, digital repositories, and virtual classrooms) are well-positioned to significantly improve access to learning in higher education. Research evidence generally supports this relationship, with (García-Martínez et al., 2020a) and (Sousa et al., 2022) demonstrating that digital platforms can enhance flexibility and create participation opportunities. Furthermore, (Rafiq et al., 2024) indicated enhanced accessibility when students had the opportunity to engage with online resources outside the classroom. Yet the research was conducted in higher education contexts in which resourcing was adequate thus the extent of applicability in places such as Tanzania where there are still considerable infrastructure and digital divides remains to be determined.

Although available evidence demonstrates positive effects, the link between digital tools and access is not always linear. For example, (Sormunen et al., 2022) showed that digital interventions produced improvements in learning outcomes but noted that the outcomes were entirely dependent on institutional support and staff capability. Similarly, (Okoye et al., 2023) noted that digital technologies had gained broad adoption across large parts of Latin America, yet persistent infrastructural bottlenecks continued to limit equitable access. Studies such as Fareen (2022) are often too optimistic, discussing transformations while not properly unpacking the inequalities in implementation. This equivocal evidence suggests that while digital tools may be enabling factors, access cannot be assumed unless significant contextual barriers are addressed.

From a methodological perspective, previous work is characterised by the use of cross-sectional surveys and self-reported data, which limit causal inference and often overlook contextual factors (Dr. Neeraj Yadav, 2024); (Hamadi & El-Den, 2024). Many of the studies also utilise small or convenience samples, making it difficult to generalise from the findings to broader higher education populations (Adetayo et al., 2023); (Hrytsenchuk & Trubachev, 2021)). Furthermore, most of the literature comes from developed or middle-income contexts. At the same time, Sub-Saharan Africa is under-researched and has distinct infrastructure and policy challenges, which further highlight existing contextual issues. There is thus a clear need for context-specific evidence in Tanzania as digital tools likely interact with unique and different institutional realities and student needs.

Hypothesis (H1): Digital learning tools have a positive and significant influence on educational access in higher education.

2.3 Digital learning tools and the Digital Competence of Academic Staff

Digital learning tools combine online environments, modalities and technologies to enable teaching and learning. The digital competency of academic staff relates to their knowledge, skills and attitudes for suitably applying these tools in their pedagogy. Scholars have stated that it is difficult to separate the incorporation of technology, or digital learning tools, from lecturers' digital competencies. Without digital competency, their use of the tools is limited, if not outright ignored (Falloon, 2020); (Lindfors et al., 2021a). (Fursykova et al., 2022a), for example, showed that distance learning contexts are likely to develop faster teachers' digital competency in utilizing technology, which may suggest that the actual act of using technology reinforces the way skill development occurs in a digital environment. However, most studies take place in Western or European contexts, which suggests that empirical reflections on these associations and implications from a resource-constrained context, such as Tanzania, remain under-explored.

Research shows that using digital learning tools helps teachers get better at their jobs, no matter how they use them. (Gameil & Al-Abdullatif, 2023) found that these platforms helped teachers-in-training improve their lesson planning skills and get students more involved. Still, their study was small, so it's hard to say if the same is true everywhere. (Kallas & Pedaste, 2022) talked about ways to improve e-learning skills, but their findings came from lab experiments, which don't always reflect how things work in the real world. Also, surveys often miss important details. For example, (Santos et al., 2021) said that a teacher's skills, along with school stuff, matters. These different views tell that it's hard to associate competence growth with tools alone because institutional things matter.

Researchers have often applied reviews and self-assessment scales in order to measure these variables. For instance, (Yang et al., 2021) created and validated a digital learning competence scale for a standard approach to measure, and (Ovcharuk, 2021) used questionnaires to monitor how well individuals were at lifelong learning. (Basilotta-Gómez-Pablos et al., 2022) and (Revuelta-Domínguez et al., 2022) pointed out in their reviews that while there are a lot of digital tools, they will only be helpful if they are constantly trained and relevant to the case. Nevertheless, most research work up until then did not have enough numbers to back them up, especially when taking into consideration higher education within nations like the Global South. Therefore, this research focuses on Tanzania, which has not been the subject of many studies on how technology transforms the abilities of teachers and thus the performance of students.

Hypothesis (H2): The use of digital learning tools has a positive and significant effect on the digital competence of academic staff.

2.4 Digital Competences of Academic Staff and Educational Access in Higher Education

Academic staff's digital competence means having the knowledge, skills, and attitudes needed to incorporate digital tech into teaching and research. Educational access in higher

learning is about giving students fair learning opportunities and resources. Studies, like those by (Fernández-Batanero et al., 2021) and (Zhao et al., 2021), make clear that a lecturer's digital skills greatly affects how accessible and inclusive digital learning is. (Dang et al., 2024a) saw a connection between a lecturer's digital competence and how valuable students found the learning experience, showing that access involves more than just infrastructure; it also requires capable academic staff. Still, people often criticize these studies for not considering differences in digital readiness, especially in higher education systems that do not have enough resources.

For instructors in higher education, digital competence means having the know-how to incorporate digital tools into their teaching and studies. Educational access means students are able to equally participate in learning. Research, like the work of (Fernández-Batanero et al., 2021) and (Zhao et al., 2021), shows that when instructors are good with technology, it creates more accessible and inclusive digital learning spaces. (Dang et al., 2024a) discovered that students learn more from instructors who are skilled with digital tools, which means access is about more than just having the tech available; it's also about instructors being able to use it well. Still, some critics say that a lot of this kind of research fails to consider how different institutions have varied levels of digital resources, especially schools that don't have many resources to begin with.

Researchers use different ways to measure digital skills, like surveys (Martin et al., 2020); (Monteiro & Leite, 2021) and studies of assessment methods (Sillat et al., 2021); Bong & Chen, 2024). These methods show trends, but often don't have enough statistical proof that they improve students' access to education, especially in poorer countries. For instance, (Gilligan, 2020) and (Bong & Chen, 2024) talk about accessibility, but they don't show much proof that skills lead to equal learning chances. This shows a problem: most studies assume that skills automatically improve access, but they don't test this idea in places like Tanzania. This research will look at this in higher learning system with limited resources, where teachers' digital skills could be crucial for including students.

Hypothesis (H3): Digital competences of academic staff have a positive and significant influence on educational access in higher education.

2.5 Mediating Role of Digital Competence of Academic Staff

Digital competence is about having the skills, understanding, and mindset to use tech well for teaching and learning. It also acts as a go-between, affecting how other things impact higher education results. For academic staff, being good with tech can shape how digital tools and teaching methods affect what students learn (Peng et al., 2024); (Hizam et al., 2021). Past research shows that if teachers lack tech skills, fancy digital tools might not improve education, which is a major problem when trying to use tech (Ermolovich & Timoshkov, 2020; (Yu et al., 2023). Still, there's not much research on this go-between role in African higher education, especially in Tanzania, so it's worth looking into.

Recent quantitative research reveals the mediating role of digital competence, frequently employing structural equation modeling (SEM) to evaluate these associations. (Heidari et al., 2021) found that informal digital learning acts as a mediator between students' digital competence and their academic performance, underscoring the critical role of intermediate skills. Likewise, (Wang et al., 2024) utilized a PLS-SEM methodology to establish that digital competence mediates the impact of facilitating conditions on the digital learning results of students. Though, their studies was conducted in a highly digital environments, potentially restricting its relevance to the context of Tanzanian universities. The findings indicate that the mediating effect is affected by contextual variables, highlighting the importance of examining how the proficiency of academic personnel can transform existing resources into meaningful educational outcomes.

Assessment of digital competence in mediation studies generally uses validated scales, self-assessment surveys, and behavioural indicators of ICT integration (Heidari et al., 2021); (He et al., 2021). Although these approaches are useful to provide quantitative evidence, the sample sizes and cultural contexts differ greatly leading to findings that, at times, are limited in robustness and generalisability (Pan et al., 2024). Additionally, there are few longitudinal studies exploring how competence develops, as an outcome of training, or digital infrastructure, so understanding if and how the causal mechanisms lead to the development is challenging. By addressing these weaknesses in higher education in Tanzania, a better determination can be made if academic staff's digital competence mediates the impact of digital tools on educational access and quality, and opportunities for intervention will be explored.

Hypothesis (H4): Digital competence of academic staff positively mediates the relationship between digital learning tools and educational access in higher education.

2.6 Conceptual Framework

The conceptual framework in Figure 1, asserts that Digital Learning Tools are the independent variable. Digital learning tools can include websites, learning management systems, software simulations, and interactive, multi-media that replaces and supports teaching and learning in higher education. Digital learning tools are hypothesised to affect the dependent variable, Educational Access in Higher Education, which is the availability and access to students' participation, inclusivity, and equitable access, especially with students studying Science and Technology course contexts. The significance of the Digital Learning Tools and Educational Access relationship is moderated by the Digital Competence of Academic Staff, which is the knowledge, skills, attitudes, and confidence that allow a lecturer to use digital tools in their teaching practice. Digital competence is significant as it will determine whether having digital learning tools improves students' access to education, in line with potentially broader goals such as the Mwalimu Nyerere Legacy in Science and Technology to help ensure that technological innovations are used effectively to help students develop critical thinking,

problem solving, and scientific skills. Previous studies demonstrate that digital learning tools will only be effective if instructors have digital literacies to consider possible pedagogical methods to integrate resources, suggesting that the significance of digital competence mediating Educational Access is paramount.

Figure 1. Conceptual Framework

3. METHODS

3.1 Study Design and Setting

This research used a cross-sectional quantitative survey design to explore the relationships between digital learning tools, accessibility to education, and digital competence amongst university academic staff in Tanzania's higher education institutions (HEI). The approach was appropriate, as it provided a means of statistically testing the relationships between the variables at one point in time without inferring causality (Hair et al., 2019). The decision was to utilize quantitative as a means of objectivity, generalizability, and statistical verification of the hypothesized model (Sarstedt et al., 2019).

The research took place in four higher education institutions: Mwalimu Nyerere Memorial Academy, located in Dar es Salaam, the Institute of Social Work in Dar es Salaam, St. Augustine University of Tanzania located in Mwanza, and the Catholic University of Mbeya located in Mbeya. These higher education institutions were deliberately chosen as they represent both public and private institution found in the three main regions of Tanzania, Coastal, Lake, and Southern Highlands. The public and private higher education institutions vary greatly in their digital infrastructure and have varying levels of technology integrated into pedagogy. However, it was important to include these institutions in order to look at a diverse context for academics to talk about their experiences and digital activities across institutional types and across regions.

3.2 Population, Sampling Procedures and Sample Size

The target population consisted of academic staff working at the four selected institutions. A multistage stratified sampling method was used to allow for generalizability and broader representation. The first stage used types of higher education institution, at each of the institutions as strata. The second stage involved randomly selecting participants from each stratum proportional to institution size. Finally, purposive selection guaranteed that the academic staff selected were involved in teaching and learning using digital technologies or educational technologies (Etikan et al., 2016).

A total of 250 academic staff were invited to participate in the study, and 218 completed and returned questionnaires to provide a response rate of 87%. Specifically, the responses were: the Institute of Social Work 48; the Catholic University of Mbeya 55; St. Augustine University of Tanzania 57; Mwalimu Nyerere Memorial Academy 58. The sample size achieved for this study was above the minimum sample size recommended when using PLS-SEM based on the inverse square root method indicating a sample size of at least 210 participants is needed for the proposed model (Hair et al., 2021). The high response rate is beneficial to strengthening the trustworthiness and representativeness of the data that was collected in the study (Saunders et al., 2009).

3.3 Instrument Development and Validation

The data collection involved a structured, self-administered questionnaire that was administered electronically using faculty mailing lists. The included questionnaire consisted of closed-ended items that were intended to measure three primary constructs: (1) accessibility to education, (2) digital learning tool usage, and (3) digital competence. Each of the constructs was measured using multi-item scales that had already been validated. The constructs measuring accessibility to education and digital learning tool usage were adapted from Teo (2011), Davis (1989), and Tinto (1997), and those measures for digital competence were adapted from the European Digital Competence Framework (Redecker, 2017) and revised from Suzer and Koc (2024) and Yuanyuan et al. (2024). All of the items were adapted and contextualized to the Tanzanian higher education setting.

To assess the degree of respondents' beliefs, a five-point Likert scale (1 = "strongly disagree" to 5 = "strongly agree") was used for all survey items. This scale was chosen as it has been tried-and-tested for reliability and interpretation in the field of educational research (Hossan, 2025). Before the main survey took place, the survey was subjected to content validation with a panel of three experts in educational technology and higher education pedagogy. Additionally, a pilot study was conducted with 30 academic staff from an institution similar in profile, which assessed clarity, flow of questions and structure, and internal consistency. Item revisions were made in response to this feedback. As a test of internal reliability, all constructs met the cutoff of a Cronbach's alpha of over 0.70. To reduce common method bias, there were a number of procedural remedies to address: the respondents were assured of anonymity, item wording was balanced to reduce social desirable response effects, and question ordering was done to reduce potential priming effects (Podsakoff et al., 2012).

3.4 Data Collection Procedures

Data were electronically collected during [insert months and year] via institutional online platforms and official mailing lists. Before completing the questionnaire, the respondents were informed of the study's purpose, voluntary nature, and confidentiality. Electronic data collection provided a means of a broader geographic reach, convenience, and consistency among participating institutions.

3.5 Data Analysis

Data were first exported to Microsoft Excel for cleaning, coding, and validation before using SmartPLS version 4.0 to analyze the data. We chose to use Partial Least Squares Structural Equation Modeling (PLS-SEM) because it is

appropriate for complex models that include multiple latent variables, mediation effects, and data that is either non-normally distributed or have underlying distributions that are not known (Sarstedt et al., 2020; Hair et al., 2021).The analysis proceeded in two stages:

Measurement Model Evaluation - Indicator loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) were utilized to assess the reliability and validity of constructs. The criteria were ≥ 0.70 for loadings, alpha, and CR, and ≥ 0.50 for AVE (Hair et al., 2021). Discriminant validity was assessed using the heterotrait–monotrait (HTMT) ratio, with values less than 0.85 indicating valid discriminant validity. Multicollinearity was checked using variance inflation factors (VIF < 3).

Structural Model Evaluation - The hypothesized relationships were assessed using bootstrapping with 5,000 subsamples (two-tailed, $p < 0.05$). Fit indices were assessed using the standardized root mean squared residual (SRMR < 0.08) and the normed fit index (NFI > 0.90). Predictive relevance was evaluated using Stone–Geisser's Q^2 criteria.

4. FINDINGS

4.1 Measurement Model

The measurement model in Table 1 and Figure 2 were tested to determine that the constructs meet the PLS-SEM literature reliability and validity criteria. For Academic Staff Digital Competence, the factor loadings ranged from 0.69 to 0.788, where factor loadings of 0.70 are expected (Hair et al., 2019). Although one indicator (ASDC3) fell slightly below 0.70, it was retained as this was close to 0.70 and indicated some conceptual contribution to the construct (Hair et al., 2017). The constructs indicated reliable results, with a Cronbach's alpha of 0.793, rho_A of 0.796, composite reliability (CR) of 0.858, and average variance extracted (AVE) of 0.547 which indicates acceptable convergent validity (Fornell & Larcker, 1981).however ASCD 1 & ASCD 7 were deleted since fell below 0.4 and have no contributions to AVE

For the Digital Learning Tools construct, the loadings were between 0.667 and 0.881, where two items (DLT_2 and DLT_4) were slightly below the desired cutoff of 0.70, but were retained for theoretical reasons. The construct reached a reliability Cronbach's alpha of 0.851, reliability rho_A of 0.864, composite reliability (CR) of 0.890, and AVE of 0.575, demonstrating enough reliability and convergent validation. These were in accordance with previous methodological recommendations which suggest that indicators with loadings between 0.60 and 0.70 are acceptable given there is overall construct reliability (Hair et al., 2019).

The construct of Educational Access provided satisfactory measurement properties. The indicator loadings were found to be between 0.576 and .772 with one indicator (EA_4) slightly below the minimum of 0.60, but because the construct had theoretical significance, we retained it. Cronbach's alpha of .804, rho_A .819, CR .859, and AVE .506 are all above the minimum requirements. Consequently, these results indicate that the construct has an acceptable level of reliability and convergent validity as well as internal consistency (Fornell & Larcker, 1981); (Henseler et al., 2015).

The findings have identified that all constructs were reliable and valid, therefore providing confidence and credibility of the measurement model and appropriate for the next step of the study related to the structural model analysis. This is consistent with the procedure in PLS-SEM articulated above in which the measurement model was assessed in relation to internal consistency and convergent validity (Hair et al., 2017) (Hair et al., 2019)

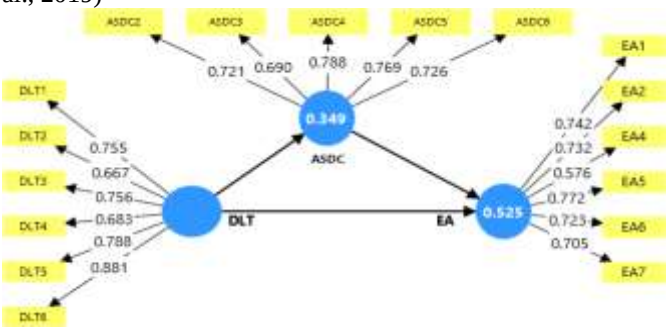

Figure 2. Measurement Mode

Table 1 Measurement Model

Construct& indicators	Loadings >0.7	Cronbach's ά>0.7	rho_a	CR > 0.7	AVE >0.5
Academic Staff Digital Competence		**0.793**	**0.796**	**0.858**	**0.547**
ASDC_2	0.721				
ASDC_3	0.690				
ASDC_4	0.788				
ASDC_5	0.769				
ASDC_6	0.726				
Digital Learning Tools		**0.851**	**0.864**	**0.89**	**0.575**
DLT_1	0.755				
DLT_2	0.667				
DLT_3_	0.756				
DLT_4	0.683				
DLT_5	0.788				
DLT_6	0.881				
Education Access		**0.804**	**0.819**	**0.859**	**0.506**
EA_1	0.742				

EA_2	0.732				
EA_4	0.576				
EA_5	0.772				
EA_6	0.723				
EA_7	0.705				

ASDC=Academic Staff Digital Competence,DLT=Digital Learning Tool &EA=Education Acess

4.2 Discriminant Validity

The (Fornell & Larcker, 1981)-recommended limits were considered with respect to the constructs' discriminant validity. A summary of the findings is provided in Table 2. For each construct the root of AVE is greater than the correlation with the other constructs and thus are confirmed to have discriminant validity (Fornell & Larcker, 1981); (Sarstedt et al., 2022a)For example, the square root of AVE for Academic Staff Digital Competence (ASDC) was 0.74 which is higher than ASDC with Digital Learning Tools (0.591) and Education Access (0.68). The square root of AVE for Digital Learning Tools was 0.758 which is higher than ASDC (0.591) between the two constructs, and Education Access (0.603). The square root of AVE for Education Access was 0.711 which is greater than ASDC (0.68) and Digital Learning Tools (0.603). The results demonstrated that scholar have empirical distinct constructs as is required to demonstrate discriminant validity within the measurement model (Hair, 2021); (Henseler et al., 2015)

Table 2. Discriminant Validity (Fornell-Larcker Criterion)

	Academic Staff Digital Competence (ASDC)	Digital Learning Tools	Education Access
Academic Staff Digital Competence (ASDC)	0.74		
Digital Learning Tools	0.591	0.758	
Education Access	0.68	0.603	0.711

4.3 Assessment of Model Fit

The measurement model reflected acceptable convergent validity, as the average variance extracted (AVE) for all of the constructs was greater than 0.50 (Fornell & Larcker, 1981). To make explicit the findings, the AVE for academic staff digital competence was 0.547, digital learning tools was 0.575, and educational access was 0.506 – indicating that the respective constructs had captured more than 50% of variance in the indicators. Thus, the measurement model achieved adequate convergent validity.

The structural model results demonstrated moderate levels of explanatory power for the endogenous constructs. To start, the antecedent academic staff digital competence explained 34.9% variability ($R^2 = 0.349$). Combined, educational access also appeared to show good explanatory power with an $R^2 = 0.525$, which was considered moderate to substantial by Hair et al. (2021). These findings indicate that the predictor constructs significantly explained variance in the endogenous variables.

In terms of predictive relevance, the Q^2 values for Academic Staff digital competence ($Q^2 = 0.34$) and Education access ($Q^2 = 0.355$) were both greater than zero providing evidence for adequate predictive validity of the model (Chin, 1998). This confirms the structural model has an adequate predictive validity in respect to the constructs included in the study.

The global model fit indices provided further strength to the PLS-SEM results. The standardised root mean square residual (SRMR) value of 0.075 was below the cut-off of 0.08 indicating an acceptable fit (Hu & Bentler, 1999). Additionally, the discrepancy measures d_ULS (0.861) and d_G (0.249) were within the respective acceptable cut-off thresholds giving more evidence towards the adequacy of the model (Henseler, et al. 2016). The chi-square statistic ($\chi^2 = 420.714$), and the normed fit index (NFI = 0.809) also provided support for the model being reasonably fitted to the data overall.

Table 3. Assessment of Model Fit

CONSTRUCT	Average variance extracted (AVE)	R2	Q2
Academic Staff Digital Competence	0.547	0.349	0.34
Digital learning tools	0.575		
Education access	0.506	0.525	0.355
SRMR	0.075		
d_ULS	0.861		
d_G	0.249		
Chi-square	420.714		
NFI	0.809		

SRMR=Standardized root mean square residual, d ULS & d G = discrepancy measures, NFI= Normed Fit Index, R^2=Proportion of Variation, & Q^2=Predictive relevance

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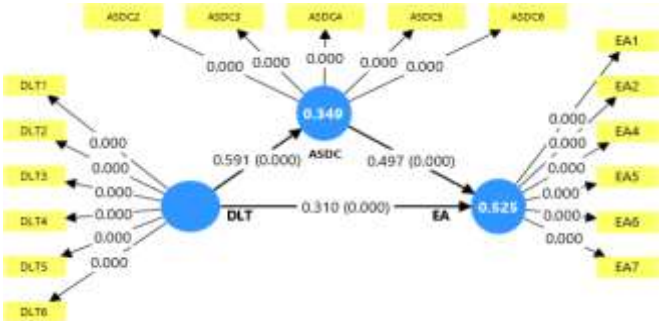
4.4 Structural Model

The findings in Table 4 support all of the hypothesized link in this study. The first hypothesis, that academic staff digital competence positively impacted education access received strong support. The results showing a significant influence (β = 0.497, t = 9.381, p = 0.000), with a moderate influence size (f^2 = 0.338), indicate that the digital competence of academic staff is essential to enhance education access, and effectively illustrates the need to improve staff digital skill competencies.

The second hypothesis, which sought to investigate the influence of digital learning tools upon academic staff digital competence, also received support. The results indicated a substantial positive influence (β = 0.591, t = 14.583, p < 0.001), and a considerable influence size (f^2 = 0.536). The results indicate that the use and integration of digital learning tools can increase the digital competence of academic staff making support for digital learning resources critical to providing staff with the competencies to better connect in a digitalized educational environment.

In addition, the third hypothesis, which examined the direct relationship between digital learning tools and access to education, was confirmed. The results demonstrate a positive and significant association (β = 0.310, t = 5.303, p = 0.000), although with a smaller effect size (f^2 = 0.132) compared to the other relationships. This implies that while digital learning tools directly contribute to improving education access, their influence is not as strong as when mediated through academic staff digital competence.

The fourth hypothesis that examined the mediating role of academic staff digital competence a mediation variable in the link between digital learning tools and education access was supported. The results indicated there was significant indirect effect (β = 0.294, t = 7.121, p = 0.000), which emphasized the role of digital competence as a mediation variable. As such, the results illustrate that digital learning tools have a direct effect on education access and a further effect by improving the digital competence of academic staff. Overall, the results indicate that combining digital learning tools with development opportunities for academic staff are interrelated variables that increase access to education.



DLT=Digital learning tools, ASDC=Academic staff digital competence, EA= Education access

Figure 3. Structure Model

Table 4 The Hypotheses Testing

Hypotheses	Standard Beta (β)	t-Value	p-Value	Result	f^2
H1:ASDC -> EA	0.497	9.381	0.000	Accepted	0.338
H2:DLT -> ASDC	0.591	14.583	0.000	Accepted	0.536
H3:DLT -> EA	0.31	5.303	0.000	Accepted	0.132
H4:DLT -> ASDC ->EA	0.294	7.121	0.000	Accepted	

DLT=Digital learning tools, ASDC=Academic staff digital competence, EA= Education access

5. Discussion of the Findings

The findings highlighted in Table 4 provide strong empirical evidence for the hypothesized relationships, and when viewed using the Unified Theory of Acceptance and Use of Technology (UTAUT) and the legacy of Mwalimu Julius K. Nyerere in science and technology, they call into picture theoretical and contextual interpretations of the role of digital transformation in education.

The first finding is that digital competence of academic staff strongly enhances access to education (β = 0.497, t = 9.381, p = 0.000). This is consistent with the performance expectancy UTAUT construct where individuals are more likely to adopt technology when they perceive the technology with useful characteristics that improve their outcomes of working (Dwivedi et al., 2019b). In the given context, educators who are digitally competent are best positioned to design, deliver and assess learning digitally, thereby increasing educational access for whom who are formally and informal education. This aligns with Nyerere's view of education as a means for liberation and development, in which science and technology were characterised as vital means to self-reliance towards development and national progress. By providing educators with digital competence through higher education institutions, there is improved efficiency and higher education institutions are answering Nyerere's point, as it pertains to education responding to the needs of society and addressing inequality, becoming, without loss to the meaning of this word, a reality (Marginson, 2016b).

The second hypothesis shows a strong positive effect of digital learning tools on academic staff digital competence (β = 0.591; t = 14.583; p = 0.000), demonstrates the facilitating conditions construct of the UTAUT model. Facilitating conditions refer to the organisational and technological infrastructure available to support technology usage in education (Dwivedi et al., 2019b). In circumstances where educators are provided with sufficient digital tools, they will

create competences that enable them to explore, adapt and subsequently embed new pedagogical practices. The results overlay studies that indicate that digital resources contribute to professional development and technological flexibility for lecturers (Lindfors et al., 2021b); (Fursykova et al., 2022b). Out results connect with Nyerere's legacy, particularly his call to invest in infrastructure for science and technology as a basis for education and development. Nyerere believed education was unable to empower societies without appropriate tools and resources, similar to today's digital learning discussions.

The third finding shows that digital learning tools independently have positive benefits on educational access ($\beta = 0.310$, $t = 5.303$, $p = 0.000$) although this was less than the mediated effect on educational access through academic staff digital competence. This is consistent with the implication of the use of effort expectancy as delineated in UTAUT to indicate that effort expectancy as an accuracy in judging ease of use of a system may influence adoption (Teo T, 2011). Digital learning tools potentially provide access to education by providing alternative modes of learning (García-Martínez et al., 2020b); (Alenezi, 2023b) but they achieve maximum effect on educational access when the lecturers have a good digital competence. This supports Nyerere's argument that just because technology is available does not mean change will occur unless people, specifically educators, are trained appropriately to use it productively. Consequently, technology should be considered as an aspect of human capacity development in order to actualise the possibilities of on-line learning.

The confirmation of the mediating role of academic staff digital competence in the relationship between digital tools and educational access ($\beta = 0.294$, $t = 7.121$, $p = 0.000$) exemplifies the interdependence of technological infrastructure and human capacity. In respect of UTAUT the study exemplifies the interaction of social influence and facilitating conditions, as it is argued that educators' adoption of technology will be shaped by institutional support and their own perceived competence (El-Masri & Tarhini, 2017b). The finding reinforces the point that investment made in digital learning is only truly effective investment when there is ongoing professional development as well. This is closely aligned to Nyerere's educational philosophy, whereby he promoted education that develops not only knowledge but also the practical competence in youth to apply theoretical knowledge to develop solutions to real-world problems. An ongoing investment in the digital competence of lecturers allows institutions to grow the next generation of educators who are able to used technology to broaden educational opportunities while continuing the legacy of education for liberation, equity and sustainable development that Nyerere advocated for.

The findings highlight that the interplay between digital learning tools and academic staff competence is central to improving education access. Theoretically, they validate UTAUT constructs by showing that performance expectancy, effort expectancy, and facilitating conditions remain crucial in shaping technology adoption in higher education. Contextually, they echo Nyerere's enduring legacy that science and technology, when embedded in human capacity development, form the cornerstone of meaningful and inclusive educational transformation.

6. Implications of the study

This research presents several significant implications for higher education in Tanzania, both theoretically and practically. The study illustrates that the utility of digital learning technologies for expanding educational access ultimately rests more on the digital capacity of the academic staff than on university computing infrastructure. This dictates that universities and policymakers should go beyond providing infrastructure and devote quality resources to developing the human capacity. This coincides with Mwalimu Julius K. Nyerere's philosophy on education and self-reliance, and Nyerere's conviction that science and technology are tools for equitable and transformative national development. The study suggests for policymakers, some ability building for educators, equitable resource distribution to support the minimizing of differences between institutions, and incentives for ongoing digital innovation, will be critical policy considerations for reducing digital resource gaps in Tanzanian higher education for inclusivity. For universities, the study highlights that an ongoing commitment to providing professional development and mentorship opportunities for academic staff, will be necessary for agencies that invest in digital transformation. By identifying and interpreting digital learning initiatives through the lenses of Mwalimu Julius K. Nyerere's vision and commitment to education, Tanzania's higher education sector will foster socially innovative and responsive graduates who demonstrate replacements and alternatives for collectively progressive social engagement and national development.

Theoretically, the study expands on the Unified Theory of Acceptance and Use of Technology (UTAUT) by empirically demonstrating that academic staff digital competence is a mediator between digital learning tools and education access, which reinforces the central principle of the role of educator competence in technology-mediated learning environments (Dwivedi et al., 2019b). Practically, the findings suggest that higher education institutions need to strike the right balance between integrating digital learning tools with professional development programs to enhance their lecturers' digital competences, thereby improving access to quality education for students (Dang et al., 2024b); (Fursykova et al., 2022b). In terms of policy, the study also provides evidence that national and institutional policies that support digital infrastructure, capacity building of academic staff for ongoing professional development, and equitable and inclusive policies in digital education will enable more learners and educators easier access to learning opportunities in higher education (UNESCO, 2017); (García-Martínez et al., 2020b)

7. Conclusion and Recommendations

This research provides robust evidence that both technological learning tools as well as faculty digital competence are instrumental in addressing educational access in postsecondary education. Findings indicate that faculty digital competence not only is a direct determinant of

education access as identified in the literature but also mediates the relationship between technological learning tools and delivery. Further, the findings delineate a triad relationship between educational design, the use of technology, and human competence. The findings show the importance of training when implementing technology in higher education by showcasing that both the implementation of technological tools and capabilities in addition to the training of staff required for capacity building are important for inclusion and equitable access to education. The study has theoretical contributions for extending UTAUT to the space of higher education and empirical contributions that inform policymakers about the ways in which technological learning tools can provide improved educational accessibility. The study also provides practical suggestions for universities and other institutions in developing policy on digitally enabled learning systems and how to strengthen not only the digital infrastructures but also staff competencies as part of an ongoing effort by universities or other educational institutions to create sustainable and comprehensive learning systems.

Conflict of interest

The authors declares that they have no conflict of interest in this study.

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