THE TRANSFORMATION OF DIGITAL TECHNOLOGY FOR ENHANCING INTERACTIVITY AND COMMUNICATION IN TEACHER EDUCATION IN SELECTED SOUTHERN AFRICAN HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

The advancement of technology has significantly transformed the landscape of education, including teacher education in higher education institutions. This study explores how digital technology has transformed to enhance interactivity and communication in teacher education. A qualitative research methodology was conducted in two higher education institutions that were purposely chosen and offered teacher education, one in South Africa and the other in the Kingdom of Eswatini. Twenty-eight participants in both higher education institutions comprising Heads of Departments (HODs) and lecturers took part in the study. The data was gathered through online questionnaires, internet interviews, and focus group discussions. The findings of the study reveal that there was a transformation from overhead projectors and chalkboards to electronic projectors and whiteboards in lesson delivery. There has been a transformation from the use of traditional face-to-face interactions during lectures, seminars, and office hours, as well as written communication through postal mail, memos, and official letters to Learning Management Systems (LMSs), such as Moodle platform. The study concludes that the transformation of digital technology in teacher education is hindered by inadequate updates to existing digital resources and limited digital skills among educators, impeding the full utilisation of these tools. Unequal access to reliable technology exacerbates the digital divide and creates barriers to the effective transformation of digital technology. The study recommends prioritisation of updating and upgrading digital resources, providing comprehensive training and support to trainee teachers, and increasing funding for transforming digital education, bridging the digital divide to technology, by ensuring equal access to technology and promoting collaboration among educators for sharing the best practices in transforming digital technology in teacher education.

KEYWORDS: Technology, teacher education, interactivity, communication, digital transformation.

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INTRODUCTION

Due to the rapid growth of technology, the education sector has experienced considerable transformations in recent years, which has an impact on higher education institutions' teacher education programs (Hesse, Kobsda, Leiser, & Austauschdienst, 2021). The trainee teachers are prepared for the modern classroom which has changed from the traditional classroom because of the technology advances. To improve interaction and communication between lecturers and trainee teachers, educational institutions are using interactive platforms and virtual classrooms in teacher education. Transforming digital technology in teacher education has become crucial for the modern classroom, necessitating the change of curriculum and resources needed to successfully address the advancements brought about by the 4IR (Smith, 2023). An important way to get valuable insights into how to use technology effectively for trainee teachers is to understand the experiences and viewpoints of lecturers and Heads of Departments (HODs) who are integrating technology into their teaching practices. This study aims to establish how technology has transformed the field of teacher education and how this has affected the creation of dynamic and captivating virtual learning environments.

Background to the study

Historically, higher education institutions in Southern Africa relied on traditional teaching methods that lacked the innovative and interactive elements of modern digital technology (Chigbu, Ngwevu & Jojo, 2023). Further, Govender (2015) explains that traditional educational practices are being challenged by information-age technologies. Furthermore, Jakoet-Salie and Ramalobe (2023) explain that with the advent of the Fourth Industrial Revolution (4IR), it has become imperative for higher education institutions to transform digital technology in teacher education programs to enhance interaction and communication. Oliver, (2022) also mentions that technology transformation in teacher education in higher education institutions, not only aligns instructional processes with the demands of the 4IR but also helps institutions adapt to the global transition and keep pace with technological advancements.

Digital transformation in the global higher education industry according to Mohamed, Hashim, Tlemsani and Matthews (2022), determines the future roadmap to a sustainable education management strategy. Again, Dlamini (2020) highlights that for higher education institutions to effectively meet the demands of the Fourth Industrial Revolution (4IR), their teacher education instructional delivery methods should transform and be carefully thought out as well as adequately resourced. Consequently, Higher education institutions need to adapt to the technological changes that are brought about by technological transformation (Al-Ghurbani, Jazim, Abdulrab, Al-Mamary, & Khan, 2022). Therefore, embracing digital technology transformation in teacher education is imperative for higher education institutions to thrive in the 4IR era and ensure a successful transition to a sustainable education management strategy.

Learning Management Systems (LMSs), according to Agaçi (2017) one significant development in this regard is the emergence of, such as Moodle, which provides platforms for both synchronous and asynchronous educational activities. Further, Almodaires, Almutairi, and Almsaud (2021) reveal that LMSs enable lecturers and pre-service teachers to collaborate and communicate in real time or through chat rooms, document sharing, and assessment tools. Singaram, Mayer and Oosthuizen (2023) note that redesigning higher education programs in Southern Africa has been recognized as a necessity to equip graduates with the knowledge and skills required to thrive in the 4IR workplace. Therefore, institutions must appropriately plan and allocate resources to ensure effective technology transformation in teacher education, considering the changing global environment.

The impact of 4IR on technological transformation

The evolution of technology in education can be traced through different industrial revolutions Beno (2019). Hassan (2022) notes that every industrial revolution created a system of education and learning that addressed its needs. Gershon (2017) mentions that in the past, blackboards and chalk were commonly used in teacher education. Further, Hassan (2022) explains that the second industrial revolution introduced whiteboards and blackboards, while the third revolution witnessed advancements in computing power, digital systems, and communication, leading to the use of overhead transparencies, the internet, and whiteboards. Schwab (2016) reveals that the fourth industrial revolution, which brought about more sophisticated and intelligent digital technologies and the 4IR, technologies such as smart factories, the Internet of Things (IoT), and artificial intelligence (AI) are merging the physical and digital worlds, with routine tasks being automated.

Assessing the technology skills and knowledge of higher education staff is crucial to determining their alignment with the 4IR (Singaram, Mayer & Oosthuizen, 2023). Again, Ebekozien, Aigbavboa, Adekunle, Aliu and Thwala (2023) reveal that training personnel as technology transforms has been recognised as an essential educational expectation for the 4IR era and is vital for the growth of human society. Thus, continuous updating of technological knowledge and skills is necessary to ensure appropriate technology transformation in the 4IR education system. The 4IR has had a profound impact on various systems, including education, and has interconnected organisations and communities worldwide (Penprase, 2018). Mohamed (2020) notes that in Southern Africa, it is crucial to address challenges such as poverty, inequities, and inadequate infrastructure in educational institutions. Therefore, this requires exploring the local environment and identifying suitable ways to incorporate technology effectively. Higher education institutions play a vital role in shaping institutional culture and driving technology transformation in teacher education. Through embracing cutting-edge digital tools and learning how to adapt them to the specific needs of teacher education (Haleem, Javaid, Qadri & Suman, 2022). Thus, transforming technology in teacher education is essential in the 4IR era, as it acknowledges the evolving expectations of teachers and the need for technical development to align with human needs and the industries of the 4IR.

Digital transformation in higher education institutions

A study conducted by Benavides, Arias, Serna, Bedoya and Burgos (2020) in Switzerland revealed that digital transformation was an emerging field and none of the found digital transformation proposals in higher education institutions had been developed in a holistic dimension. Further, in Switzerland Robert (2023) mentions that technology in education can now be incorporated in a variety of different ways, allowing for better access to learning, improving the learning experience and providing students with a set of skills that will help them throughout their future careers. Thus, the use of technology in higher education in Switzerland enhances access, engagement, and learning outcomes by providing interactive and dynamic opportunities for teachers and students to deliver and receive information more engagingly.

Laterza, Asante, Tømte and Pinheiro (2023) conducted a study in Norwegian higher education and concluded that challenges and bottlenecks associated with digital implementation like having to build digital infrastructure and introduce the new Learning Management System (LMS). Again, (Tømte, Fossland, Aamodt, and Degn (2019) mention that higher education (HE) across the Nordic countries has been the target of numerous government-mandated reforms, including digitalization to ensure effective and efficient public service delivery. Further, Orr, Weller and Farr emergencies and that in the Nodic countries, the digital transformation initiatives in higher education institutions included upgrading and introducing new digital systems, training academic and non-academic staff on new digital platforms and systems, providing online support to resolve connectivity issues and other emergencies, and diffusing new digital technologies to faculties and departments. Furthermore, Swanson (2012) concluded that digitalization requires a substantial assembly of resources for effective and efficient implementation in Norway.

Global resourcing (2023) reveals that in the United Kingdom (UK) digital transformation has brought about numerous advances, but there are still several issues that need to be resolved. These difficulties include out-of-date software and e-learning portals, in addition to problems like spotty Wi-Fi that can negatively impact remote learning. This shortcoming might result from leaders' narrow vision, which keeps them from fully appreciating how digitally literate their students are and how competitive the contemporary commercial marketplace is. In addition, there are worries regarding a culture of resistance among leaders regarding digital transformation, along with a lack of confidence in its necessity and potential. Global resourcing (2023) concludes by stating that, leaders may be hesitant in having a complete digital strategy in the UK because they do not trust their digital abilities.

A study done by Omoregie and Baruwa (2020) reveals that interactivity and communication have been transformed in the field of teacher education in Nigerian higher education institutions by the advent of digital technology. The study further reveals that beyond physical and geographical boundaries, new communities and spaces have been made possible by digital technology. Again, Ogunode and Ndayebom (2023) in another study in Nigeria found that inadequate funding for digital education, inadequate facilities, erratic power, spotty internet coverage, expensive facilities, high maintenance costs, a lack of staff with digital skills, students with inadequate digital skills, resistance to change, and a lack of self-control were all contributing factors. However, Ogunode and Ndayebom (2023) proposed increasing funding for higher

education in Nigeria, with a specific allocation for the development of digital education in all of the nation's higher institutions as a solution to these issues.

Makori and Osebe (2016) conducted a study in Kenya and concluded that the modern educational environment implies that academic institutions need to provide adequate information infrastructure to support access to education, learning, information and knowledge resources through digital technologies, internet of Things applications, digital repositories, mobile computer devices and social media technologies, Facebook, Twitter and YouTube. Similarly, Omoregie, (2014) alludes to the fact that media technologies of television, radio, computer and the internet offer flexible and formidable digital technology for teaching and learning in higher education institutions. The digital environment provides e-learning, e-research, e-information and electronic repositories and therefore must be enhanced through modern technological resources and facilities such as social cloud computing and internet connections.

A study done in Namibia by Shikwambi and Angula (2021) noted that approximately 60% of respondents found the University of Namibia's digitalisation program beneficial, while a significant portion expressed dissatisfaction and a lack of trust in the digital platforms, highlighting the need for improvements and updates to enhance performance and promote a collaborative learning environment. Further, the main findings of a study conducted in Namibia by Haipinge, Kadhila and Josua (2022) reveal that higher education institutions could benefit from the forced COVID-19 migration to digitally enabled assessment.

In South Africa, Kanyane (2023) notes that there are twenty-six public universities in South Africa. Yet, there is no digital transformation in most higher education workplaces. In some universities, digital technologies are advanced, and in others, they are not. The education landscape is partially transformed, and in others, it is a work in progress. Masinde and Roux, (2020) mention that the South African government in 2017 launched a project to transform the higher education system and all universities in the country adopted and rolled out a customised transformation agenda and among these universities, are six universities of technology (UoTs) meant to play a critical role in achieving economic growth and social progress. Further, Mtshali and Sooryamoorthy (2018) reveal that more than 90% of UoTs students are black, the UoTs are just over ten years old, and they have limited resources. Thus, the UoTs in South Africa present unique opportunities and challenges in the face of transformation.

The conclusions of a study conducted by Rugube, Mthethwa-Kunene and Maphosa (2020), in Eswatini reveal that there was unequal access to technological devices and internet connectivity across the country including the higher education institutions and recommend that there is a need for concerted efforts to build better technological infrastructure and human resource capacity to drive the online learning agenda. Marie-Nelly (2023) alludes to the fact that Eswatini's undeveloped digital systems in higher education institutions have negatively impacted the digital economy and untapped potential to embark on a digital revolution that would bring its small population a range of promising benefits. Again, Dlamini (2020) reveals that in the education system in Eswatini, much remains to be done to elevate education to the current digital age.

Theoretical Framework of the study

This study was guided by the Diffusion of Innovations theory by Everett Rogers (1962). The Diffusion of Innovations theory provides a framework for understanding how new ideas, technologies, or innovations are adopted and spread within a social system. Regarding the challenges faced by lecturers and HODs in transforming digital technology in teacher education in selected Southern African higher education institutions, the theory is relevant in explaining the process of adopting technology transformation and the barriers that hinder its effective integration into teacher education as illustrated in Figure 1 below.

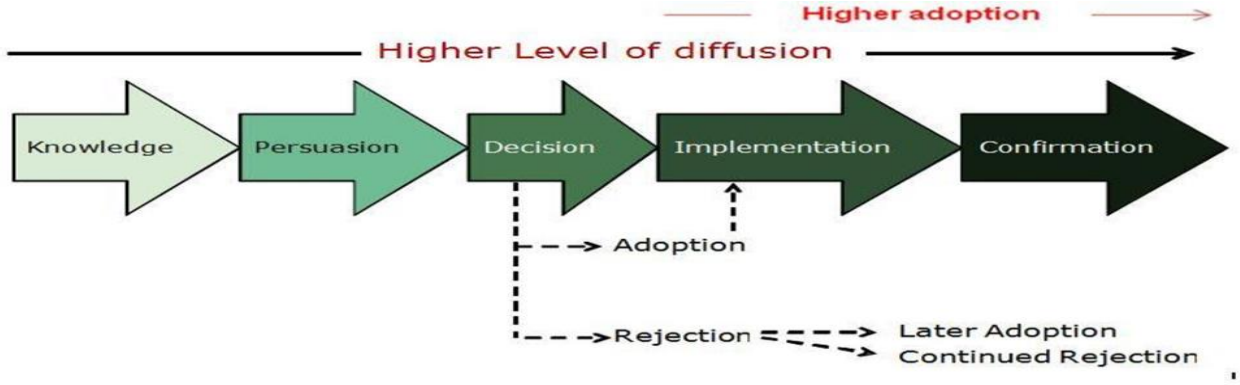

Figure 1: A Model of Five Stages in the Innovation-Decision Process (Sahin, 2006).

The Diffusion of Innovations theory is relevant in this study as it highlights how digital technology transformation is communicated. With the current study in which lecturers and HODs participated, the theory is relevant and related to the study in the five stages of knowledge, persuasion, decision, implementation and confirmation. In the knowledge stage lecturers and HODs are at a point of learning about the transformation existing in digital technology and its possible advantages for improving communication and interaction in teacher preparation. The persuasion stage is the phase in which the lecturers and HODs actively search out information, assess the benefits and drawbacks of transforming digital technology into teacher education, and consider how it might affect their pedagogical approaches. In the decision-making stage, the lecturers and HODs consciously decide to embrace the transformation and integrate digital technology into their practices for educating trainee teachers, considering both the technology's advantages and how well it aligns with their learning objectives. Lastly, in the implementation stage lecturers have an opportunity to transform digital technology in teacher education courses, integrating it into teaching strategies, and creating interactive, communicative activities are the first steps in this process.

Furthermore, the Diffusion of Innovations theory can shed light on the perceived benefits and barriers associated with transforming digital technology. It can provide insights into the factors that hinder the adoption and utilisation of updated digital tools and software, such as inadequate digital skills and knowledge among individuals. Additionally, the theory can help explain how the existence of barriers, such as unequal access to reliable technology and the digital divide, can impede the transformation of digital

technology into teacher education. Applying the Diffusion of Innovations theory gives a deeper understanding of the factors influencing the adoption and spread of transformative digital technology in teacher education. This understanding can inform strategies and interventions to address the identified barriers and promote the successful transformation of digital technology in the educational context.

Statement of the problem

Lecturers and HODs in the selected higher education institutions in Southern Africa have a challenge in the obsolete nature of the digital resources now available to lecturers and HODs (Bhebhe, Luzaan & Gawie, 2023). The software, hardware, and online materials they have access to frequently do not reflect the most recent advances in educational technology, limiting their ability to effectively integrate cutting-edge digital tools and platforms that could improve interactivity and communication in their teaching practices (Moonasamy. & Naidoo, 2022). The software, hardware, and online materials they have access to frequently do not reflect the most recent advances in educational technology, limiting their ability to effectively integrate cutting-edge digital tools and platforms that could improve interactivity and communication in their teaching practices.

Haleem, Javaid, Qadri, and Suman (2022) highlight a significant challenge in higher education institutions, not all lecturers and Heads of Departments (HODs) possess the necessary digital skills to effectively use digital tools. This skills gap hinders the successful integration of digital technologies in teacher education programs, limiting their ability to create interactive learning experiences and adapt to the evolving technological landscape. Addressing this skills gap is crucial for empowering lecturers and HODs. Further, Timotheou, Miliou, Dimitriadis, Sobrino, Giannoutsou, Cachia, and Ioannou (2023) allude to that, technological transformation can exacerbate the digital divide as some institutes may not be able to use modern technologies that are interactive and simulate live classroom experience in teacher education. Again, Moonasamy and Naidoo (2022) reveal that in Southern African higher education institutions there are also challenges in having equal access to transformed technology that is reliable and connected to the internet and this limits the lecturers' and HODs' ability to fully participate in digital learning environments. Thus, lecturers and Heads of Departments HODs in selected higher education institutions in Southern Africa have challenges regarding the effective transformation of digital technology into teacher education.

Research objectives

The objectives of the study are to:

- Determine how digital technology has transformed to enhance interactivity and communication in teacher education in higher education institutions.
- Establish the challenges faced by lecturers and HODs in digital transformation for enhancing interactivity and communication in teacher education.

Research questions

The research questions of the study are:

- How has digital technology transformed to enhance interactivity and communication in teacher education at higher education institutions?
- What are the challenges faced by lecturers and HODs in digital transformation for enhancing interactivity and communication in teacher education at higher education institutions?

RESEARCH METHODOLOGY

This study also used a qualitative research approach that leaned toward the interpretive research paradigm (Halkias & Neubert, 2020). Two Southern African universities that were conveniently chosen to be the authors' places of employment hosted the study (Mudavanhu, 2017). A purposive sample of participants was selected from lecturers and heads of department manning education programs (Tapala et al., 2021). Twenty-two (22) lecturers participated in this study, 11 from each university. Explicit Asking questions: Open-ended questionnaires were distributed to all of the lecturers participating in teacher education. The purpose of these questionnaires was to collect qualitative data and observations about the application of technology in the field. Talks in Focus Groups: There was a focus group discussion with six lecturers.

Two cases were used in the study, which employed a multiple-case study research strategy (Calandra et al., 2022). The chosen university in the Kingdom of Eswatini is a top organisation that advances knowledge and develops human capital. The university also encourages economic diversification by promoting an atmosphere of cooperation and entrepreneurship through research and innovation. The University of Technology in South Africa is a well-known and prestigious institution of higher learning that values imparting education that applies to the real world of work. The university emphasises practical learning and the development of professional skills through a wide range of programs offered in multiple disciplines. The university places a strong emphasis on the use of digital platforms, online resources, and creative teaching techniques. Furthermore, The University of Technology encourages innovation and research, advancing technology and collaborating with business partners for practical effects. This study also used a qualitative research approach that leaned toward the interpretive research paradigm (Halkias & Neubert, 2020). Ethical measures were considered in this study.

Ethical measures are crucial in educational research, as they protect participants' rights and dignity. Full transparency, voluntary engagement, and informed consent are essential aspects of ethics. The researcher obtained permission from the institution, Faculties of Education, and universities where the research took place. Participants were guaranteed confidentiality, safety of information, and their rights to voluntary participation and withdrawal at any stage of the study process. Informed consent was obtained from participants through email, open-ended questionnaires, and online interviews. Anonymity was maintained, ensuring researchers were unaware of individual participants' identities. Data was obtained electronically through open-ended questionnaires, online interviews, and focus group discussions. Confidentiality is crucial in studies involving human participants or collecting personally identifiable data. Participants signed

a consent agreement, ensuring researchers are aware of their identities. Audio recordings, questionnaires, and documents were saved on a secure computer, ensuring only the researcher had access to the material.

RESULTS OF THE STUDY

The results of the study are presented under the themes of the use of learning management systems. The use of social media and Limitations in technology use.

The use of learning management systems

The HODs and lecturers revealed that the technology they used when they were trained was the overhead projectors and transparencies and recalled that much effort was also put into ensuring that they took care of the pen used on transparencies. These were used in the chalk and green board era, but now they can be taught in virtual classrooms. The participants described the nature of the technology they use in their lecture rooms as interactive since trainee teachers can talk to their lecturer through technology. This was confirmed by HOD3 from institution A, who mentioned that *"We normally use Moodle LMS and the Big Blue Button allows the students to interact as if they are in a face-to-face classroom."* Similarly, Lecturer 3 from institution A through a focus group discussion noted that "*The technologies we use allow us through the LMSs to have discussion forums where one can ask questions and the students can respond in time or in their own time."* The HOD from institution B in an interview explained, *"There are platforms like Google Meet, MS Teams and so on, but we normally use Zoom for meetings and LMSs for classes." This realisation of the need to transform is in line with the Diffusion of Innovation Theory, the persuasion stage.* The need to transition and employ digital technologies entails teachers and institutions examining the advantages of digital technology, such as increased interactivity and enhanced multimedia capabilities to realise the value of adopting the use of digital technologies in the education system.

The participants observed that technology had moved from overhead projectors in traditional classrooms to electronic projectors utilised in lesson delivery. Technology has moved from traditional green or blackboards in schools to whiteboards in online classes. These current technologies are interactive and simulate a live class session in a real classroom. They explained that in virtual classrooms students may communicate with one another and their instructor and by sharing their documents during presentations. Participants demonstrated that the technology they integrate into teacher education allows them to communicate with the trainee teachers. The participants can use LMSs to engage students in synchronous and asynchronous time through the technology they integrate into their teaching. They use discussion forums, which might be real-time or delayed, in LMSs. This study also showed that students can be assessed through the LMSs, submit assignments and receive comments using technology.

The use of social media

Participants in the study revealed that communication in higher education institutions was primarily conducted through more traditional means. This included face-to-face interactions during lectures, seminars, and office hours, as well as written communication through postal mail, memos, and official letters. Additionally, communication was facilitated through landline telephones, fax machines, and email, which allowed for more efficient and asynchronous correspondence compared to postal mail. Further, the participants in this study mentioned the use of various communication platforms, including social media in teacher education from both higher education institutions. HOD5 from institution A agreed they use social media and other platforms to communicate with the trainee teachers, mentioning, "*We are using WhatsApp, telephone calls and we even use SMS. We also use emails, and social media for communication."*

On the same note, Lecturer 4 from institution A expressed that, "…*social media is one of the technologies that we are using to communicate with trainee teachers. We use platforms such as WhatsApp in communicating with the trainee teachers."* HOD1 from institution A added, "*We use WhatsApp or social media at times particularly for communication, officially for teaching we use the Moodle platform which is our LMS."* Similarly, Lecturer 3 from institution A noted in the questionnaire: *"Trainee teachers have WhatsApp groups where they interact. We also use WhatsApp where we communicate with the trainee teachers.* HOD5 and Lecturer 4 mentioned the use of platforms like WhatsApp for communication, while HOD1 highlighted the official use of the Moodle platform for teaching. *Lecturer 3 emphasised* the convenience and cost-effectiveness of WhatsApp for trainee-teacher interactions because *"WhatsApp is almost instant, fast and cheaper…"* in data consumption.

The study established the transformation of digital technology in selected Southern African higher education institutions to enhance interactivity and communication in teacher education. The results revealed that traditional communication methods such as face-to-face interactions, written correspondence, and email were commonly used. However, participants also mentioned the adoption of newer platforms like WhatsApp for communication, along with the official use of the Moodle platform for teaching. The convenience and cost-effectiveness of WhatsApp were emphasised by participants, particularly in facilitating interactions with trainee teachers.

Limitations in technology transformation

The study highlights limitations in the transformation of technology in teacher education due to limited resources, including a shortage of gadgets and outdated desktops provided by the institutions. Participants in this study point out that limited resources were a challenge in transforming technology in teacher education as lecturer 2 from institute A stated that *"...shortage of resources for the lectures and the trainee teachers were a hindrance in the integration of technology".* Contrary to the Diffusion of Innovation Theory in the implementation stage there should be enough resources for a proper transition into technology integration in the education system. HOD1 from institute A in an open-ended interview revealed some of the limitations such as that, "*There are no gadgets that the university has bought for the lecturers nor the*

students and since digital tools are transforming, the university has not bought new tools." Further, lecturers from both institutes indicated that both higher education institutions do give lecturers a desktop, but unfortunately, most of the desktops are outdated as the institutes cannot afford to change gadgets now and then with the transforming technology.

Lecturer 3 from Institute A also indicated that *"I have an outdated desktop without webcams nor speakers."* HOD4 from Institute A in an open-ended interview stated that "*...our Wi-Fi is slow, and this limits the integration of technology in teacher education. We also do not have laptops and we rely on desktops which are also outdated. The students also use their laptops during presentations and that limits effective integration of technology.* Lecturer 3 from Institute A also stated, *"Low rate of updating the technology tools and updating the lecturers on the new features on the software and technology tools of network band or poor network is always a problem which limits the integration of technology in teacher education".*

Lecturer 1 from Institute A in a questionnaire indicated that, *"The expense of data is on the trainee teachers, yet they are already overlaid with tuition fees and transport expenses they are already incurring."* Lecturer 3 from Institute B points out*, "Sometimes network connectivity would be poor such that it becomes impossible to know if participants remain active throughout the session."* Lecturer 1 from Institute B stated *"Electrical cuts due to load shedding were a challenge. In some instances, scheduled lessons failed to take off due to power cuts, hence integrating technology into teacher education becomes impossible without electricity."*

Limited resources, according to study participants, made it difficult for the transforming technology to be integrated into teacher education. The study reveals that despite the ongoing transformation of digital tools, the university has not invested in acquiring new tools, resulting in outdated technology. Both institutes provide desktops to lecturers; however, these desktops are often outdated due to budget constraints. Participants in this study noted that one of the institutions under study had spotty Wi-Fi, which made it difficult to integrate technology into teacher education. While some participants remarked that they were utilising PCs without an internet connection. The low frequency of upgrading the technology tools and lectures on the newest features of the software and technology tools was another issue raised by the participants. The Wi-Fi network band was subpar and did not cover every area of the university, which made it difficult for any technology transformations.

DISCUSSION OF FINDINGS

The results of the study revealed that technology had moved from overhead projectors in traditional classrooms to electronic projectors utilised in lesson delivery. Everett Rogers' (1962) Diffusion of Innovation Theory offers valuable insights into the adoption and spread of new ideas, technologies, or practices over time. In the knowledge stage in this stage, individuals or organizations are made aware of the innovation which is technology integration into teacher education and gain an understanding of how they need to utilise the digital tool in the virtual classroom. This perspective is like the views of Mohamed, Hashim, Tlemsani, and Matthews (2022) who emphasize the importance of digital transformation in the global higher

education industry for a sustainable education management strategy. They emphasize the need for careful planning and adequate resources in teacher education delivery methods to meet the demands of the

Fourth Industrial Revolution (4IR)

Again, the study revealed that technology had moved from traditional green or blackboards in schools to whiteboards to enhance interactivity and communication in teacher education. Similarly, Robert (2023) emphasises that technology integration in Swiss education enhances access, engagement, and learning outcomes. However, Govender (2015) Jakoet-Salie, and Ramalobe (2023) highlight the challenges posed by information-age technologies in traditional educational practices. They emphasise the need for digital transformation in teacher education programs to align with the Fourth Industrial Revolution demands and global transition.

The study further found that the current technologies are interactive and simulate a live class session in a virtual classroom. This is in line with the persuasion stage in the Diffusion of Innovation Theory which points to that after realising the advantages of transformation, institutions must adopt digital technologies for enhanced interactivity and multimedia capabilities in the education system. On the same note Omoregie and Baruwa (2020) highlight how digital technology has transformed communication and created new spaces in Nigerian teacher education. However, Timotheou, Miliou, Dimitriadis, Sobrino, Giannoutsou, Cachia, and Ioannou (2023) reveal that technological transformation can exacerbate the digital divide because some institutes may be unable to use modern interactive technologies that simulate live classroom experiences in teacher education.

Participants in this study demonstrated that the technology they integrate into teacher education allows them to communicate with the trainee teachers. This is in line with the Implementation stage in the Diffusion of innovation Theory which relates to the involvement of implementing new technology in classrooms, including physical installation, teacher training, and integration into established practices. The transformation to technology use in the classrooms would involve the physical installation of the equipment, the provision of appropriate training and support for teachers, and the integration of the technology into the established teaching practices. In this regard, Makori and Osebe (2016) emphasise the need for adequate information infrastructure and digital technologies in the education system. However, Global Resourcing (2023) points out issues such as outdated software and resistance to digital transformation in the education system which may hinder proper communication between the lecturers and trainee teachers.

Limited resources, according to study participants, made it difficult for the transforming technology to be integrated into teacher education. This perspective is contrary to the view by Smith (2023) who posits that transforming digital technology in teacher education is critical for the modern classroom but needs curriculum and resource changes to effectively handle the developments brought about by the 4IR. Similarly, Ogunode and Ndayebom (2023) propose increased funding and development of digital education

in higher institutions. Again, Orr et al. (2019) suggest that there should be digital transformation initiatives which include upgrading systems and providing training and support, in education systems.

The study reveals that despite the ongoing transformation of digital tools, the universities have not invested in acquiring new tools, resulting in outdated technology. This is contrary to the confirmation stage of the Diffusion of invention Theory which reveals that people or organisations seek confirmation for their decision to adopt the invention. Positive feedback from teachers and students, as well as ongoing support and investment from the educational institution in maintaining and improving the technology, would all contribute to the successful transition to technology in modern classroom settings. Again, Laterza et al. (2023) identified challenges in digital implementation and the need for digital infrastructure in Norwegian higher education. Further, Dlamini (2020) acknowledges the need for further advancements in Eswatini's education system to align with the digital age.

CONCLUSION

Based on the findings, the study concludes that the transforming digital technology in teacher education is hindered by inadequate updates to existing digital resources, limiting the ability of lecturers and Heads of Departments (HODs) to fully utilise the potential of these tools. This should be done in recognition of the decision-making stage in the Diffusion of innovation Theory as some decisions to transform technology cannot be made without adequate updates to existing digital resources. In the studied higher education institutions, not all individuals possess the necessary digital skills and knowledge to effectively use updated digital tools and software, further impeding the integration of technology in teacher education as knowledge is an important stage in the Diffusion of Innovation theory.

The transformation of digital technology in education can exacerbate the digital divide, as some institutions may lack the resources and capacity to adopt modern, interactive technologies that simulate a live classroom experience. Challenges in equal access to reliable and internet-connected technology in Southern African higher education institutions create barriers for lecturers and HODs to fully engage in digital learning environments, limiting their ability to transform digital technology effectively. Again, lecturers and HODs in selected higher education institutions in Southern Africa face numerous challenges in transforming digital technology in teacher education, including inadequate updates to digital resources, limited digital skills, and access to reliable technology.

Recommendations of the study

Based on the literature and findings provided, the study provides recommendations aimed at supporting the transformation of digital technology for enhancing interactivity and communication in teacher education institutions and maximising the benefits of digital transformation in teaching and learning environments. Institutions need to invest in updating knowledge of technology adoption in teacher education and upgrading their digital resources to keep pace with technological advancements and ensure that lecturers

and Heads of Departments can fully utilise the potential of these tools as alluded to in the Diffusion of Innovation theory stage one. Higher education institutions should also provide comprehensive training and support to educators to enhance their digital skills and knowledge, enabling them to effectively implement updated digital tools and software as referred to by the implementation stage in the Diffusion and Innovation theory, implementation stage.

The study recommends that there should also be adequate funding allocated specifically for the transformation of digital education in higher institutions to address the challenges associated with digital implementation, such as building digital infrastructure and introducing new learning management systems. Higher education institutions should develop and implement supportive policies that encourage and incentivise technology integration in higher education. These policies should address issues such as funding, intellectual property rights, privacy, and security concerns related to technology use. It is recommended in this study that higher education institutions should be able to make efforts to transform practices and bridge the digital divide by ensuring equal access to reliable internet-connected technology, particularly in regions where access is limited. There is also a need to encourage collaboration and sharing of best practices among educators within and across institutions. Further, platforms, such as communities of practice or online forums, where educators can exchange ideas, experiences, and resources related to technology transformation in higher education should be established.

The study also recommends that concerted efforts should be made to build better technological infrastructure, including improving internet connectivity and providing necessary technological devices, to support online learning and create a conducive digital learning environment. Again, research can be done to provide valuable insights into effective strategies, identify challenges, and inform evidence-based decision-making for further improvements.

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