# REVOLUTIONIZING EDUCATION IN AFRICA: THE IMPACT OF IMMERSIVE TECHNOLOGIES ON DIGITAL LITERACY PROGRAMS IN ACADEMIC LIBRARIES

By

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## Abstract

The evolving landscape of education embraces immersive technologies like Virtual Reality(VR), Augmented Reality (AR), and Mixed Reality (MR), integrated into digital literacy initiatives in academic libraries to enhance learning experiences, though challenges such as resource allocation and accessibility persist. Interest is growing in Africa regarding the impact of these technologies on higher learning institutional libraries. This research aims to examine the implications of immersive technologies on educational paradigms within academic libraries in Nigeria and Tanzania. Through surveys, the study seeks to assess the current landscape of digital literacy programs, identify the availability and acceptance of immersive technologies, and explore the relationship between immersive technologies and digital literacy programs. The research also aims to provide recommendations for effectively integrating immersive technologies into digital literacy programs in academic libraries, contributing to the broader discourse on the role of libraries in advancing digital literacy and lifelong learning initiatives. By adopting the Technology Acceptance Model (TAM) as a theoretical framework, the study aims to provide valuable insights into the factors influencing the successful deployment of immersive technologies in academic library environments. The findings of this research will contribute to informing decision-making, policy development, and best practices in integrating immersive technologies into digital literacy programs in academic libraries in Nigeria and Tanzania, ultimately enhancing information literacy skills and user experiences in the digital age.

**Keywords:** Academic Libraries; Augmented Reality (AR); Digital Literacy; Immersive Technologies; Librarians; Nigeria; Tanzania; Virtual Reality (VR).

## Introduction

The landscape of education is undergoing a profound transformation propelled by rapid advancements in technology. In this digital age, higher learning institutional libraries serve as vital hubs for information access, research support, and lifelong learning initiatives (Marpelina, 2024). Recognizing the imperative to equip students, faculty, and researchers with essential digital literacy skills, libraries have increasingly integrated technology-driven approaches into their educational programs(Oladokun et al., 2023). One such transformative trend is the incorporation of immersive technologies, including virtual reality (VR), augmented reality (AR), and mixed reality (MR), into digital literacy initiatives hosted by higher learning institutional libraries (Hui et al., 2022; Liu et al., 2023; Sviridova et al., 2023).

Hui et al., (2022; Shahzad & Khan, (2023) express that immersive technologies offer unparalleled opportunities to revolutionize education by providing immersive and interactive learning experiences that transcend the limitations of traditional instructional methods. Within the context of higher learning institutional libraries, these technologies hold immense potential to enhance digital literacy skills, foster lifelong learning habits, and empower library patrons to navigate the complexities of the digital age with confidence and competence.

Liu, (2021); Oladokun et al., (2023); Tella et al., (2023) explain that historically, libraries have played a central role in fostering information literacy and promoting lifelong learning among students, faculty, and researchers. However, in the face of rapid technological advancements and evolving information landscapes, libraries must adapt their educational offerings to meet the changing needs and preferences of

their patrons. Immersive technologies present a compelling solution to this challenge, offering innovative tools and resources to engage learners, enhance comprehension, and promote critical thinking skills (Alam & Mohanty, 2023).

Despite the growing interest and adoption of immersive technologies in educational settings, there remains a need for comprehensive research to explore their impact within the unique context of higher learning institutional libraries (Tang, 2023). This research will contribute to the broader discourse on the role of libraries in advancing digital literacy and lifelong learning initiatives. By examining the integration of immersive technologies into digital literacy programs, this study seeks to uncover best practices, identify challenges, and provide insights into the transformative potential of these technologies in revolutionizing education within library settings in Nigeria and Tanzania.

Moreover, Sviridova et al., (2023) stress that as higher education institutions grapple with the dual challenges of technological innovation and the democratization of knowledge, libraries must position themselves as dynamic and forward-thinking entities capable of meeting the diverse needs of their patrons. By embracing immersive technologies and leveraging their potential to enhance digital literacy programs, higher learning institutional libraries can reaffirm their relevance and significance in the digital age, empowering learners to thrive in an increasingly complex and interconnected world (Adeyemi & Sulaiman, 2023; Tella et al., 2023).

**Statement of the problem**

Haleem et al., (2022) express that education is a lifelong process, essential for fostering continual growth and adaptation in an ever-evolving world. With the rapid advancement of technology permeating various aspects of society, the integration of immersive technologies into educational frameworks, particularly within higher learning institutional libraries, heralds a transformative shift in educational paradigms(Gadelha, 2018; Sviridova et al., 2023). Augmented reality (AR), virtual reality (VR), and mixed reality (MR) present unprecedented opportunities to revolutionize digital literacy programs, offering innovative approaches to teaching and learning(Gadelha, 2018; Tang, 2023).

The utilization of AR, VR, and MR in digital literacy programs within higher learning institutional libraries represents a dynamic departure from traditional instructional methods, promising enhanced engagement, interactivity, and effectiveness(Liu et al., 2023). These immersive technologies have the potential to transform the educational experience, providing learners with immersive and interactive environments that stimulate curiosity, deepen understanding, and facilitate skill development (Camilleri, 2023).

By engaging with AR, VR, and MR technologies, library users can explore concepts, environments, and scenarios in ways previously inaccessible through conventional means. Whether through interactive simulations, virtual tours, or immersive storytelling experiences, these technologies offer novel avenues for learning and knowledge acquisition(Adeyemi & Sulaiman, 2023).

However, Sarkar, (2023) explains alongside the transformative potential of immersive technologies lie significant challenges and considerations. The integration of AR, VR, and MR into digital literacy programs necessitates careful planning, resource allocation, and pedagogical innovation(Shahzad & Khan, 2023). Furthermore, issues related to accessibility, equity, and digital literacy skills among librarians must be addressed to ensure that all users can benefit from these immersive learning experiences.

Given the profound implications of immersive technologies on educational paradigms, there is an urgent need to critically examine their impact within the context of digital literacy programs offered in selected academic libraries in Nigeria and Tanzania. By conducting a thorough exploration of the opportunities and challenges associated with the integration of AR, VR, and MR into digital literacy programs, researchers can provide valuable insights to inform decision-making, policy development, and best practices within library settings(Taha, 2023).

Therefore, this research endeavours to critically examine the implications of immersive technologies on educational paradigms within higher learning institutional libraries. By analyzing the opportunities and challenges presented by AR, VR, and MR in digital literacy programs, this study aims to contribute to the ongoing discourse on the integration of technology into education, ultimately fostering a deeper understanding of how immersive technologies can revolutionize learning experiences in library settings.

**Research Objectives**

The research aims to explore the following key issues.

i. Assess the Current Landscape of Digital Literacy Programs in academic libraries in Nigeria and Tanzania;
ii. Identify the availability of immersive technologies in academic libraries in Nigeria and Tanzania;
iii. Examine the technology acceptance level of immersive technologies digital literacy programs of academic libraries in Nigeria and Tanzania.
iv. Determine the relationship between the use of immersive technologies and digital literacy programs in academic libraries in Nigeria and Tanzania.
v. Provide Recommendations for integrating immersive technologies in digital literacy programs in academic libraries in Nigeria and Tanzania.

**Research Questions**

i. How do librarians perceive the effectiveness and relevance of existing digital literacy programs in addressing the information needs of users in academic libraries in Nigeria and Tanzania?
ii. What is the level of awareness and utilization of immersive technologies among librarians in academic libraries in Nigeria and Tanzania, and how do they perceive these technologies in terms of enhancing user engagement and learning?
iii. What factors influence librarians' acceptance or resistance towards the integration of immersive technologies into digital literacy programs within academic libraries in Nigeria and Tanzania?
iv. How do librarians perceive the impact of integrating immersive technologies into digital literacy programs on user engagement, learning outcomes, and overall library services in academic libraries in Nigeria and Tanzania?
v. What strategies and best practices can be recommended for effectively integrating immersive technologies into digital literacy programs in academic libraries in Nigeria and Tanzania to enhance information literacy skills and user experiences?

**Hypothesis:**

$H_{01}$: There is no significant relationship between the use of immersive technologies and digital literacy programs in academic libraries.

**Theoretical framework**

One of the most suitable frameworks is the Technology Acceptance Model (TAM). The Technology Acceptance Model (TAM), developed by Fred Davis and Richard Bagozzi in the 1980s, is a widely used theoretical framework for understanding users' acceptance and adoption of new technologies. TAM posits that perceived ease of use and perceived usefulness are key determinants of users' attitudes and intentions toward adopting a technology (Davis, 1993).

Perceived Usefulness: This aspect delves into the degree to which librarians perceive that the incorporation of immersive technologies into digital literacy programs will improve library patrons' digital literacy skills, interaction with library resources, and overall educational outcomes. Examining librarians' perceptions of the usefulness of immersive technologies provides valuable insights into their readiness to embrace and include these technologies in their educational endeavours.

Perceived Ease of Use: This section explores the ease or difficulty experienced by librarians when engaging with immersive technologies in digital literacy programs conducted by academic libraries. Elements like the design of user interfaces, accessibility features, and support mechanisms for instruction can impact librarians' views on the ease of using immersive technologies and consequently, their inclination to integrate them into educational programs.

Attitudes towards Use: Through an analysis of librarians' attitudes towards the integration of immersive technologies in digital literacy programs, this aspect identifies the factors influencing their perceptions, convictions, and preferences concerning these technologies. Positive attitudes towards immersive technologies are likely to foster greater acceptance and adoption by librarians, while negative attitudes may hinder their willingness to include these technologies in their educational provisions.

Behavioural Intention to Use: This part investigates librarians' intentions to incorporate immersive technologies into digital literacy programs, exploring the motivators and barriers affecting their readiness to embed these technologies into their educational initiatives. Understanding librarians' behavioural intentions can guide strategies for promoting the uptake and integration of immersive technologies in academic library contexts.

Through the adoption of the Technology Acceptance Model (TAM) as a theoretical foundation, this research systematically scrutinizes librarians' perceptions, attitudes, and intentions regarding the integration of immersive technologies in digital literacy programs. TAM offers a comprehensive framework for comprehending librarians' acceptance and adoption of new technologies, providing valuable insights into the factors influencing the successful deployment of immersive technologies in academic library environments.

## LITERATURE REVIEW

**Immersive technologies in libraries across the world**

Hill, (2019) explains that in 1999 U.S. Army established the Institute of Creative Technologies (ICT) at the University of Southern California, to expand immersive technologies to enhance training and education benefiting not only the military but also the society at large. In the early 2000s, academic libraries began experimenting with incorporating digital literacy programs into their services, focusing primarily on basic computer skills, internet browsing, and information retrieval. Immersive technologies were in their infancy during this period, with limited applications in educational settings(Anthes et al., 2016). However, some pioneering institutions started exploring the potential of technologies like virtual reality (VR) and augmented reality (AR) for educational purposes (Chang et al., 2023; Enakrire & Fasae, 2022).

Throughout the 2010s, immersive technologies such as VR and AR began to gain traction, fueled by advancements in hardware and software capabilities. Academic librarians recognized the potential of immersive technologies to enhance learning experiences and started experimenting with integrating them into digital literacy programs(Chang et al., 2023). Early initiatives included VR simulations for information literacy instruction, AR overlays for library tours, and virtual collections accessible through immersive interfaces (De Sarkar, 2019).

Dalili Saleh et al., (2022); Suen et al., (2020) showed that, as immersive technologies became more accessible and affordable, academic librarians worldwide showed increasing interest in their educational applications. Libraries began investing in VR headsets, AR devices, and software platforms to develop immersive digital literacy programs. Collaborations between librarians, instructional designers, and technologists led to the creation of innovative VR and AR learning experiences tailored to the specific needs of academic communities(Dalili Saleh et al., 2022).

In recent years, academic institutions have provided greater support for immersive technology initiatives in libraries, recognizing their potential to enhance student engagement and learning outcomes. Librarians have conducted research studies to assess the effectiveness of immersive technologies in digital literacy instruction, exploring their impact on information retention, critical thinking skills, and user satisfaction(Suen et al., 2020; Yavarkovsky, 2013).

Professional organizations and conferences have devoted sessions and workshops to immersive technologies in academic libraries, facilitating knowledge sharing and collaboration among practitioners(Ogbomo, 2022; Roy et al., 2022; Suen et al., 2020).

Academic librarians are increasingly integrating immersive technologies into curriculum-aligned digital literacy programs, collaborating with faculty to incorporate VR and AR experiences into course modules. With the shift towards online and hybrid learning environments, libraries are exploring virtual platforms and simulations to deliver digital literacy instruction remotely, ensuring accessibility and flexibility for students(Grant & Rhind-Tutt, 2019; Ogbomo, 2022).

According to Fujiuchi & Riggie, (2019); Margam, (2023); Suen et al., (2020); and Witt et al., (2015) stated the history of immersive technologies with digital literacy programs among academic librarians worldwide reflects a trajectory of experimentation, innovation, and growing recognition of the transformative potential of these technologies for teaching and learning in higher education.

**Academic libraries on immersive technologies with digital literacy programs across Africa**

Academic libraries across Africa have been actively involved in digital literacy programs and the integration of immersive technologies(Inskip, 2020; Khumalo, 2022; Patrick & Tweve, 2022). These programs aim to enhance the digital literacy skills of library professionals and user communities, particularly in the context of the Fourth Industrial Revolution and the increasing importance of digital skills(Inskip, 2020).

Libraries in Kenya, Ghana, Nigeria, South Africa, and Uganda have implemented various initiatives to teach digital literacy and provide access to ICT resources (A et al., 2022; Inskip, 2020; Khumalo, 2022). According to Khumalo, (2022), Subject Librarians in academic libraries in South Africa have used information and communication technologies (ICTs) for digital literacy instruction, although there is a need for further training in this area.

The role of academic librarians in the digital environment and their pedagogical competencies are also being explored, with a focus on integrating suitable technologies with teaching methods. Overall, academic libraries in Africa are actively engaged in promoting digital literacy and leveraging immersive technologies to enhance teaching and learning experiences(Daniel, 2015; Isa, 2023; Ogbomo, 2022; Tella et al., 2023).

According to Gastinger, (2006) libraries have to be focused on cost-effectiveness, performance measurement, quality standards and user acceptance to enhance significant status in their workplace. Academic libraries worldwide have enthusiastically embraced immersive technologies, such as augmented reality (AR) and virtual reality (VR), to elevate their digital literacy programs(Almeida et al., 2016; Enakrire & Fasae, 2022; Khan et al., 2023).

These remarkable technologies have revolutionized the way users are taught and have greatly enhanced their learning experiences within academic libraries (Chang et al., 2023). The advent of the Fourth Industrial Revolution, coupled with the ever-growing influence of technology on pedagogy, has brought about an overwhelming wave of change in the role of academic librarians, transforming them into online educators(Hussain, 2020; Levien & American Library Association, 2011).

Nonetheless, academic librarians must acquire proficient pedagogical and digital skills to effectively educate in a digital environment. The vital role that subject librarians play in digital literacy instruction cannot be overlooked, but regrettably, there is a dearth of adequate digital literacy skills among them, thus compromising their ability to offer pertinent training(Cruceru, 2013; Shahzad & Khan, 2023).

The stance of academic libraries towards immersive technologies with digital literacy programs varies, but there is a growing recognition of the potential benefits and opportunities these technologies offer for enhancing educational experiences(Almeida et al., 2016; Ogbomo, 2022; Suen et al., 2020).

Some key aspects of their stance include:

Recognition of the importance of academic libraries in Africa: acknowledge the importance of digital literacy in today's world and understand that immersive technologies can play a crucial role in promoting digital literacy skills among students and faculty.

According to Adetayo, (2023); Bala & Bala, (2022); Granchak & Bondarenko, (2021); Grant & Rhind-Tutt, 2019; Greene & Groenendyk, 2018; Phetteplace, 2015; Roy et al., (2022) and Yavarkovsky, (2013) elaborate that Academic libraries, including those in Africa, are increasingly interested in utilizing immersive technologies like VR, AR, and MR to enrich educational experiences. There's a strong focus on ensuring accessibility and inclusivity, particularly in underserved areas, with librarians actively working to make these technologies available to all students and faculty. However,Bala & Bala, (2022); Granchak & Bondarenko, (2021) challenges such as cost constraints and the need for staff and user training are acknowledged, alongside the importance of adapting initiatives to local contexts to ensure effectiveness and relevance.

Despite recognizing the potential of immersive technologies, academic libraries face hurdles such as cost constraints and infrastructure limitations, particularly in African contexts. Yet, efforts are underway to adapt these technologies to local needs, considering factors like language, culture, and educational requirements (Camilleri, 2023; De Sarkar, 2019; Sarkar, 2023). Collaborative endeavors with stakeholders help overcome challenges, emphasizing the importance of shared resources and expertise to maximize the impact of digital literacy initiatives (Buckland, 1992)while maintaining a commitment to accessibility and relevance within higher education institutions(Camilleri, 2023; Chang et al., 2023; Haleem et al., 2022) .

**Immersive technologies with digital literacy programs status among Academic Libraries in Nigeria and Tanzania**

The intersection of immersive technologies and digital literacy programs in academic libraries presents a dynamic landscape for enhancing educational outcomes and empowering learners in diverse contexts. This section explores the current status of immersive technologies within digital literacy programs in academic libraries, with a focus on Nigeria and Tanzania. As two prominent countries in Africa, Nigeria and Tanzania share common challenges in advancing education and digital literacy, while also exhibiting unique socio-cultural and infrastructural contexts influencing the adoption and implementation of immersive technologies.

Immersive technologies like virtual reality and augmented reality are gradually gaining ground in educational settings, but specific data on their integration into academic libraries in Nigeria and Tanzania is limited. In the African context, electronic resources are available, and librarians show willingness to embrace digital literacy programs to incorporate immersive technologies; however, access can sometimes be hindered by several factors such as internet connectivity issues, lack of electricity, or limited knowledge on the use of Information Technology(James Mwamasso & Oduor Onyango, 2020; Patrick & Tweve, 2022; Wema, 2021).

In Tanzania, for instance, a study at Teofilo Kisanji University showed that internet resources are significantly deployed, indicating a shift from print to digital learning resources (Alphonse & Mwantimwa, 2019). While this demonstrates a move toward embracing digital resources, it doesn't specifically highlight the use of immersive technologies in libraries.

The role of libraries is evolving, and there is a push for librarians to reimagine their roles in the context of modern technology. Librarians are becoming more involved in facilitating digital literacy and managing technology-driven projects (Bourdeaux, 1981). As immersive technologies become more accessible and affordable, it is likely that academic libraries, including those in Nigeria and Tanzania, will begin to explore their potential to support digital literacy efforts more actively (Ogbomo, 2022; Tella, 2020; Tella et al., 2023).

However, for a more accurate picture of the current integration of immersive technologies with digital literacy programs specifically in academic libraries in Nigeria and Tanzania, a direct investigation into these countries' educational institutions would be necessary.

Nigeria and Tanzania are grappling with the imperative to integrate digital technologies into educational settings to meet the demands of the 21st century. Academic libraries in both nations serve as crucial hubs for providing access to information, supporting research endeavours, and promoting digital literacy among students, faculty, and researchers(Adetayo, 2023; Mwilongo & Kotoroi, 2023; Sife & Matto, 2022). Understanding the status of immersive technologies within digital literacy programs requires exploring the contextual factors shaping educational practices and technological adoption in Nigeria and Tanzania.

In Nigeria, academic libraries increasingly recognize the potential of immersive technologies such as VR and AR to enrich teaching, learning, and research experiences(Enakrire & Fasae, 2022). Initiatives like establishing VR labs and partnerships with technology companies signal growing interest. However, challenges related to infrastructure limitations, funding constraints, and technological readiness persist, impacting widespread adoption(Adetayo, 2023; Enakrire & Fasae, 2022; Margam, 2024; Oladokun et al., 2023).

Contrastingly, Tanzania is also witnessing efforts to integrate immersive technologies into digital literacy programs within academic libraries. Government initiatives and partnerships with international

organizations have facilitated the introduction of immersive learning experiences. Despite similar challenges as Nigeria, Tanzania's unique socio-economic context shapes the trajectory of adoption and implementation(Margareth, 2017; Mgaya, 2018; Ministry of Information, 2023; Oreku, 2022).

Both countries exhibit emerging trends and innovations highlighting the evolving nature of immersive technologies within digital literacy programs. Strategies range from developing locally relevant educational content to exploring low-cost VR solutions for resource-constrained environments(Ogbomo, 2022; Oladokun et al., 2023; Sife & Matto, 2022).

While there's growing recognition of the potential benefits of immersive technologies in enhancing digital literacy programs, empirical research is needed. Exploring stakeholders' experiences and perspectives, including librarians, educators, students, and technology developers, offers valuable insights and informs future strategies for integration.

In Nigeria and Tanzania, academic libraries play a vital role in promoting digital literacy and are increasingly exploring the potential of immersive technologies such as virtual reality and augmented reality to enhance educational experiences. While immersive technologies hold promise for enriching learning and aiding in the development of digital literacy skills, their adoption within the academic library landscape faces various contextual factors that can affect implementation and success.

For Nigeria, there seems to be a growing interest in immersive technologies, with some universities establishing VR labs or collaborating with tech companies to support digital literacy(Dalili Saleh et al., 2022). Despite this interest, widespread adoption faces challenges like infrastructure and funding limitations, technological readiness, and the need for skilled personnel to manage and integrate these technologies effectively(Ogbomo, 2022; Oladokun et al., 2023; Tella et al., 2023).

In Tanzania, while there is evidence of a transition from traditional learning resources to electronic ones, indicating an acknowledgement of digital trends in education, the specifics of immersive technologies in academic libraries are less clear(James Mwamasso & Oduor Onyango, 2020; Kirita & Mwantimwa, 2022; Patrick & Tweve, 2022; Wema, 2021). There are general challenges similar to Nigeria, like internet connectivity, reliable electricity, and tech proficiency that can hinder the integration of advanced technologies(Anthes et al., 2016; De Sarkar, 2019; Tella et al., 2023).

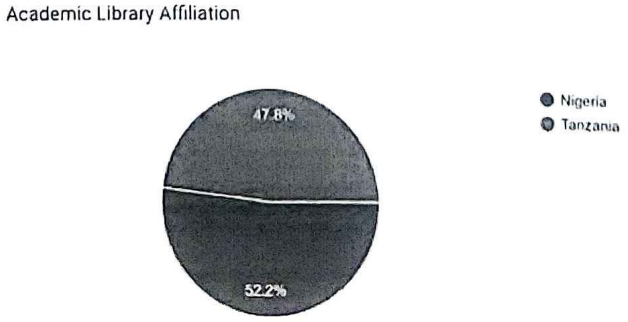
Therefore, there is interest and potential for immersive technologies to play a significant role in digital literacy within the regions' academic libraries, the realism of this vision depends on overcoming infrastructural, economic, and educational barriers that currently exist. The success of these initiatives requires strategic investments, better infrastructure, professional development for librarians, and collaborative efforts to develop locally relevant and sustainable programs that leverage advanced technologies for educational excellence(Granchak & Bondarenko, 2021; Haleem et al., 2022; Isa, 2023; Lockwood, 2004).

Overall, both Nigeria and Tanzania are witnessing increasing interest and adoption of immersive technologies in their academic libraries. Collaborative efforts, research initiatives, and a focus on access and inclusivity are essential for leveraging immersive technologies to enhance digital literacy education and empower learners effectively.

## METHODOLOGY

The research methodology centers on a dual approach of survey-based data collection and comprehensive literature review. Surveys, meticulously designed and distributed among stakeholders in Academic libraries, aim to gather diverse perspectives on the integration of immersive technologies into digital literacy programs. These surveys target librarians to ensure a comprehensive understanding of the subject matter. Complementing the survey data, a thorough literature review sourced from reputable platforms such as Emerald Insight, Springer, and Research 4Life provides scholarly insights into the topic.

The survey-centric approach is anticipated to yield a substantial volume of quantitative data, facilitating in-depth analysis of opportunities, challenges, and recommendations related to immersive technology integration in academic libraries. By focusing exclusively on quantitative data, the research aims to provide a robust foundation for understanding the complexities of this integration. Additionally, the inclusion of a sizable sample size, with 265 responses targeted from academic libraries in Nigeria and Tanzania, ensures geographic diversity and captures regional nuances in technology adoption and implementation. This is shown in Figure 1.



This comprehensive methodology, integrating surveys, literature review, and a significant sample size, aims to provide valuable insights into digital literacy programs within academic libraries. By leveraging diverse perspectives and scholarly research, the study seeks to offer nuanced understanding and recommendations for the effective utilization of immersive technologies in educational settings. Emphasizing quantitative analysis to triangulate findings and validate results effectively, this streamlined approach ensures a nuanced understanding of the research topic, enhancing the validity and reliability of the study's conclusions, particularly within the context of digital literacy programs in higher learning institutional libraries.

## FINDINGS AND DISCUSSION

The collected data was analysed using percentages, bar charts and graphs and the result is attached as a Google Drive Link (https://shorturl.at/drwWX) and as an Appendix. This section will further discuss the findings from the analysis.

In recent years, there has been a burgeoning interest in harnessing immersive technologies to transform educational practices, particularly within the African context. Academic libraries, serving as pivotal hubs of knowledge dissemination, play an integral role in this paradigm shift by offering digital literacy programs designed to equip learners with essential skills for navigating the increasingly complex digital landscape(A et al., 2022; Inskip, 2020).

The present study seeks to delve into the impact of immersive technologies on digital literacy initiatives within academic libraries across Africa, with a specific focus on the contexts of Nigeria and Tanzania. Framed within this overarching objective, the research endeavours to achieve five distinct aims: to assess the prevailing landscape of digital literacy programs in academic libraries within Nigeria and Tanzania, to identify the availability and adoption of immersive technologies within these library settings, to gauge the level of acceptance and utilization of immersive technologies among stakeholders involved in digital literacy programs, to explore the relationship between the use of immersive technologies and the efficacy of digital literacy initiatives, and to propose recommendations for integrating immersive technologies into digital literacy programs within academic libraries in Nigeria and Tanzania.

A comprehensive analysis of the study's findings offers a nuanced understanding of the demographic profile of participants engaged in digital literacy programs within academic libraries. Notably, the data reveals a discernible concentration of highly educated individuals, with a substantial proportion holding either Master's degrees (39.1%) or PhDs (39.1%). This demographic composition underscores the imperative of tailoring digital literacy initiatives to accommodate the diverse educational backgrounds represented within the learner community, thereby fostering inclusivity and ensuring equitable access to educational resources(Khan et al., 2023; Patrick & Tweve, 2022).

Furthermore, the findings shed light on the utilization and adoption of immersive technologies within the academic library landscape. Specifically, the study unveils a considerable level of engagement with immersive technologies, with approximately half of the participants actively participating in programs incorporating these innovative tools. Such findings underscore the growing interest and acceptance of immersive technologies as enablers of enhanced learning experiences within academic settings(Bresnahan & Yin, 2017; Fujiuchi & Riggie, 2019; Isa, 2023).

As the study advances, it elucidates the prevailing challenges and opportunities associated with the integration of immersive technologies into digital literacy programs. These challenges range from technical hurdles and infrastructure limitations to the imperative of capacity-building initiatives aimed at enhancing stakeholders' proficiency with these emerging technologies. Despite these obstacles, the study highlights the potential of immersive technologies to augment digital literacy efforts, particularly in facilitating interactive and experiential learning modalities(Daniel, 2015; Enakrire & Fasae, 2022).

In light of these insights, the study culminates in a series of recommendations aimed at fostering the seamless integration of immersive technologies into digital literacy programs within academic libraries in Nigeria and Tanzania. These recommendations encompass a multifaceted approach, including investment in infrastructure upgrades, the provision of specialized training programs, and the cultivation of collaborative partnerships to harness the transformative potential of immersive technologies effectively(Granchak & Bondarenko, 2021; Greene & Groenendyk, 2018).

The findings of this study offer valuable insights into the intersection of immersive technologies and digital literacy initiatives within the academic library context in Africa. By elucidating demographic trends, utilization patterns, and challenges encountered, the study paves the way for informed strategies aimed at leveraging immersive technologies to enhance educational outcomes and foster digital literacy proficiency among learners across diverse educational landscapes.

### Current Landscape of Digital Literacy Programs in Academic Libraries in Nigeria and Tanzania

According to the study findings, the analysis of responses about the utilization of Digital Literacy programs and engagement with immersive technologies unveils notable trends and insights. Specifically, data indicates that 30.4% of respondents reported utilizing digital literacy programs every week, followed

closely by daily engagement at 21.7%. This pattern suggests a consistent and regular uptake of these programs among respondents, reflecting a significant level of engagement with digital literacy initiatives within academic libraries(Buckland, 1992; Patrick & Tweve, 2022; Schmidt Hanbidge et al., 2018).

The data reveals that approximately half of the participants (52.2%) have actively participated in programs featuring immersive technologies, indicating a growing interest and adoption of these innovative tools within educational contexts. Moreover, when examining the types of immersive technologies experienced, the data shows that Virtual Reality (VR) is slightly more prevalent compared to Augmented Reality (AR) and Mixed Reality (MR), with VR being reported by 41.7% of respondents, while AR and MR are reported by 33.3% and 41.7% respectively. This suggests a higher degree of implementation or accessibility of VR technologies within academic settings compared to other immersive technologies(Anthes et al., 2016; Isa, 2023; Suen et al., 2020).

The perceived usefulness of immersive technologies is also evident in the data, with 35% of respondents expressing a positive experience. Additionally, the data highlights that interactivity and hands-on learning are perceived as the most beneficial aspects of immersive technologies, with 35% of respondents highlighting these features. Such recognition underscores the potential of these technologies to enhance educational outcomes and facilitate active engagement among learners (Davis, 1993; Yoon et al., 2022).

However, alongside the reported benefits, a myriad of challenges are also identified in the data. Technical issues and infrastructure limitations emerge as primary obstacles to the effective implementation of immersive technologies in academic settings. These challenges are echoed by the data, which shows that 100% of respondents reported encountering challenges such as adjusting to the scenery, bandwidth issues, challenges of internet connectivity, and inadequate tools meant to enhance learners' experiences(Adetayo, 2023; Isa, 2023; Tella et al., 2023).

**Availability of Immersive Technologies in academic libraries in Nigeria and Tanzania**

This study unveils significant insights into the current state of technological infrastructure in academic libraries, with statistics revealing prevailing trends. It indicates that while a majority of libraries are moderately equipped with digital resources, only a relatively small proportion offer immersive technologies. Specifically, findings show that approximately 43% of libraries possess a moderate level of digital resources, while only 4% are advanced with immersive technologies. Additionally, regarding awareness among librarians, the data suggests a mixed level of familiarity with immersive technologies, with 43% demonstrating moderate awareness and 48% displaying low awareness(Adetayo, 2023; Ogbomo, 2022; Sviridova et al., 2023; Tella et al., 2023).

Analysis of specific immersive technologies available in academic libraries reveals that only a small percentage offer these resources. For instance, only 17% reported having Virtual Reality (VR) technologies available, while Augmented Reality (AR) and Mixed Reality (MR) technologies are available in 13% and 22% of libraries, respectively(Lockwood, 2004).

In terms of initiatives integrating immersive technologies, the data indicates that 35% of libraries report ongoing projects, showcasing a fair amount of activity in this area. However, challenges persist in implementation, with infrastructure insufficiency being the most prominent hurdle, as highlighted by 52% of respondents. Strategies to overcome these challenges include increased funding allocation and specialized training programs, which are commonly adopted by 35% and 26% of respondents, respectively(Khan et al., 2023).

The impact of immersive technologies on learning and research is perceived positively by a significant majority of respondents, with 78% acknowledging a positive impact. However, there is a notable variation in experiences among users, with 35% finding immersive technologies very useful while 26% consider them not useful(Adeyemi & Sulaiman, 2023; Almeida et al., 2016; Mwilongo & Kotoroi, 2023).

Despite the enthusiasm surrounding immersive technologies, challenges such as infrastructure limitations and technical issues persist, hindering widespread adoption in academic libraries. For instance, over half of respondents cited insufficient infrastructure as a barrier to implementation, reflecting the sentiment of 52% of participants. Addressing these challenges necessitates a multifaceted approach, including investments in infrastructure upgrades, capacity-building initiatives for staff, and collaborative partnerships with external stakeholders(A et al., 2022; Allen et al., 2015; Z. Liu et al., 2023).

**The technology acceptance level of immersive technologies digital literacy programs of academic libraries in Nigeria and Tanzania**

The examination of technological infrastructure within academic libraries reveals a prevailing trend: the majority of libraries are moderately equipped with digital resources, indicating a baseline level of technological advancement, although there is room for improvement. Specifically, data indicates that 43% of libraries are moderately equipped with digital resources, while 30% have basic infrastructure primarily consisting of traditional library resources. This observation suggests a foundational infrastructure to support digital literacy initiatives but also underscores the need for ongoing improvements and investments to enhance technological capabilities within these institutions(Buckland, 1992; Inskip, 2020; Lockwood, 2004; Roy et al., 2022).

Regarding awareness among librarians, the findings indicate a mixed level of understanding regarding immersive technologies. Approximately 43% demonstrate moderate awareness, while 48% exhibit low awareness, suggesting a need for targeted education and training initiatives aimed at enhancing awareness and utilization of immersive technologies among library staff and educators. Such initiatives could facilitate the effective integration of immersive technologies into digital literacy programs, thereby maximizing their potential impact on educational outcomes(Inskip, 2020; Sarkar, 2023).

Furthermore, the data on specific immersive technologies available in academic libraries underscores the challenges associated with adoption. Despite the growing interest in immersive technologies, only a relatively small proportion of libraries offer immersive technologies, with VR reported by 17%, AR by 13%, and MR by 22% of respondents. The relatively low availability of immersive technologies within these settings highlights barriers such as cost constraints and technical expertise requirements. Addressing these challenges necessitates concerted efforts to overcome barriers to implementation and ensure equitable access to immersive technologies for educational purposes(De Sarkar, 2019; Sviridova et al., 2023).

Infrastructure insufficiency emerges as a major barrier to the effective implementation of immersive technologies within academic libraries. The data underscores the critical need for investments in technology infrastructure to support the seamless integration of immersive technologies into digital literacy programs. For example, 22% of respondents reported insufficient infrastructure as a significant challenge, highlighting the imperative of infrastructure upgrades to support the integration of immersive technologies(Camilleri, 2023; Gadelha, 2018; Shahzad & Khan, 2023).

In response to these challenges, the strategies reported by respondents reflect proactive approaches aimed at overcoming implementation hurdles. Increased funding allocation and specialized training programs are cited as common strategies employed to address infrastructure insufficiency and enhance staff proficiency with immersive technologies. Such proactive measures demonstrate a commitment to fostering an environment conducive to the effective utilization of immersive technologies within academic libraries(Dimitrov, 2023; IFLA, 2020; Inskip, 2020; Wema, 2021).

In conclusion, the findings underscore the importance of addressing challenges related to technological infrastructure, awareness among stakeholders, and implementation barriers to maximize the potential impact of immersive technologies on digital literacy programs within academic libraries. By leveraging proactive strategies and targeted initiatives, institutions can overcome barriers and create an enabling environment for the effective integration of immersive technologies into educational practices(Enakrire & Fasae, 2022; Hussain, 2020; Suleski & Draper, 2013; Tella et al., 2023).

**The relationship between the use of immersive technologies and digital literacy programs in academic libraries in Nigeria and Tanzania.**

The findings reveal a significant level of importance attributed to the ease of use of immersive technologies in influencing willingness to engage with digital literacy programs. Specifically, 39.1% of respondents indicated that ease of use is very important, while 52.2% considered it important. This underscores the critical role of user-friendly interfaces and intuitive design in facilitating effective engagement with immersive technologies within educational contexts(Haleem et al., 2022).

Moreover, respondents exhibited overwhelmingly positive attitudes towards the integration of immersive technologies into digital literacy programs. A striking 82.6% of participants expressed a positive overall attitude, indicating a strong endorsement of the potential of immersive technologies to enhance educational experiences and foster digital literacy skills among learners. Conversely, a smaller proportion (17.4%) reported a neutral stance, suggesting opportunities for further exploration and clarification of the benefits and implications of immersive technology integration(Grant & Rhind-Tutt, 2019; Khumalo, 2022; Shahzad & Khan, 2023).

The willingness of respondents to embrace immersive technologies within digital literacy programs is evident in their expressed intentions. A resounding 87% of participants indicated that they would be willing to use immersive technologies if made available in their academic library, with an additional 13% expressing a probable inclination towards adoption. This high level of willingness underscores the perceived value and potential impact of immersive technologies in enriching educational practices and advancing digital literacy initiatives within academic settings(Chalukya, 2015; Davis, 1993; Phetteplace, 2015).

This symbiotic relationship between immersive technologies and digital literacy programs in academic libraries in Nigeria and Tanzania. The findings highlight the importance of ease of use, positive attitudes towards integration, and willingness to adopt immersive technologies among stakeholders, signalling a promising trajectory for the advancement of digital literacy initiatives through innovative technological solutions.

**Recommendations for integrating immersive technologies in digital literacy programs in academic libraries in Nigeria and Tanzania**

The perceived positive impact of immersive technologies on learning and research activities aligns with the overarching goal of revolutionizing education in Africa. For instance, 78% of respondents reported that

immersive technologies have positively impacted learning, research, or other academic activities. Anticipated future trends, such as increased integration of VR technologies (35%) and exploration of new applications, signal a promising trajectory for digital literacy programs in academic libraries(Bourdeaux, 1981; Hill, 2019; Inskip, 2020).

Several recommendations emerge for the integration of immersive technologies into academic libraries in Nigeria and Tanzania.

Firstly, a significant emphasis should be placed on investment in infrastructure. According to the data, 43% of libraries are moderately equipped with digital resources, indicating a need for increased investment in technology infrastructure to support immersive technology integration. This investment should prioritize upgrading hardware, software, and network capabilities to ensure compatibility and functionality with immersive technology solutions(Hussain, 2020; Khan et al., 2023; Tella et al., 2023).

Secondly, capacity-building and training initiatives are paramount. The mixed level of awareness among librarians regarding immersive technologies, with 43% demonstrating moderate awareness and 48% showing low awareness, highlights the necessity for comprehensive training programs. These programs should provide hands-on training on the use of immersive technologies, equipping staff with the necessary skills and knowledge to effectively integrate these technologies into digital literacy programs(Bala & Bala, 2022; Chang et al., 2023; Suen et al., 2020).

Collaborative partnerships also hold immense potential for advancing immersive technology integration. According to the data, 35% of respondents reported ongoing initiatives or projects integrating immersive technologies into library services, indicating an existing interest in collaboration. By engaging with technology vendors, educational institutions, and other stakeholders, academic libraries can access the expertise, resources, and support necessary for successful implementation. Exploring collaborative opportunities can facilitate the sharing of knowledge and best practices, accelerating progress in immersive technology adoption(Adeyemi & Sulaiman, 2023; Almeida et al., 2016; Hussain, 2020; Sviridova et al., 2023).

Moreover, promoting accessibility is imperative. Immersive technology solutions must be designed with accessibility considerations in mind to ensure inclusivity and equitable access for all learners. This involves addressing barriers to access and ensuring compatibility with assistive technologies, thereby catering to the diverse needs of learners, including those with disabilities(Haleem et al., 2022; Tella et al., 2023).

Pedagogical integration is equally critical for effective immersive technology implementation. Aligning immersive technology initiatives with educational objectives and fostering active learning experiences requires innovative instructional approaches. According to the data, 82.6% of respondents expressed a positive attitude towards the integration of immersive technologies into digital literacy programs, indicating a favourable environment for pedagogical innovation. Educators and librarians should explore pedagogical strategies that leverage immersive technologies to enhance learning outcomes and engage learners effectively(Ecem Gürsen et al., 2023; Haleem et al., 2022; Isa, 2023).

Furthermore, continuous evaluation and assessment are essential for monitoring progress and measuring the effectiveness of immersive technology initiatives. According to the data, 87% of participants indicated a willingness to use immersive technologies if made available in their academic library, highlighting a strong interest in evaluation and adoption. Academic libraries should develop robust evaluation frameworks and assessment tools to gather feedback, make data-driven decisions for improvement, and ensure accountability in immersive technology integration efforts(Hussain, 2020; Ogbomo, 2022).

Engagement with the broader community is vital for the success of immersive technology initiatives. By fostering a culture of collaboration and participation, academic libraries can solicit input and feedback from stakeholders, ensuring the relevance and effectiveness of immersive technology integration efforts.

Lastly, promoting research and innovation in immersive technologies is fundamental to driving advancements and uncovering new possibilities for educational applications. Academic libraries should support research endeavours and provide access to resources to foster a culture of experimentation and exploration in immersive technology integration(Haleem et al., 2022; Mwilongo & Kotoroi, 2023; Tella et al., 2023).

Implementing these recommendations, academic libraries in Nigeria and Tanzania can effectively harness the potential of immersive technologies to revolutionize digital literacy programs, enhance educational experiences, and empower learners in the digital age.

## Conclusion

In conclusion, immersive technologies have the potential to revolutionize education in Africa by enhancing digital literacy programs in academic libraries. Despite challenges, there are opportunities for innovation and collaboration to leverage these technologies effectively. By addressing the needs and preferences of diverse learner populations, academic libraries can play a pivotal role in fostering a culture of lifelong learning and innovation in the digital age.

The data highlight the importance of investment in infrastructure, capacity building, collaborative partnerships, accessibility considerations, pedagogical integration, continuous evaluation, community engagement, and research and innovation to facilitate the effective integration of immersive technologies.

By prioritizing these recommendations, academic libraries can harness the potential of immersive technologies to revolutionize digital literacy programs, enhance educational experiences, and empower learners in the digital age.

Overall, the findings underscore the transformative impact of immersive technologies on education in Africa, offering new possibilities for advancing digital literacy and promoting lifelong learning. However, it is essential to address challenges such as infrastructure limitations, awareness gaps, and accessibility barriers to ensure equitable access and maximize the benefits of immersive technology integration. With concerted efforts and strategic initiatives, academic libraries can play a pivotal role in driving innovation and revolutionizing education through immersive technologies in Nigeria and Tanzania.

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