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APPLICATION AND AWARENESS OF VIRTUAL AND AUGMENTED REALITY IN LIBRARIES FOR ENHANCING USER EXPERIENCE IN KADUNA STATE UNIVERSITY, KADUNA STATE, NIGERIA

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Abstract

This study is conducted to examine the application and awareness of virtual and augmented reality in libraries for enhancing user experience in Kaduna State University, Kaduna State, Nigeria. Fifty (50) librarians and library users in the university library made up the population of the study. A questionnaire was used as a data collection instrument. The data collected for the study were presented and analyzed using frequency distribution tables, mean and standard deviation. The study demonstrated the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff for effective service delivery in Kaduna State University was very low. The findings ascertained that, low level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff and users in Kaduna State University. The study revealed the perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies into library services in Kaduna State University were; VR/AR can support ongoing digitization initiatives by making digital content more accessible and interactive and VR/AR can add contextual information, recreate and preserve historical artifacts, manuscripts, and cultural heritage materials in a virtual environment, protecting them from physical degradation and reducing handling of fragile items. The finding of the study revealed challenges Kaduna State University library faced in implementing virtual reality (VR) and augmented reality (AR) technologies were; VR/AR hardware and software are expensive, posing a significant financial barrier for a university library with limited budgets and library staff lack the technical skills and knowledge to manage, operate, or teach users about VR/AR tools. The study recommended that the management of the institution library should initiate awareness campaigns and conduct regular training workshops for both students and library staff to enhance understanding of VR and AR technologies and their potential benefits in the academic library setting.

Keywords: Virtual reality, Augmented reality, Academic libraries, User experience, Library services, Technology adoption and Digital learning

Introduction

The evolution of technology has dramatically transformed the operations of libraries globally, moving them from mere repositories of physical books and documents to innovative knowledge centers equipped with advanced tools and technologies. Virtual Reality (VR) and Augmented Reality (AR) are two of the most significant technological advancements that have reshaped how users interact with information. These technologies have the potential to revolutionize library services by creating immersive and interactive environments that enhance learning and research experiences (Brunskill, 2020). Virtual Reality (VR) refers to computer-generated simulations of three-dimensional environments that users can interact with in a seemingly real way, often through specialized devices such as VR headsets. Augmented Reality (AR), on the other hand, overlays digital information, such as text, images, and videos, onto the real-world environment using devices like smartphones or AR glasses (Milgram & Kishino, 1994). Together, VR and AR enable users to access

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information in more dynamic and engaging formats, promoting deeper understanding and retention of knowledge.

In the global context, libraries have started to leverage VR and AR technologies for various applications. For example, VR is used to create virtual tours of historical landmarks, allowing students and researchers to explore these sites remotely (Luo et al., 2021). Similarly, AR applications in libraries enable users to interact with 3D models of complex objects, such as molecules in chemistry or artifacts in archaeology, enriching their learning experiences (Cruz-Lara et al., 2020). These applications illustrate the growing role of immersive technologies in redefining the scope of library services. The integration of technology into libraries has transformed the way information is accessed, managed, and delivered. Virtual Reality (VR) and Augmented Reality (AR) technologies, in particular, have shown great potential in enhancing user experiences by creating immersive and interactive environments. Libraries worldwide are exploring these technologies to improve user engagement, accessibility, and learning outcomes. Libraries, traditionally known for their role in information dissemination, have begun adopting these technologies to enhance the user experience (Perryman, 2019).

Libraries are increasingly adopting VR/AR to provide innovative services, improve accessibility, and create immersive learning environments. VR, for instance, has been employed in academic libraries to simulate historical environments, offer virtual tours, and provide interactive learning experiences (Lam et al., 2020). AR has been used for enhancing bibliographic services, allowing users to view additional information about books or library resources through mobile apps (Wu et al., 2021). In libraries, VR and AR have been utilized to make the learning process more engaging. These technologies help in creating visual and experiential connections with academic materials, supporting an immersive learning environment. For example, VR can help in the visualization of scientific concepts that are difficult to explain through traditional methods (Chen et al., 2020). The application of Virtual and Augmented Reality in libraries has the potential to significantly enhance the user experience, especially in academic institutions such as Kaduna State University. While the awareness and adoption of these technologies are still in their nascent stages in Nigerian libraries, the benefits, including immersive learning, accessibility, and engagement, provide a compelling case for their integration. However, to realize the full potential of VR/AR, libraries in Nigeria must overcome challenges related to cost, infrastructure, and user awareness.

In Nigeria, the adoption of VR and AR in libraries remains limited. Challenges such as inadequate funding, low technical expertise, and limited awareness of these technologies have hindered their integration into library systems (Oyeleye & Oyewole, 2019). Kaduna State University, being one of the prominent academic institutions in northern Nigeria, has the potential to lead the adoption of these technologies. However, the extent of awareness and readiness for VR and AR implementation among library staff and users remains unclear. This study seeks to investigate the application and awareness of VR and AR technologies in the Kaduna State University Library. By assessing the current state of these technologies and exploring their potential benefits and challenges, this research aims to provide insights into how VR and AR can be integrated to enhance library services. Ultimately, this study will contribute to the growing body of knowledge on the use of immersive technologies in libraries, particularly in the Nigerian context, and support efforts to modernize academic libraries in the country.

Statement of the Problem

Libraries have historically been at the forefront of knowledge dissemination and research support. However, the rapid evolution of technology has created a growing demand for innovative services that meet the changing needs and expectations of library users. Virtual Reality (VR) and Augmented Reality (AR) technologies offer transformative opportunities to enhance user experience in libraries by creating immersive and interactive environments that promote effective learning and engagement. Despite their global impact, the adoption and awareness of these technologies remain limited in many developing countries, including Nigeria. At Kaduna State University, the library plays a crucial role in supporting the academic and research endeavors of students and faculty members. However, like many academic libraries in Nigeria, it relies heavily on traditional methods of information delivery, which may not sufficiently engage a technology-driven generation of users. The lack of modern, interactive tools such as VR and AR limits the library's ability to provide cutting-edge

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services that align with global best practices. Preliminary observations suggest that there is limited awareness of VR and AR technologies among library staff and users at Kaduna State University. Furthermore, the absence of these technologies in the library raises concerns about the institution's readiness to adopt innovative solutions that can enhance the accessibility, interactivity, and overall user experience of library services. This gap not only impacts the library's ability to fully support digital learning but also hinders its competitiveness in an increasingly globalized academic environment.

The problem, therefore, lies in the inadequate application and awareness of VR and AR technologies in the Kaduna State University Library. Understanding the extent of this gap and the challenges associated with implementing these technologies is crucial for addressing the needs of library users and improving service delivery. This study seeks to investigate the level of awareness, potential applications, and perceived benefits of VR and AR in enhancing library services at Kaduna State University. By doing so, it aims to provide actionable insights into how these technologies can transform the user experience and contribute to the modernization of academic libraries in Nigeria.

Purpose of the Study

The main purpose of the study is to investigate the application and awareness of VR and AR technologies in the Kaduna State University Library. However, the study specifically sought to:

1. ascertain the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff for effective service delivery in Kaduna State University;
2. investigate the level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff and users in Kaduna State University;
3. know the perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies into library services in Kaduna State University
4. identify the challenges the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies

Research Questions

The following research questions guided the study:

1. What is the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff for effective service delivery in Kaduna State University?
2. What is the level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff and users at Kaduna State University?
3. What are the perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies into library services in Kaduna State University?
4. What challenges does the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies?

Methodology

The study adopted a descriptive survey research design. According to Nworgu (2015), descriptive survey research is concerned with collecting data from a population and describing the characteristics, opinions, attitudes, and conditions of that population as they exist. The design was considered appropriate because it enabled the researcher to obtain information on the application and awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies in enhancing user experience at Kaduna State University Library. The population of the study comprised fifty (50) respondents consisting of librarians and library users of Kaduna State University Library. Data were collected using a structured questionnaire titled Application and Awareness of Virtual and Augmented Reality in Libraries for Enhancing User Experience Questionnaire (AAVARLEUEQ). The instrument was designed based on the objectives of the study and consisted of two sections. Section A elicited demographic information of respondents, while Section B contained items grouped into four clusters covering the extent of application of VR and AR technologies, level of awareness, perceived benefits of VR and AR integration, and challenges associated with their implementation in the library.

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The questionnaire items were structured on a four-point Likert scale of Very High (VH), High (H), Low (L), and Very Low (VL), assigned values of 4, 3, 2, and 1 respectively. To ensure face and content validity, the instrument was examined by two experts in Library and Information Science. Their observations guided the revision of the questionnaire before administration. Data collected were analyzed using mean and standard deviation to answer the research questions, with a criterion mean of 2.50 used for decision-making.

Results

RQ 1: What is the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff for effective service delivery in Kaduna State University?

Table 1: The extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies

S/N	Statements	VH	H	L	VL	Mean	StD
1	VR/AR is applied to create immersive learning environments or interactive educational content.	5	8	20	17	2.0200	1.7205
2	the library has the necessary equipment (e.g., VR headsets, AR-enabled devices, or supporting software) to facilitate the application of VR/AR.	2	7	16	25	1.7200	1.4000
3	Library staff applied VR/AR technologies in their daily activities.	2	3	22	23	1.6800	1.3115
4	VR/AR technologies are applied for user satisfaction and engagement with the library.	1	2	18	29	1.5000	1.0954
5	VR/AR tools are applied for advanced research support, such as virtual labs or simulations.	1	2	8	39	1.3000	0.8944
	Cumulative mean					**1.6800**	**1.3316**

Key: Very High (VH), High (H), Low (L), Very low (VL), Standard Deviation (StD)

Source: Fieldwork, 2024

Analysis of table 1 reveals the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff for effective service delivery in Kaduna State University. "VR/AR is applied to create immersive learning environments or interactive educational content." This opinion attracted the respondent's highest mean response of 2.0200 and standard deviation of 1.7205 as details showed that 5 very high, while 8 high while 20 low and the rest 17 very low. In the same vein, "the library has the necessary equipment (e.g., VR headsets, AR-enabled devices, or supporting software) to facilitate the application of VR/AR". This opinion attracted the respondent's second highest mean response of 1.7200 and standard deviation of 1.4000 with details showing that 2 very high, 7 others high while 16 low and the rest 25 very low. The cumulative mean of respondents on the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies is 1.6800 and standard deviation is 1.3316 which is less than 2.50 index score for high, this implies that majority of the respondents diverge with the opinions of the researcher in the options on the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies. This demonstrates the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff for effective service delivery in Kaduna State University is very low.

RQ 2: What is the level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff and users at Kaduna State University?

Table 2: The level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies

S/N	Statements	HA	MA	SA	NA	Mean	StD
1	The university library has introduced any VR/AR initiatives or demonstrations for staff and users.	6	7	13	24	1.9200	1.6733
2	Library users have been oriented on the availability or potential use of VR/AR in the library.	1	2	17	30	1.4800	1.0770
3.	Library staff have used VR/AR technologies in any capacity (e.g., research assistance, navigation,	3	8	20	19	1.9000	1.5748

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	learning resources).						
4.	Training programs or awareness campaigns are organized.	5	4	16	25	1.7800	1.5232
5.	Library staff have received formal training or attended workshops on VR/AR technologies.	3	7	18	22	1.8200	1.5099
	Cumulative mean					**1.7760**	**1.4716**

Key: Highly aware (HA), Moderately aware (MA), Slightly aware (SA), Not Aware (NA), Standard Deviation (StD) **Source: Field Survey, 2024 Decision mean =2.5**

Table 2 explicates the level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff and users in Kaduna State University. The mean value of 1.9200 and standard deviation of 1.6733 indicates the highest response of the university library has introduced any VR/AR initiatives or demonstrations for staff and users. Details of response on this opinion showed that 6 of the respondents highly aware, while 7 others moderately aware as against 13 that slightly aware and the rest 24 of them not aware with this opinion. In the same vein, library staff has used VR/AR technologies in any capacity (e.g., research assistance, navigation, learning resources) attracted the respondent's second highest response mean value of 1.9000 and standard deviation of 1.5748 with details showing that 3 highly aware, 8 others moderately aware while 20 slightly aware and the rest 19 not aware. Analysis of the data collected on the level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff and users in Kaduna State University shows the cumulative mean of 1.7760 and standard deviation of 1.7760 which is less than 2.50 index score for high, this indicate that the library staff and users of the university library do not support the provided opinions of researcher on the level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies. This proves low level of awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies among library staff and users in Kaduna State University.

RQ 3: What are the perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies into library services in Kaduna State University?

Table 3: The perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies

S/N	Statements	SA	A	D	SD	Mean	StD
1	VR/AR can support ongoing digitization initiatives by making digital content more accessible and interactive	28	20	1	1	3.5000	3.0265
2	AR/VR systems can collect user data to provide insights into user preferences and improve library services.	22	18	6	4	3.1600	2.7713
3	VR/AR technologies in libraries can improve users' and staff's digital literacy and technological competence.	20	18	5	7	3.0200	2.6758
4	Integrating VR/AR in the library can foster collaborations across faculties (e.g., computer science, history, or education) by providing shared tools and resources.	17	22	7	4	3.0400	2.6458
5.	VR/AR can add contextual information, recreate and preserve historical artifacts, manuscripts, and cultural heritage materials in a virtual environment, protecting them from physical degradation and reducing handling of fragile items.	24	19	4	3	3.2800	2.8636
	Cumulative mean					**3.2000**	**2.7966**

Key: Strongly agree (SA), Agree (A), Disagree (D), Strongly disagree (SD), Standard Deviation (StD)
Source: Field Survey, 2024 Decision mean =2.5

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Analysis of table 3 reveals the perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies into library services in Kaduna State University. The highest mean response of 3.5000 and standard deviation of 3.0265 indicates "VR/AR can support ongoing digitization initiatives by making digital content more accessible and interactive". Details of response on this opinion showed that 28 of the respondents strongly agreed, while 20 others agreed as against 1 that disagreed and 1 strongly disagreed with this opinion. In the same vein, "VR/AR can add contextual information, recreate and preserve historical artifacts, manuscripts, and cultural heritage materials in a virtual environment, protecting them from physical degradation and reducing handling of fragile items." This opinion attracted the respondent second highest mean response of 3.2800 and standard deviation of 2.8636 with details showing 24 strongly agreed, 19 others agreed while 4 disagreed and the rest 3 strongly disagreed. Analysis of the data collected on the perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies showed the cumulative mean of 3.2000 and standard deviation of 2.7966 which is greater than 2.50 index score for agree, this implies that most of respondents agree with researcher opinion on the perceived benefits of integrating Virtual Reality (VR) and Augmented Reality (AR) technologies into library services in Kaduna State University.

RQ 4: What challenges does the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies?

Table 4: Challenges the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies

S/N	Statements	SA	A	D	SD	Mean	StD
1	VR/AR hardware (e.g., VR headsets, AR-enabled devices) and software are expensive, posing a significant financial barrier for a university library with limited budgets.	26	21	2	1	3.4400	2.9732
2	The library may lack the required infrastructure, such as high-speed internet, reliable power supply, or dedicated VR/AR spaces.	25	16	4	5	3.2200	2.8425
3	Library staff may lack the technical skills and knowledge to manage, operate, or teach users about VR/AR tools.	23	20	5	2	3.2800	2.8495
4	Users may not be aware of VR/AR technologies or their potential benefits, leading to underutilization.	18	22	3	7	3.0200	2.6608
5.	Cultural or generational differences may make some staff and users hesitant to embrace VR/AR technologies.	18	14	8	10	2.8000	2.5139
	Cumulative mean					**3.1520**	**2.7679**

Key: Strongly agree (SA), Agree (A), Disagree (D), Strongly disagree (SD), Standard Deviation (StD)

Source: Field Survey, 2024 Decision mean =2.5

Table 4 above illustrates the challenges the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies. The highest mean response of 3.4400 and standard deviation of 2.9732 indicates "VR/AR hardware (e.g., VR headsets, AR-enabled devices) and software are expensive, posing a significant financial barrier for a university library with limited budgets." which could be one of the challenges the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies with their response showing that 26 strongly agreed, while 21 others were agreed as against 2 that disagreed while 1 strongly disagreed. Library staff may lack the technical skills and knowledge to manage, operate, or teach users about VR/AR tools as the opinion attracted the second highest mean response of 3.2800 and standard deviation of 2.8495 with details showing that 23 strongly agreed while 20 agreed as against 5 that disagreed while the rest 2 strongly disagreed. Analysis of the data collected on the challenges the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies reveals the cumulative mean of 3.1520 and standard deviation of 2.7679 is greater than 2.50 index score for agree, this implies that larger number of library staff and users of *the*

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*uni*versity library agree with the options provided on the challenges the Kaduna State University Library face in implementing Virtual Reality (VR) and Augmented Reality (AR) technologies.

Discussion of the Findings

The findings of the study revealed that the extent of application of Virtual Reality (VR) and Augmented Reality (AR) technologies in Kaduna State University Library was very low. This indicates that VR/AR technologies are not yet fully integrated into library operations and services. The finding is consistent with Aithal and Aithal (2023), who observed that the adoption of immersive technologies in many academic libraries remains limited due to inadequate infrastructure and financial constraints. The study also found a low level of awareness of VR/AR technologies among library staff and users. This finding agrees with Sharma and Singh (2022), who reported that insufficient awareness and training opportunities significantly affect the adoption of emerging technologies in libraries.

Despite the low level of application and awareness, respondents strongly acknowledged the potential benefits of VR/AR technologies in enhancing digital content accessibility, user engagement, and preservation of information resources. This finding supports Moro, Piteira, and Pedro (2021), who noted that immersive technologies improve learning experiences and facilitate interactive access to information resources. Furthermore, the study identified high implementation costs, inadequate infrastructure, and lack of technical expertise as major challenges. This finding concurs with Khan and Rahman (2024), who emphasized that financial limitations and insufficient technical capacity remain significant barriers to the successful implementation of VR/AR technologies in academic libraries.

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Conclusion

By and large, the application and awareness of Virtual Reality (VR) and Augmented Reality (AR) technologies in the Kaduna State University Library represent a promising frontier in enhancing user experience and educational outcomes. While challenges such as cost, infrastructure, and user adaptation remain, the potential benefits in terms of immersive learning environments and expanded access to information make these technologies worthwhile investments for the future of academic libraries. As KASU continues to evolve its library services, embracing VR and AR can position it at the forefront of educational innovation, enriching the learning journey for students and researchers alike**.** The results of this research show that although VR and AR technologies have great promise for improving library services in Kaduna State University, their use is restricted. Among library users and staff, knowledge is rather limited, therefore impeding the complete use of these new technologies. Chief obstacles are lack of specific training for consumers and library staff, high implementation costs, and inadequate infrastructure. Notwithstanding these difficulties, there is rising enthusiasm for incorporation of VI and AR into the library's services especially for research support, digital

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displays, and virtual learning. To maximize the advantages of VR and AR technologies, Kaduna State University Library should run training programs, upgrade technical infrastructure, and develop awareness initiatives to inform consumers about the benefits of these technologies. Furthermore, working with educational organizations and technology vendors would help to create creative VR/AR apps customized to academics' and researchers' requirements. Strategic planning and investment can substantially change the library experience by means of VR and AR, enhancing the interactive, engaging, effective information access.

Recommendations

1. The management of the institution library should initiate awareness campaigns and conduct regular training workshops for both students and library staff to enhance understanding of VR and AR technologies and their potential benefits in the academic library setting.
2. The library management should advocate for increased investment in the necessary hardware (e.g., VR headsets, AR-enabled devices) and software to support the effective implementation of VR and AR technologies.
3. The library management needs to ensure that the library's network infrastructure is capable of supporting the high data demands of VR and AR applications.
4. The university institution should explore opportunities for joint projects or grants that could provide financial support for the procurement of VR and AR equipment and software.
5. The library administration should engage students, faculty, and staff in the design and development of VR and AR content to ensure that these technologies meet their needs and enhance their learning experiences.

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