Perception of a Nigerian University Radiography Students on the Use of Virtual Reality in Radiography Education

Original Article

Sharonrose O. Nwadike[1], Emmanuel C. Arungwa[1], Victor K. Nwodo[1], Chinedu E. Anyanwu[1], Charity Ezinwanne Ofojebe[1], Chukwuemeka M. Inyama[1],*Abubakar A. Abubakar[2], Obinna E. Abonyi[3], Uloma B. Nwogu[3], Sobechukwu W. Onwuzu[3]

[1]Department of Radiography, Nnamdi Azikiwe University, Awka, Nigeria, [2]Department of Radiography, Bayero University Kano, Nigeria, [3]Department of Radiography, University of Nigeria, Nsukka, Nigeria

Corresponding Author;O. Nwadike email:so.nwadike@unizik.edu.ng; +234 7061882267

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ABSTRACT

Background: Radiography education is increasingly adopting innovative technologies to enhance student learning, engagement, and clinical competence. Virtual Reality (VR) provides an interactive environment that simulate real-life imaging procedures, potentially improving conceptual understanding and diagnostic interpretation skills.

Objectives: This study aimed to assess radiography students' acceptance, perceptions, and readiness to adopt Virtual Reality in radiography education using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework.

Materials and methods: A descriptive cross-sectional survey was conducted among 56 radiography students. Data were collected using a structured, self-administered questionnaire developed on the four UTAUT constructs Performance Expectancy, Effort Expectancy, Facilitating Conditions, and Social Influence. Each construct was assessed using a five-point Likert scale ranging from *1 (Strongly Disagree)* to *5 (Strongly Agree)*. Data were analyzed using descriptive statistics, including frequencies and percentages, to summarize students' responses and highlight patterns of perception and acceptance of VR-based learning analyzed using the Statistical Package for the Social Sciences (SPSS) version 2023

Results: Most respondents demonstrated a high level of agreement across all constructs. For instance, 85.8% agreed that VR enhances understanding, while 89.3% reported that it improves academic performance. Similarly, 88.7% found VR-based learning more engaging, and 88.4% considered it user-friendly. However, challenges were observed in facilitating conditions, as 96.4% of respondents indicated inadequate infrastructure and accessibility issues. Social influence was moderately positive, with 78.6% agreeing that peer and faculty support encouraged adoption.

Conclusion: The study reveals strong acceptance and perceived usefulness of VR among radiography students. Addressing infrastructural and technical support gaps will be essential for successful integration of VR into radiography education in Nigeria.

Keywords: Radiography Education, Virtual Reality, Transformative Potential, Technology, Healthcare Education

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Introduction

Radiography education is fundamental to preparing professionals capable of acquiring and interpreting medical images for accurate diagnosis [1]. The increasing demand for skilled radiographers in an evolving healthcare landscape necessitates educational frameworks that not only convey theoretical knowledge but also cultivate advanced practical competencies [2]. The integration of emerging technologies into radiography curricula presents an opportunity to transform learning approaches, ensuring that graduates possess the skills required for contemporary clinical practice [3].

Traditional radiography training combines classroom-based lectures, static instructional materials, and hands-on practice with physical phantoms or in clinical environments. While effective, these approaches face significant challenges, including limited clinical placement availability, variability in case exposure, restricted access to advanced imaging equipment, and the inherent risks associated with ionizing radiation [4]. These limitations have driven the search for innovative, technology-enhanced teaching methods that can enhance engagement, broaden clinical exposure, and improve safety.

Virtual Reality (VR) has emerged as one of the most promising tools for addressing these challenges [5]. VR is a computer-generated, interactive 3D environment, typically experienced through head-mounted displays (HMDs), motion controllers, and, in some cases, haptic feedback systems. Based on the degree of immersion, VR can be classified into a **f**ully Immersive VR which provides complete sensory engagement, enabling students to interact with virtual imaging equipment, position simulated patients, and operate consoles in a risk-free environment, making it ideal for complex imaging simulations such as fluoroscopy or CT scans [6-8]. Semi-Immersive VR, utilizes large projection screens or desktop-based 3D environments to deliver partial immersion. This approach allows students to visualise anatomical structures, manipulate images, and practise dose optimisation while remaining aware of their real-world surroundings [9-15].

Furthermore, VR can replicate advanced imaging modalities such as computed tomography (CT), magnetic resonance imaging (MRI), and fluoroscopy, enabling students to explore cross-sectional anatomy, master sequence protocols, and learn modality-specific safety measures before clinical exposure. When integrated with haptic feedback, VR can also simulate tactile sensations, such as adjusting equipment or repositioning a patient, further enhancing procedural realism. However, barriers to implementation remain. High equipment costs, the need for technical infrastructure, and the development of pedagogically sound VR-based curricula present significant challenges [8,17,18,19]. This study aims to investigate radiography students' perceptions of VR as a teaching and learning tool, evaluate its perceived effectiveness relative to traditional methods, and explore its potential role in preparing graduates for the technological and clinical demands of modern medical imaging practice.

Materials and Methods

The study was conducted at the College of Health Sciences, Nnamdi Azikiwe University, Awka, Anambra State of Nigeria. A convenient sampling technique was used to recruit a representative sample of 56 radiography students who participated in a VR-based anatomy presentation. Participation in the study was voluntary, with assurances of confidentiality and anonymity. No identifying information was collected, and data were stored securely. Participants were informed that they could withdraw from the study at any time without academic penalty. Only students who completed the questionnaire after the presentation were included in the final analysis to ensure valid responses reflecting their perceptions of VR in radiography education. A structured questionnaire was developed based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model by Venkatesh et al. [20]. This model was chosen due to its robustness in explaining technology acceptance and usage behavior, particularly in educational and health care contexts. The questionnaire was structured into four sub-themes: Performance Expectancy: The degree to which using VR is perceived to improve understanding and enhance academic performance [20]. Effort Expectancy: The perceived ease of use of VR technology in education [17]. Facilitating

Conditions: The availability of technical support, resources, and infrastructure for integrating VR [21]. Social Influence: The extent to which students perceive peer and faculty encouragement as a motivator for using VR [16].The questionnaire employed a 4-point Likert scale to assess student perceptions of VR, with response options as follows:1 = Strongly Disagree, 2 = Disagree, 3 = Agree and 4 = Strongly Agree. This scale was chosen to eliminate neutral responses and obtain a more defined perspective on student acceptance of VR technology. The questionnaire was administered immediately after the VR-based anatomy session to assess students' readiness and perceptions regarding the integration of VR into radiography education. Quantitative data were coded and analyzed using the Statistical Package for the Social Sciences (SPSS) version 2023. Descriptive statistics such as frequencies, percentages, means, and standard deviations were calculated. The study was approved by the Ethics Committee of the Faculty of Health Sciences and Technology, College of Health Sciences, Nnamdi Azikiwe University, with protocol number FHST/REC/023/418.

Results

A total of 56 radiography students participated in the study. Their responses were categorized under the four sub-themes of the Unified Theory of Acceptance and Use of Technology (UTAUT): Performance Expectancy, Effort Expectancy, Facilitating Conditions, and Social Influence. The findings are presented in Tables 1–4, using descriptive statistics to illustrate trends in perception. Table 1 presents the students' responses on performance expectancy. A large proportion of respondents agreed or strongly agreed that the technology enhances understanding (85.8%), improves academic performance (89.3%), and promotes a more engaging learning experience (88.7%). Table 2 summarizes the participants' perceptions of effort expectancy, which reflects the ease of using the learning technology. Most also agreed that minimal effort was needed to operate the system. Table 3 shows the responses on facilitating conditions, which assess the availability of technical and institutional support for the use of the technology. Only a few respondents reported access to adequate infrastructure or an easily accessible setup. Table 4 outlines the participants' responses on social influence, which evaluates how peer and faculty opinions affect technology acceptance. As presented in Table 4, nearly four-fifths of respondents agreed that peer collaboration and feedback positively influenced their perceptions. Faculty support also played a notable role, with over 70% agreeing that faculty members encouraged the use of the technology

Table 1: Performance Expectancy

Item	Strongly Disagree	Disagree	Agree	Strongly Agree	Total (%)
Enhances understanding	5.4%	8.9%	55.4%	30.4%	100%
Improves academic performance	3.6%	7.1%	58.9%	30.4%	100%
More engaging learning	4.5%	6.8%	60.7%	28.0%	100%
Improves image interpretation	2.7%	5.4%	57.1%	34.8%	100%
Enjoyable learning experience	3.6%	6.3%	59.8%	30.4%	100%

Table 2: Effort Expectancy

Item	Strongly Disagree	Disagree	Agree	Strongly Agree	Total (%)
Easy navigation	7.1%	10.7%	55.4%	26.8%	100%
Less complicated than traditional methods	5.4%	8.9%	58.9%	26.8%	100%
Straightforward to use	4.5%	7.1%	60.7%	27.7%	100%
Minimal effort needed	3.6%	6.3%	62.5%	27.7%	100%
User-friendly	4.5%	6.8%	61.6%	27.1%	100%

Table 3: Facilitating Conditions

Item	Strongly Disagree	Disagree	Agree	Strongly Agree	Total (%)
Accessible setup	50.0%	46.4%	3.6%	0.0%	100%
Adequate infrastructure	25.0%	75.0%	0%	0.0%	100%
Prepared for technical issues	23.2%	73.2%	3.6%	0.0%	100%
Technical support improved experience	0.0%	3.6%	50.0%	46.4%	100%
Willingness if support is provided	0.0%	0.0%	73.2%	26.8%	100%

Table 4: Social Influence

Item	Strongly Disagree	Disagree	Agree	Strongly Agree	Total (%)
Peer reactions influence perception	10.7%	14.3%	46.4%	28.6%	100%
Motivated by peer feedback	8.9%	12.5%	48.2%	30.4%	100%
Peer collaboration likely	7.1%	10.7%	50.0%	32.1%	100%
Faculty opinion varies	17.9%	21.4%	35.7%	25.0%	100%
Faculty support VR use	12.5%	16.1%	41.1%	30.4%	100%

Discussion

This study contributes to the growing body of evidence supporting the integration of Virtual Reality VR in radiography education by offering contextualized insights specific to a resource-limited setting. The findings indicate that students perceive VR as a valuable tool for enhancing learning outcomes, consistent with global research. Notably, the positive reception aligns with the Technology Acceptance Model (TAM), which emphasizes perceived usefulness and ease of use as key predictors of technology adoption in educational environments.

In line with studies by O'Connor et al. [22] and Radianti et al. [6], this research reaffirms VR's potential to improve student engagement, knowledge retention, and procedural skill development. However, only 57.1% of respondents in our study believed that VR significantly enhanced diagnostic interpretation skill slower than the 70% reported by O'Connor et al. [22]. This variance may reflect differences in the complexity of VR content, student familiarity with diagnostic imaging, or prior VR exposure. It also suggests a need to design VR simulations that mirror real-world diagnostic challenges more closely, thereby enhancing their perceived clinical relevance.

With regard to effort expectancy, 62.5% of participants found VR tools intuitive and userfriendly. This supports Abichandani et al.'s [8] findings on high usability among dental students. However, the contrast with Kononowicz et al. [7], where some medical students struggled with VR interfaces, underscores the influence of prior technological competence. According to the Unified Theory of Acceptance and Use of Technology (UTAUT), such individual differences in experience significantly affect easeofuse perceptions. These findings highlight the importance of offering orientation programs and user-friendly interfaces to minimize technological barriers.

Institutional readiness or facilitating conditions emerged as a critical barrier. A significant 75% of participants indicated inadequate infrastructural support for VR integration. This aligns with the observations of Lang et al. [24] and emphasizes the disparity in access between high- and low-resource settings. Ward et al. [23], for instance, reported minimal infrastructural challenges in well-funded institutions. These disparities point to systemic inequities that must be addressed through strategic investment, public-private partnerships, and policy reforms aimed at democratizing access to educational technologies.

Social influence also shaped students' willingness to adopt VR. Peer motivation was moderately impactful (48.2%), consistent with findings by Radianti et al. [6]. However, only 35.7% of students reported receiving encouragement from faculty, highlighting a lack of institutional leadership and educator involvement. This diverges from Sujar [15] study, where faculty played an active role in promoting VR learning. Faculty engagement is essential, not only for technical implementation but also for aligning VR content with curricular goals and pedagogical principles.

Constructive Learning Theory supports this, emphasizing the instructor's role in facilitating meaningful, student-centered learning experiences within immersive environments.

Despite these promising findings, several limitations must be acknowledged. The sample size of 56 students from a single institution limits generalizability. Larger, multi-institutional studies are needed to validate these results across diverse contexts. Furthermore, this study focused solely on self-reported perceptions without evaluating objective learning outcomes or long-term skill retention. Future research should adopt longitudinal and mixed-method designs to assess the sustained educational impact of VR. Additionally, the omission of faculty perspectives represents a missed opportunity, given their central role in technology integration. Investigating educator attitudes and readiness, along with the effectiveness of targeted professional development programs, would offer a more holistic view.

Future research should evaluate the pedagogical utility, affordability, and scalability of various VR systems across radiographic sub-specialties, including CT, MRI, and interventional imaging.

Conclusion: The findings reveal that radiography students generally perceive VR as an effective tool for enhancing conceptual understanding, academic engagement, and practical skill acquisition. These positive perceptions support the broader integration of VR in health sciences education. Despite these benefits, the study also identified significant challenges. Institutional constraints, including insufficient technical infrastructure and limited faculty support, were prominent barriers to effective VR adoption. The findings emphasize the need for strategic investment in educational technology, capacity-building programs for faculty, and long-term planning for implementation.

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