Basic Technology Teachers Perceived Usefulness and Ease of Use of Virtual Reality for Steam Instruction in Fct-Abuja

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ABSTRACT

Virtual Reality (VR) has emerged as an instructional technology capable of enriching experiential learning, creativity, and conceptual understanding in Science, Technology, Engineering, Arts, and Mathematics (STEAM) education. Despite its growing global recognition, VR integration within Nigerian secondary school classrooms remains limited. This study investigated Basic Technology teachers' perceived usefulness and ease of use of Virtual Reality for STEAM instruction in FCT-Abuja. A descriptive survey design was adopted, with 74 Basic Technology teachers drawn from public (n = 42) and private (n = 32) junior secondary schools across selected Area Councils in FCT-Abuja using proportionate stratified sampling. Data were collected via the researcher-designed Virtual Reality for STEAM Instruction Questionnaire (VRSIQ; α = 0.87). Mean and standard deviation answered research questions, while independent samples t-test and Pearson Product Moment Correlation tested hypotheses at α = 0.05. Findings indicated favourable perceptions of VR usefulness (cluster mean = 3.47) and ease of use (cluster mean = 3.11). No significant difference in either construct was found based on school ownership (perceived usefulness: $t(72) = 0.363$, $p = 0.718$; perceived ease of use: $t(72) = 0.375$, $p = 0.709$). A significant positive relationship was established between perceived usefulness and perceived ease of use ($r = 0.684$, $p < .001$). Although grounded in self-reported perceptions, these findings affirm that Basic Technology teachers in FCT-Abuja hold favourable attitudes towards VR integration. Practical realisation of these perceptions, however, requires targeted investment in infrastructure, teacher professional development, and context-sensitive implementation support.

Keywords: Virtual Reality, STEAM instruction, perceived usefulness, perceived ease of use, Basic Technology, Technology Acceptance Model

INTRODUCTION

The continuous advancement of digital technologies has profoundly reshaped instructional practices across educational institutions worldwide. Among the emerging technologies receiving considerable scholarly attention, Virtual Reality (VR) stands out for its immersive and interactive learning capabilities. VR enables users to interact with computer-generated environments that simulate real-life experiences through digital devices such as head-mounted displays, motion sensors, and mobile applications (Radianti et al., 2020). In Science, Technology, Engineering, Arts, and Mathematics (STEAM) education, VR's capacity to support experiential learning, virtual experimentation, and collaborative problem-solving makes it a compelling instructional innovation (Yakman & Lee, 2012).

In Nigeria, Basic Technology is a major pre-vocational subject taught at the junior secondary school level, aimed at developing technological literacy, manipulative skills, and practical problem-solving abilities. However, instructional delivery in many secondary schools continues to rely heavily on conventional, exposition-centred methods that provide limited opportunities for practical engagement. Merchant et al. (2014) established through meta-analysis that VR-based instruction significantly improves students' learning outcomes and engagement compared with traditional approaches, while Parong and Mayer (2018) confirmed that immersive VR environments support students' understanding of abstract concepts through experiential learning activities.

The Technology Acceptance Model (TAM), developed by Davis (1989), identifies perceived usefulness and perceived ease of use as the two primary determinants of technology acceptance and sustained utilisation. Understanding teachers' perceptions regarding these constructs is therefore critical for the successful integration of VR into STEAM instruction. Despite VR's growing global relevance, its classroom adoption in many Nigerian secondary schools remains constrained by inadequate infrastructure, irregular electricity supply, limited technological facilities, and variations in teachers' digital competencies (Danmali et al., 2025; Eze et al., 2018). Although previous studies have examined educational technology adoption in Nigeria, limited empirical attention has been directed specifically at Basic Technology teachers' perceived usefulness and ease of use of VR for STEAM instruction in junior secondary schools within FCT-Abuja. This study fills that gap, with findings intended to inform educational policy, teacher training programmes, and VR integration strategies in Nigerian secondary schools.

The study was guided by the following objectives: (i) to determine Basic Technology teachers' perceived usefulness of VR for STEAM instruction; (ii) to examine their perceived ease of use of VR for STEAM instruction; and (iii) to determine the relationship between perceived usefulness and perceived ease of use. Three null hypotheses were tested: Ho_1 no significant difference in perceived usefulness based on school ownership; Ho_2 no significant difference in perceived ease of use based on school ownership; and Ho_3 no significant relationship between perceived usefulness and perceived ease of use.

LITERATURE REVIEW

Theoretical Framework: Technology Acceptance Model

This study was anchored on the Technology Acceptance Model (TAM) developed by Davis (1989). TAM posits that technology acceptance is primarily governed by two beliefs: perceived usefulness the degree to which a user believes a technology improves performance and perceived ease of use the degree to which a technology is seen as requiring minimal effort. Technologies perceived as both useful and easy to use are more likely to gain acceptance and sustained utilisation. The relevance of TAM to this study lies in its explanatory capacity regarding Basic Technology teachers' dispositions towards VR as an instructional innovation. However, TAM has been critiqued for assuming a context of rational voluntariness, potentially overlooking the structural and institutional barriers that mediate the gap between positive perceptions and actual technology integration, particularly in resource-constrained settings (Vongkulluksn et al., 2018). This study therefore applies TAM as an analytical lens while remaining attentive to contextual factors that may constrain its predictive utility.

Virtual Reality in STEAM Education

Virtual Reality is a computer-generated immersive technology that enables users to interact with simulated environments through devices such as head-mounted displays, smartphones, and motion sensors (Radianti et al., 2020). In educational settings, VR creates realistic learning experiences that improve learners' engagement and conceptual understanding through three-dimensional representations and interactive simulations. STEAM education, which integrates Science, Technology, Engineering, Arts, and Mathematics to promote creativity, innovation, and problem-solving (Yakman & Lee, 2012), offers a particularly productive context for VR deployment. Within STEAM, VR enables learners to engage in virtual experimentation and collaborative activities that conventional classrooms cannot easily provide (Makransky & Mayer, 2022). Ibáñez and Delgado-Kloos (2018) further confirmed that immersive technologies support active learning, creativity, and collaboration in STEM-related disciplines, while Makransky and Petersen (2021) established that user-friendly immersive environments enhance learners' cognitive engagement and technology acceptance.

Perceived Usefulness and Ease of Use of VR

Perceived usefulness in educational technology contexts concerns teachers' beliefs regarding a technology's

capacity to improve instructional outcomes. Merchant et al. (2014) established through meta-analysis that VR-based instruction yielded significant gains in academic achievement, retention, and motivation. Makransky and Lilleholt (2018) similarly found that positive usefulness perceptions significantly influenced users' willingness

to integrate VR into educational activities. Perceived ease of use, by contrast, is more directly sensitive to practical contextual factors. Parong and Mayer (2021) found that learners responded positively to VR environments that were interactive and easy to navigate, while within Nigerian schools, infrastructural limitations, unstable electricity, inadequate technical support, and limited professional training may compound perceived usability challenges (Danmali et al., 2025; Eze et al., 2018). Most existing studies, however, were conducted in well-resourced settings in developed countries and focused predominantly on student rather than teacher populations. Within Nigeria, limited studies have specifically examined Basic Technology teachers' VR perceptions in junior secondary schools, constituting the empirical gap this study addresses.

METHODOLOGY

The study adopted a descriptive survey research design, appropriate for systematically gathering teachers' perceptions regarding VR usefulness and ease of use in FCT-Abuja. The study was conducted across selected Area Councils within the Federal Capital Territory (FCT-Abuja), Nigeria. The target population comprised Basic Technology teachers in public and private junior secondary schools in FCT-Abuja. A total of 74 teachers were selected using proportionate stratified sampling, comprising 42 from public schools and 32 from private schools, to ensure equitable representation across school ownership types.

Data were collected using the researcher-designed Virtual Reality for STEAM Instruction Questionnaire (VRSIQ), structured on a four-point Likert scale (Strongly Agree = 4, Agree = 3, Disagree = 2, Strongly Disagree = 1). The VRSIQ was validated by experts in Educational Technology and Measurement and Evaluation, and Cronbach's Alpha reliability analysis established an internal consistency coefficient of $\alpha = 0.87$. Mean and standard deviation were used to answer research questions, with a decision rule of Mean ≥ 2.50. Independent samples t-test and Pearson Product Moment Correlation were used to test hypotheses at 0.05 significance level. It is acknowledged that this study relied exclusively on self-reported perceptual data, which may not fully capture actual VR integration practices in classrooms; this limitation is discussed further below.

RESULTS

Research Question One and Hypothesis One: Perceived Usefulness

Research Question One sought to determine Basic Technology teachers' perceived usefulness of VR for STEAM instruction. Table 1 presents the descriptive statistics.

Table 1: Basic Technology Teachers' Perceived Usefulness of Virtual Reality for STEAM Instruction

S/N	Items	Mean	SD	Decision
1	VR improves students' understanding of STEAM concepts	3.55	0.63	Accepted
2	VR makes abstract concepts easier to understand	3.14	0.59	Accepted
3	VR enhances experiential learning in Basic Technology	3.55	0.56	Accepted
4	VR promotes creativity and critical thinking among students	3.55	0.58	Accepted
5	VR bridges theory and practical learning experiences	3.55	0.58	Accepted
	Cluster Mean	**3.47**		**Accepted**

Table 1 reveals that all five items exceeded the 2.50 decision threshold, with individual means ranging from 3.14 to 3.55. The cluster mean of 3.47 indicates that respondents consistently perceived VR as useful for improving STEAM instruction, including understanding of abstract concepts, experiential learning, and the development of creativity and critical thinking.

Hypothesis One (Ho_1) posited no significant difference in perceived usefulness based on school ownership. Table 2 presents the independent samples t-test results.

Table 2: Independent Samples t-Test Perceived Usefulness by School Ownership

School Ownership	N	Mean	SD	t	df	p	Decision
Public (n=42)	42	3.49	0.61	**0.363**	72	**0.718**	**Not Significant**
Private (n=32)	32	3.44	0.57				**Ho_1 Retained**

Table 2 shows that public school teachers (M = 3.49, SD = 0.61) and private school teachers (M = 3.44, SD = 0.57) held virtually identical perceptions of VR usefulness. The t-test yielded t(72) = 0.363, p = 0.718, which exceeds the 0.05 significance level. Ho_1 is therefore retained: school ownership does not significantly differentiate teachers' perceived usefulness of VR for STEAM instruction.

Research Question Two and Hypothesis Two: Perceived Ease of Use

Research Question Two examined teachers' perceived ease of use of VR for STEAM instruction. Table 3 presents the descriptive statistics.

Table 3: Basic Technology Teachers' Perceived Ease of Use of Virtual Reality for STEAM Instruction

S/N	Items	Mean	SD	Decision
1	VR tools are easy to learn and operate	3.28	0.63	Accepted
2	Interaction with VR devices is understandable	3.14	0.59	Accepted
3	VR applications are flexible for classroom instruction	3.03	0.56	Accepted
4	Teachers can easily integrate VR into STEAM lessons	3.00	0.58	Accepted
5	VR technologies are user-friendly for instructional delivery	3.09	0.58	Accepted
	Cluster Mean	**3.11**		**Accepted**

All five ease-of-use items exceeded the 2.50 threshold, with means ranging from 3.00 to 3.28 and a cluster mean of 3.11. While teachers perceived VR as manageable for instructional purposes, the comparatively lower cluster mean relative to perceived usefulness (3.11 vs. 3.47) suggests that usability perceptions, though favourable, are tempered by practical considerations.

Hypothesis Two (Ho_2) posited no significant difference in perceived ease of use based on school ownership. Table 4 presents the t-test results.

Table 4: Independent Samples t-Test Perceived Ease of Use by School Ownership

School Ownership	N	Mean	SD	t	df	p	Decision
Public (n=42)	42	3.13	0.59	**0.375**	72	**0.709**	**Not Significant**
Private (n=32)	32	3.08	0.55				**Ho_2 Retained**

Table 4 shows that public school teachers (M = 3.13, SD = 0.59) and private school teachers (M = 3.08, SD = 0.55) held comparable ease-of-use perceptions. The t-test yielded t(72) = 0.375, p = 0.709. Ho_2 is therefore retained: school ownership does not significantly differentiate teachers' perceived ease of use of VR for STEAM instruction.

Research Question Three and Hypothesis Three: Relationship Between Perceived Usefulness and Ease of Use

Table 5 presents the Pearson Product Moment Correlation analysis for Ho_3.

Table 5: Correlation Between Perceived Usefulness and Perceived Ease of Use of Virtual Reality

Variables	N	Mean	SD	r	p-value	Decision
Perceived Usefulness	74	3.47	0.59			
Perceived Ease of Use	74	3.11	0.57	**0.684**	**<.001**	**Sig.**

Table 5 indicates a strong positive, statistically significant relationship between perceived usefulness and perceived ease of use ($r = 0.684$, $p < .001$). Ho_3 is therefore rejected. Teachers who held stronger beliefs regarding the instructional benefits of VR concurrently perceived the technology as more manageable and user-friendly, consistent with TAM's theoretical architecture.

DISCUSSION OF FINDINGS

The findings of Research Question One confirmed that Basic Technology teachers in FCT-Abuja perceived VR as useful for STEAM instruction (cluster mean = 3.47), with particular strength on items concerning experiential learning, creativity, and abstract concept representation. This aligns with Merchant et al. (2014), whose meta-analysis established that VR-based instruction significantly improves students' learning outcomes and motivation, and with Makransky and Lilleholt (2018), who found that positive usefulness perceptions substantially influence users' willingness to adopt VR in educational activities. The retention of Ho_1 indicating no significant difference between public and private school teachers suggests that awareness of VR's instructional benefits is broadly distributed across the FCT-Abuja secondary school landscape, creating a uniform foundation for technology integration initiatives regardless of school ownership type.

The perceived ease of use findings (cluster mean = 3.11) also fell above the acceptance threshold, confirming manageable usability perceptions consistent with Davis (1989) and Parong and Mayer (2021). The retention of Ho_2 similarly confirms that usability perceptions do not differ significantly by school ownership. However, the marginally lower cluster mean for ease of use compared to usefulness (3.11 vs. 3.47) warrants careful interpretation. This gap may signal an emerging "usefulness-usability tension" in which teachers recognise VR's instructional value but experience subtle reservations regarding operational feasibility. Such tensions are consistent with findings from resource-constrained educational settings in sub-Saharan Africa, where enthusiasm for technology's potential frequently co-exists with practical usability concerns rooted in infrastructural and pedagogical realities (Eze et al., 2018).

A critical dimension inadequately addressed in prior Nigerian VR studies concerns the structural barriers that constrain technology adoption irrespective of perceptual dispositions. The practical integration of VR into Basic Technology classrooms in FCT-Abuja faces several formidable challenges. First, the acquisition cost of VR hardware including head-mounted displays, compatible smartphones or computers, and supporting peripherals remains prohibitive for most Nigerian public secondary schools operating under severely constrained capital budgets. Second, Nigeria's chronic electricity supply instability imposes a significant operational constraint; VR systems require consistent power supply for device charging, internet connectivity, and software functioning, conditions that cannot be reliably guaranteed in many FCT schools (Eze et al., 2018). Third, the bandwidth requirements for cloud-based VR content delivery and software updates exceed the connectivity capacities available in most junior secondary schools. Fourth, teachers' digital competence their ability to navigate VR platforms, troubleshoot technical difficulties, and integrate immersive environments pedagogically remains an under-addressed gap in Nigerian teacher professional development frameworks (Tondeur et al., 2017). These structural realities suggest that favourable perceptions, whilst necessary, are insufficient conditions for VR adoption; system-level investment in infrastructure, connectivity, hardware provision, and sustained technical support is equally indispensable.

The significant positive correlation between perceived usefulness and perceived ease of use ($r = 0.684$, $p < .001$) provides strong empirical support for TAM's theoretical architecture within the Nigerian secondary school context. However, a critical reading of these findings demands engagement with TAM's acknowledged limitations in resource-constrained environments. TAM was originally conceptualised within organisational contexts where technology adoption is voluntary, infrastructure is adequate, and users possess reasonable digital competence (Davis, 1989). In Nigerian secondary schools, these conditions frequently do not obtain: teachers may be unable to act on positive VR perceptions not because of motivational deficits but because of structural impossibilities lack of hardware, unreliable electricity, or inadequate technical training. Vongkulluksn et al. (2018) critically demonstrated that external barriers including technology access and institutional support significantly mediate the relationship between teachers' technology perceptions and actual classroom integration behaviour. The present findings must therefore be interpreted with this caveat: the strong usefulness-ease correlation observed here reflects a perceptual alignment that is a necessary but not sufficient predictor of actual VR adoption. Future research should incorporate behavioural and observational measures of technology integration to move beyond perceptual data and capture the intention–action gap that TAM in isolation cannot resolve.

CONCLUSION

This study concluded that Basic Technology teachers in FCT-Abuja hold favourable perceptions of both the usefulness and ease of use of Virtual Reality for STEAM instruction. No significant differences were found in either construct based on school ownership, indicating that positive VR perceptions are uniformly distributed across public and private secondary schools. The significant positive relationship between perceived usefulness and perceived ease of use ($r = 0.684$, $p < .001$) confirms TAM's explanatory applicability within the Nigerian secondary school context, whilst also underscoring the need for contextually sensitive interpretation of perception-based adoption frameworks.

These findings, however, must be situated within their methodological and contextual limitations. First, the study relied exclusively on self-reported perception data, which may not accurately reflect actual VR classroom implementation practices. Perceptual data captures attitudinal dispositions but cannot confirm whether or how teachers integrate VR into instruction in practice. Second, the sample of 74 teachers drawn from selected Area Councils in FCT-Abuja limits the generalisability of these findings beyond this context; replication across different Nigerian geopolitical zones and school types would be necessary before broader claims can be advanced. Third, structural barriers including electricity instability, hardware costs, internet connectivity, and digital skill gaps may substantially constrain the translation of positive perceptions into sustained VR adoption, irrespective of attitudinal alignment. Future research should integrate classroom observation, experimental or quasi-experimental designs, and student learning outcome measures to provide a more complete and implementation-grounded understanding of VR's role in Nigerian STEAM education.

RECOMMENDATIONS

Based on the findings and the contextual analysis above, the following recommendations are advanced:

1. Government and educational stakeholders should prioritise investment in VR hardware, reliable electricity infrastructure, and broadband connectivity in junior secondary schools to enable practical realisation of the favourable teacher perceptions documented in this study.

2. Pre-service and in-service teacher professional development programmes should explicitly incorporate VR facilitation competencies, addressing both technical operation and pedagogical integration, to bridge the digital competence gap identified as a barrier to adoption.

3. School administrators and curriculum planners should develop context-sensitive VR integration frameworks for Basic Technology and STEAM instruction that account for Nigeria's infrastructural realities, including low-bandwidth VR alternatives and offline-compatible immersive tools.

4. The Federal and State Ministries of Education should formulate explicit educational technology policies that designate VR and immersive technologies as components of the national digital education strategy, with accompanying funding frameworks for resource-constrained schools.

5. Future research should employ classroom observation studies, experimental or quasi-experimental designs, and longitudinal outcome measures to move beyond self-reported perceptions and provide robust evidence of VR's actual effects on students' STEAM achievement and engagement in Nigerian secondary schools.

Ethical Considerations

The study was conducted in accordance with ethical principles governing social science research involving human participants. Informed consent was obtained from all participating teachers prior to data collection. Respondents were assured of the confidentiality of their responses and the voluntary nature of participation. No personal identifiers were retained in the dataset. No conflict of interest is declared by the authors.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available owing to privacy considerations associated with the participating institutions.

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