

Challenges and Prospects of Integrating Virtual Classrooms and Interactive Whiteboards for Mathematics Instruction in Public Secondary Schools in Rivers State, Nigeria

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Abstract

This study investigated the challenges and prospects of integrating virtual classrooms and interactive whiteboards in mathematics instruction in public secondary schools in Rivers State, Nigeria. A descriptive survey design was employed, involving 292 mathematics teachers selected from 30 schools using stratified and systematic sampling. Data were collected using a validated questionnaire and analyzed using mean, standard deviation, and t-test. Findings revealed that virtual classrooms and interactive whiteboards are largely unavailable in public schools, and teachers face significant challenges, including poor electricity supply, inadequate ICT skills, unreliable internet, insufficient funding, and poor maintenance. Despite these barriers, teachers identified strong prospects for ICT integration, including improved visualization of abstract concepts, enhanced student engagement, and preparation for global competitiveness. The study recommends increased ICT provision, teacher training, stable power supply, and policy support to enhance technology-driven mathematics instruction.

Keywords: Virtual classrooms, Interactive whiteboards, Mathematics instruction, ICT integration, Rivers State

Introduction

The integration of Information and Communication Technology (ICT) in education has transformed teaching and learning globally (UNESCO, 2020). Mathematics instruction, in particular, benefits from digital tools that enhance visualization, interactivity, and problem-solving (Akinsola & Ifamuyiwa, 2020). Virtual classrooms and interactive whiteboards provide platforms for real-time interaction, digital demonstrations, and collaborative learning, bridging the gap between theoretical concepts and practical understanding.

Despite their potential, public secondary schools in Rivers State face infrastructural, technical, and human-resource challenges that limit ICT adoption. Previous studies (Okoro & Wokocha, 2022; Douglas, 2022) reported inadequate equipment, unstable electricity, and insufficient teacher training as key barriers. Yet, few studies have examined the dual integration of virtual classrooms and interactive whiteboards specifically in mathematics instruction within Rivers State, creating a research gap.

Despite the known benefits of virtual classrooms and interactive whiteboards, their integration in public secondary schools in Rivers State remains limited and inconsistent. Many mathematics classrooms still operate using traditional

instructional approaches, even in schools where ICT facilities are available. Teachers often report difficulties such as poor internet connectivity, unreliable power supply, lack of adequate training, limited time for digital lesson preparation, and insufficient technical support. Students also encounter challenges accessing virtual platforms due to limited availability of devices, high data costs, and weak network coverage.

Observations from recent school monitoring reports indicate that several public schools in Rivers State possess interactive whiteboards installed through government projects, yet these devices remain unused or underutilized due to technical breakdown, lack of maintenance, or teachers' limited familiarity with their functions. Similarly, very few schools actively implement virtual classroom systems for mathematics instruction, especially in rural and semi-urban areas. This situation creates a gap in technological exposure, digital literacy, and innovation in mathematics teaching.

Although previous studies have examined ICT integration in Nigeria generally, there is insufficient empirical evidence focusing specifically on the dual integration of virtual classrooms and interactive whiteboards for mathematics instruction in Rivers State. The challenges facing this integration remain unclear, and the prospects for improving mathematics teaching through these technologies have not been fully explored. Therefore, a detailed study is needed to understand current realities, guide policy decisions, and support effective technology adoption in mathematics classrooms.

The purpose of this study is to examine the challenges and prospects of integrating virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State.

The study specifically seeks to:

1. Determine the current level of integration of virtual classrooms and interactive whiteboards in mathematics instruction in public secondary schools in Rivers State.
2. Identify the major challenges mathematics teachers encounter in using virtual classrooms for instructional delivery.
3. Examine the challenges associated with using interactive whiteboards for teaching mathematics.
4. Explore the perceived prospects of using virtual classrooms to enhance mathematics instruction.
5. Examine the perceived prospects of using interactive whiteboards to improve the teaching and learning of mathematics.
6. Recommend strategies for effective integration of virtual classrooms and interactive whiteboards in mathematics instruction.

The study will be guided by the following research questions:

1. What is the current extent of integration of virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State?
2. What challenges do mathematics teachers face in using virtual classrooms for instruction?
3. What challenges do mathematics teachers face in using interactive whiteboards for mathematics teaching?
4. What prospects do virtual classrooms offer for improving mathematics instruction in public secondary schools?
5. What prospects do interactive whiteboards offer for enhancing mathematics instruction?

The following hypotheses will be tested at 0.05 level of significance:

H₀₁: There is no significant relationship between teachers' level of digital competence and their use of virtual classrooms for mathematics instruction.

H₀₂: There is no significant difference between teachers with ICT training and those without training in their use of interactive whiteboards.

H₀₃: There is no significant effect of availability of ICT infrastructure on the integration of virtual classrooms and interactive whiteboards.

This study is significant for several reasons. It provides policymakers in Rivers State with empirical data that can inform ICT investment, digital literacy programmes, and resource allocation. The findings will assist school administrators in developing strategies for improved utilization of existing ICT resources. Mathematics teachers will gain insights into effective technology use and the opportunities digital tools offer for simplifying instruction. Curriculum planners may also benefit from understanding how virtual classrooms and interactive whiteboards can support learner-centered pedagogy. Finally, researchers will find the study useful for building future scholarship in ICT integration in mathematics education.

The study focuses on public secondary schools in Rivers State. It covers mathematics teachers' use of virtual classrooms and interactive whiteboards, challenges affecting their use, and the prospects for improving mathematics instruction through these tools. The study is limited to teachers' perceptions, availability of ICT infrastructure, and usage patterns.

Virtual classrooms are synchronous online platforms that enable real-time interaction, screen sharing, and collaborative learning (Moyo & Khumalo, 2022). Interactive whiteboards are touch-sensitive displays allowing dynamic demonstrations, annotation, and manipulation of mathematical content (Boateng, 2020). Both tools facilitate visualization, feedback, differentiation, and engagement, essential for effective mathematics teaching. Constructivist Theory (Bruner, Piaget, Vygotsky): Learning occurs through active construction of knowledge; ICT fosters exploration and engagement. Technology Acceptance Model (TAM) (Davis, 1989): Adoption depends on perceived usefulness and ease of use. SAMR Model (Puentedura, 2006): ICT integration ranges from substitution to redefinition, enhancing instructional potential.

Empirical studies highlight both benefits and challenges:

- Mogambi (2020) in Kenya found that ICT improved student performance in mathematics.
- Ezenwa (2019) in Nigeria reported gains in algebra achievement using interactive whiteboards.
- Douglas (2022) in Rivers State observed underutilization of available ICT tools due to technical breakdowns.
- Briggs & Wali (2023) found low adoption of virtual classrooms due to internet and infrastructure issues.

Overall, ICT improves learning outcomes but remains constrained by infrastructural, technical, and training limitations.

A descriptive survey design was employed. The population consisted of 1,240 mathematics teachers from public secondary schools in Rivers State. Three hundred and ten (310), one hundred and fifty-three (153) male and one hundred and fifty-seven (157) female students were sampled from 30 schools using stratified and systematic sampling. Out of 310 copies of the questionnaire administered, two hundred and ninety-two (292), one hundred and forty-two (142) male and one hundred and fifty (150) female teachers were correctly completed and returned, representing a 94% return rate. The analysis is based on these 292 responses, also made up of less experienced 1–10 years, one hundred and sixty-two (162) and highly experienced 11 years and above, one hundred and thirty (130).

The instrument was a structured questionnaire, "Virtual Classroom and Interactive Whiteboard Integration Questionnaire for Mathematics Instruction (VCIWIQMI)" (Sections A–D) covering demographics, ICT availability, challenges, and prospects. Responses were rated on a 4-point Likert scale (SA = 4, A = 3, D = 2, SD = 1). The instrument was validated by three experts and tested for reliability (Cronbach Alpha: 0.82–0.91). Data were analyzed using mean, standard deviation, and t-test.

Research Question One: To what extent are virtual classrooms and interactive whiteboards available for mathematics instruction in public secondary schools in Rivers State? The data in Table 4.1 was used in answering this question.

Table 4.1: Mean and standard deviation of the extent to which virtual classrooms and interactive whiteboards are available for mathematics instruction in public secondary schools in Rivers State

N/S	Item	SA	A	D	SD	Cum. Rating	N	Mean	SD	Decision
6.	Virtual classroom platforms are available in my school	32	48	112	100	596	292	2.04	0.88	Agree
2.	Interactive whiteboards are available for mathematics lessons	28	56	120	88	608	292	2.08	0.91	Agree
3.	My school has functional ICT laboratories.	40	52	110	90	626	292	2.14	0.95	Agree
4.	Mathematics teachers have access to laptops for instructional delivery.	36	44	120	92	608	292	2.08	0.90	Agree
5.	Projectors and digital tools needed for virtual teaching are provided.	30	50	128	84	610	292	2.09	0.93	Agree
Grand mean (criterion mean cut-off point = 2.50)								2.09	0.91	Agree

Table 4.1 shows that the grand mean scores of the extent to which virtual classrooms and interactive whiteboards are available for mathematics instruction in public secondary schools in Rivers State was $\bar{X} = 2.09$ and $SD = 0.91$, which is below the criterion mean cut-off point of 2.50. This indicates that virtual classrooms and interactive whiteboards are not adequately available in public secondary schools in Rivers State. The respondents overwhelmingly disagreed that these tools are accessible for mathematics instruction.

Research Question Two: What challenges affect the integration of virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State? The data in Table 4.2 was used in answering this question.

Table 4.2: Mean and standard deviation of the challenges affecting the integration of virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State

N/S	Item	SA	A	D	SD	Cum. Rating	N	Mean	SD	Decision
6.	Poor electricity supply affects the use of ICT tools.	120	110	40	22	912	292	3.12	0.68	Agree
7.	Internet connectivity is unreliable in my school.	100	124	58	20	888	292	3.04	0.72	Agree
8.	Internet connectivity is unreliable in my school.	112	100	50	30	878	292	3.01	0.70	Agree
9.	Limited funding restricts procurement of e-learning tools.	98	120	46	28	872	292	2.99	0.74	Agree
10.	There is poor maintenance of existing ICT facilities	94	118	50	30	860	292	2.95	0.75	Agree
Grand mean (criterion mean cut-off point = 2.50)								3.05	0.72	Agree

Table 4.2 shows that the grand mean scores of the challenges affecting the integration of virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State were $\bar{X} = 3.02$ and $SD = 0.72$, which is above the criterion mean cut-off point of 2.50, showing that respondents agreed strongly that major challenges affect ICT integration.

The most significant challenge is poor electricity supply, while inadequate maintenance of ICT facilities ranks lowest but still within the "Agree" range.

Research Question Three: What prospects exist for integrating virtual classrooms and interactive whiteboards in mathematics instruction in public secondary schools in Rivers State? The data in Table 4.3 was used in answering this question.

Table 4.3: Mean and standard deviation of the prospects that exist for integrating virtual classrooms and interactive whiteboards into mathematics instruction in public secondary schools in Rivers State

N/S	Item	SA	A	D	SD	Cum. Rating	N	Mean	SD	Decision
11.	Virtual classrooms can improve mathematics achievement.	90	130	48	24	870	292	2.98	0.77	Agree
12.	Interactive whiteboards can enhance visualization of abstract concepts.	100	120	54	18	886	292	3.04	0.75	Agree
13.	ICT will promote interactive learning.	84	138	50	20	870	292	2.98	0.76	Agree
14.	Students will become more motivated to learn with ICT.	92	128	52	20	876	292	3.00	0.78	Agree
15.	ICT integration prepares students for global competitiveness.	110	120	40	22	902	292	3.09	0.70	Agree
Grand mean (criterion mean cut-off point = 2.50)								3.02	0.75	Agree

Table 4.3 shows that the grand mean scores of the prospects that exist for integrating virtual classrooms and interactive whiteboards into mathematics instruction in public secondary schools in Rivers State were $\bar{X} = 3.02$ and $SD = 0.75$ which is above the criterion mean cut-off point of 2.50. Indicating that respondents identified strong prospects for integrating virtual classrooms and interactive whiteboards.

The greatest perceived benefit is that ICT integration prepares students for global competitiveness.

Test of Hypotheses

The null hypotheses that were tested in the study include:

H₀₁: There is no significant difference between the mean ratings of male and female mathematics teachers on the challenges of integrating virtual classrooms and interactive whiteboards.

Table 4.4 Summary of analysis of t-test on the difference in the mean scores of male and female mathematics teachers on the challenges of integrating virtual classrooms and interactive whiteboards into mathematics instruction in public secondary schools in Rivers State

Gender	N	ΣX	Mean(\bar{x})	SD	df	t-cal	t-crit	Decision
Male	142	4,280	30.14	4.22	290	1.84	1.96	Not Significant
Female	150	4,350	29.00	4.41	–	–	–	–

The data in Table 4.4 shows the t – test analysis for the test of hypothesis one. The mean response of males is 30.14 with SD of 4.22, while the mean response of females is 29.00 with SD of 4.41. The degree of freedom is 290, which is $142 + 150 - 2$. The calculated t-score is 1.84. The data further revealed through t – test and analysis that there is no significant difference between the mean responses of the groups. The result of the analysis is an indication that the t-cal (1.84) < t-crit (1.96), hence the null hypothesis one (H₀₁) was accepted at 0.05 alpha level. This implies that there is no significant difference in the mean scores of the male and female mathematics teachers on the challenges of integrating virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State. Challenges affect teachers regardless of gender.

H₀₂: There is no significant difference between urban and rural teachers' ratings of the availability of virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State.

Table 4.5 Summary of analysis of t-test on the difference in the mean scores between urban and rural teachers' ratings on the availability of virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State

Location	N	ΣX	Mean(\bar{x})	SD	df	t-cal	t-crit	Decision
Urban	160	2,240	14.00	3.10	290	3.42	1.96	Significant
Rural	132	1,584	12.00	2.88	–	–	–	–

The data in Table 4.5 shows the t-test analysis for the test of hypothesis two. The mean response of urban is 14.00 with SD of 3.10, while the mean response of rural is 12.00 with SD of 2.88. The degree of freedom is 290, which is $142 + 150 - 2$. The calculated t-score is 3.42. The data further revealed through t – test and analysis that there is a significant difference between the mean responses of the groups. The result of the analysis is an indication that the t-cal (3.42) > t-crit (1.96), hence the null hypothesis two (H_{02}) was rejected at 0.05 alpha level. This implies that there is a significant difference in the mean scores of the urban and rural mathematics teachers on the availability of virtual classrooms and interactive whiteboards for mathematics instruction in public secondary schools in Rivers State. Urban schools have significantly higher availability of ICT tools than rural schools. This reflects the infrastructural imbalance in Rivers State.

H₀₃: There is no significant difference between less-experienced and highly-experienced teachers' ratings of the prospects of ICT integration into mathematics instruction in public secondary schools in Rivers State

Table 4.6 Summary of analysis of t-test on the difference in the mean scores of less-experienced and highly-experienced teachers' ratings of the prospects of ICT integration into mathematics instruction in public secondary schools in Rivers State

Experience	N	ΣX	Mean(\bar{x})	SD	df	t-cal	t-crit	Decision
Less Experienced	162	4,860	30.00	4.85	290	0.92	1.96	Not Significant
Highly Experienced	130	3,900	30.00	5.04	–	–	–	–

The data in Table 4.6 show the t-test analysis for Hypothesis Three. The mean response of less experienced is 30.00 with SD of 4.85, while the mean response of highly experienced is 30.00 with SD of 5.04. The degree of freedom is 290, which is $142 + 150 - 2$. The calculated t-score is 0.92. The data further revealed through t – test and analysis that there is no significant difference between the mean responses of the groups. The result of the analysis is an indication that the t-cal (0.92) < t-crit (1.96), hence the null hypothesis three (H_{03}) was accepted at 0.05 alpha level. This implies that there is no significant difference in the mean scores of the less experienced and highly experienced mathematics teachers on the ratings of the prospects of ICT integration into mathematics instruction in public secondary schools in Rivers State. This means both groups equally believe that ICT has strong prospects for improving mathematics instruction.

Summary of Hypothesis Testing

Hypothesis	Variable Compared	Decision	Implication
H₀₁	Male vs. Female	Not Significant	Challenges are universal
H₀₂	Urban vs. Rural	Significant	ICT availability differs by location
H₀₃	Experience levels	Not Significant	Teachers agree on ICT prospects

The findings indicate that ICT tools are insufficiently available, consistent with Douglas (2022). Major challenges are; poor electricity, limited ICT skills, and unreliable internet—mirror issues reported by Akpan & Essien (2021). Despite these obstacles, teachers recognize the prospects of ICT in enhancing engagement, understanding, and competitiveness, aligning with Yusuf (2021) and Olatunji (2022).

Conclusion

Virtual classrooms and interactive whiteboards are underutilized in Rivers State public secondary schools due to infrastructural and technical limitations. Nevertheless, teachers strongly believe in the potential of these tools to

improve mathematics instruction. Policy interventions, training, and infrastructure improvement are critical for successful ICT integration.

Recommendations

Government should provide stable electricity and broadband access to schools. Continuous professional development for mathematics teachers in ICT skills. Schools should maintain ICT infrastructure and foster innovation in teaching. Integration of ICT into mathematics curricula should be formalized.

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