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Article

Effects of Virtual Technology Teaching Strategy on Senior Secondary School Students' Interest and Achievement in Mathematics in Federal Capital Territory Abuja, Nigeria

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Abstract: This study investigated the effects of virtual technology teaching strategy (VTTS) on senior secondary school students' interest and achievement in Mathematics in FCT Abuja, Nigeria. The study employed quasi-experimental research design of pretest and posttest control group. The population for this study comprised 9,887 SS II students with sample of 120 SSII Mathematics Students. The schools were selected using simple random sampling technique. Two instruments were constructed for the study. These were: Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS) which were validated by experts and the reliability yielded 0.79 and 0.84 using Kuder-Richardson 21 formula and Cronbach Alpha respectively. Data collected were analyzed using mean rank, mean and standard deviation to answer the research questions while Mann-Whitney U test and ANCOVA were used to test the null hypotheses at 0.05 level of significance. The findings revealed that there was statistically significant difference between the mean interest and achievement scores of students taught Mathematics using VTTS and those taught using conventional teaching method in favour of the experimental group. However, there were no significant difference between male and female students' mean interest and achievement scores in the experimental group. Based on the findings, it was amongst others recommended that Virtual Technology Teaching Strategy (VTTS) be adopted by the teachers as it appeared to have a positive effect on students' interest compared to conventional teaching method. Stakeholders in education should encourage teachers on the use of virtual technology teaching strategy as an equitable approach that supports balanced achievement outcomes across genders.

Keywords: Mathematics, Virtual Technology, Students' Interest, Achievement

1. Introduction

Mathematics is a fundamental field of study that plays a crucial role in understanding the world and making important discoveries. Its applications are vast, and it provides a powerful tool for solving problems, analyzing data, and making predictions in a wide range of fields. According to Iyoke, mathematics is a science visualized in symbols, logical statements, shapes, numerical quantities and arrangement. Mathematics like other science subjects, therefore, demands the teacher

using appropriate teaching methods that will give students opportunity to be actively involved [1]. Teaching methods according to Omwirhiren and Khalil are meant for helping students to study effectively. Despite the place of mathematics in the development of our society, many research reports such as Zalmon and Wonu; Iyoke show that the achievement of students in mathematics at all levels of our educational system is poor [2], [3].

Students' achievement in Mathematics has remained low as many of the candidates earn less than 40% (West Africa Examination Council (WAEC) Chief Examiner's Report). To arrest students' attention, interest, achievement, curiosity and promote their performance in Mathematics, the use of activity stimulating and student-centered approach like virtual technology/Computer Assisted Instruction (CAI) method instead of depending on the conventional approach need to be embraced. Virtualization is technology that lets one creates useful Information Technology (IT) services using resources that are traditionally bound to hardware [4]. Virtual Technology (VT) Method of Teaching is a computer assisted instruction (CAI) and information and communication technology (ICT) method of teaching. In the words of Suleman, et. al, VT is an instructional approach where a computer is used to communicate the instructional materials and evaluate the learning outcomes. In support of this, Sedega, et al, said that the students might be given various degrees of control over their own learning, instruction could be tailored according to individual student's needs and Feedback on student performance could be stored for further reference under VT instructional approach [5], [6].

The advantages of VT method according to Orjika in Suleman, et al, (2017) include, ensuring the application of proven teaching methods to students; offering equal educational opportunities for students by using the same programme; changing the role of the teacher from teaching capacity to that of a guide; also when properly handled, removing fright and embarrassment on students and bringing about meaningful learning and academic achievement [7]. VT instruction may also motivate both male and females (both gender) for better achievement in mathematics. Gender remains a significant factor in mathematics education, influencing students' interest and performance, with recent research indicating that instructional context and technology use can shape these outcomes rather than inherent ability [8].

Investigations into gender and technology-based teaching methods reveal that when appropriately designed and implemented, virtual learning tools may reduce traditional disparities in motivation and achievement by providing engaging, visually supported instruction that appeals to diverse learners [9]. Studies have shown that virtual technology can significantly enhance students' learning outcomes by providing interactive and adaptive learning experiences. Radianti et al found that virtual reality-based instruction significantly enhanced students' interest and engagement as well as their conceptual understanding in science-related subjects when compared with conventional teaching methods using a quasi-experimental design. Ityavzua found that type of mathematics laboratory had significant effect on students' interest in circle geometry.

Sam-Kayode revealed that there was a significant difference in the achievement of students in Applied Mathematics when exposed to virtual learning. The study also revealed a significant difference in the achievement of male and female students taught Applied Mathematics using virtual learning. Similarly, Anaduaka et al. revealed that students exposed to multimedia technology instruction demonstrated significantly higher achievement in Mathematics than those taught using the conventional method. Adebayo and Mohammed also revealed that students taught using blended virtual learning strategy demonstrated significantly higher achievement and interest than those taught using conventional teaching methods. Salami et al. found that students exposed to virtual classroom instruction achieved significantly higher scores than those taught using traditional face-to-face methods [10].

Technology has the potential to bring an optimistic difference in simulating abstract concepts. Many countries (Nigeria inclusive) are nowadays seeking to develop their education systems through the use of technologies and methods of modern learning in order to keep pace with

technological developments and to achieve satisfactory results, as education is considered a real investment for any country and its people.

2. Statement of the Problem

The general interest and achievement of students in mathematics has been a great concern to Nigeria and the world at large. Despite the important of mathematics in our daily activities and our educational system with effort made by researchers and mathematics educators to enhance performance in mathematics, it is very worrisome that students' achievement in mathematics is still low. The general achievement of the candidates has not been stable. It varies with a wide disparity across schools in different regions [11]. Several factors have been identified for students' poor achievement in mathematics such as usage and availability of teaching and learning facilities, teachers' method of mathematics teaching. The teaching and learning of mathematics topics has been frustrated by the nature of the topics, the clumsy method and instructional strategy used by the teacher therefore resulting to students' poor achievement in both internal and external examinations [12]. Several research works had been carried out on use of virtual technology across FCT-Abuja Nigeria, past studies recognized VT as a learner-centred method that allows students to work individually or in groups at their own pace. According to these researchers, the VT can be used to teach a concept through attractive animations, sound and demonstrations. The teaching approach provides immediate feedback for students to enable them know whether their answers are correct or wrong. However, there are still conflicting research results on the effectiveness of Virtual Technology in teaching of Mathematics. This calls for further studies. Therefore this study was designed to ascertain the effects of virtual technology teaching strategy on senior secondary students' interest and achievement in Mathematics in FCT Abuja [13].

3. Research Questions

The following research questions were raised to guide this study:

1. What is the difference between the mean rank interest scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional method?
2. What is the difference between the achievement scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional method?
3. What is the difference between the mean rank interest scores of male and female senior secondary school students taught Mathematics using the Virtual Technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?
4. What is the difference between the mean achievement scores of male and female senior secondary school students taught Mathematics using Virtual Technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?

4. Hypotheses

The following null hypotheses were generated and tested at 0.05 level of significance:

H_{O1}: There is no significant difference between the mean interest scores of senior secondary school students taught Mathematics using the Virtual Technology teaching strategy and those taught the using conventional method of teaching.

H_{O2}: There is no significant difference between the mean achievement scores of senior secondary school students taught Mathematics using the Virtual Technology teaching strategy and those taught the using conventional method of teaching.

H_{O3}: There is no significant difference between the mean rank scores of male and female senior secondary school students taught Mathematics using the Virtual Technology teaching strategy in the FCT Abuja, Nigeria.

H_{O4}: There is no significant difference between the mean achievement scores of male and female senior secondary school students taught Mathematics using the Virtual Technology teaching strategy in the FCT Abuja, Nigeria.

5. Methodology

The research design for this study was a quasi-experimental non-randomised control group research design adopting the pretest and posttest control group type. The population of the study comprised of nine thousand eight hundred and eighty-seven (9,887) SS II students. Among this was four thousand one hundred and seventeen (4,117) male and five thousand seven hundred and seventy (5,770) female students. A sample size of 120 Mathematics students formed the sample for the study. Two (2) co-educational schools were selected using simple random sampling technique out of the thirteen (13) co-educational schools in Bwari Area Council, FCT Abuja. The schools selected were two. One was assigned as experimental group while the second was assigned as the control group. In each of the schools, SS II intact classes were involved in the study. The sample size consisted of one hundred and twenty (120) SS II students, 70 for experimental group and 50 for control group. The teacher in the experimental school was trained by the researcher for two hours daily over one week on how to use virtual technology to teach Mathematics while the teacher in the control school taught the students using the conventional method to which they were accustomed. The treatment lasted for eight weeks.

Two instruments, Mathematics Achievement Test (MAT) and Mathematics Interest Scale (MIS) were constructed for the study. The Mathematics Achievement Test (MAT) consists of twenty (20) multiple choice questions, with four options (A, B, C, D) of which one is the only correct option. It was developed by the researcher using basic procedures of constructing a test with the aid of a Table of Specification, which was developed from the content taught to both the experimental and control groups. Mathematics Interest Scale (MIS) on the other hand consists of twenty (20) items developed by the researcher and designed to assess students' interest in Mathematics. The instrument is on four-point modified likert scale format of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) and were scored as: SA = 4, A = 3, D = 2 and SD = 1. Both MAT and MIS were validated by two experts. Observations and corrections were made by the experts. All the corrections observed were implemented by the researcher and the validated instruments were used for collection of data.

Pilot study was carried out in a public senior secondary school different from the study school and the results were subjected to reliability test using Kuder-Richardson formula 21 (K-R21) and Cronbach Alpha which gives a reliability indices of 0.79 and 0.84 respectively. The collected data were analysed using mean rank, mean and standard deviation to answer the research questions while Mann-Whitney U test and ANCOVA were used to test the hypotheses formulated for the study at 0.05 level of significance. The Statistical Package for Social Science (SPSS) version 25 was used to analyse the data.

6. Results

Research Question 1: What is the difference between the mean rank interest scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional method?

Table 1: Mean Rank and Sum of Ranks of Interest Scores of Experimental and Control Group

Group	N	Mean Rank		Sum of Ranks	
		Pretest	Posttest	Pretest	Posttest
Experimental	70	44.57	64.85	2044.500	2517.500
Control	50	38.92	39.77	1836.500	1754.500
Mean Rank Difference		**5.65**	**25.08**		
Total	**120**				

Table 1 shows the mean rank and sum of ranks of interest scores of students in the experimental and control group before (Pretest) and after (Posttest) the treatment. The results indicate a significant positive impact of Virtual Technology Teaching Strategy (VTTS) on students' interest towards Mathematics. The mean rank of the experimental group increased from 44.57 to 64.85 while the control group's mean rank slightly increase from 38.92 to 39.77. The difference in mean rank between the two groups increased from 5.65 to 25.08, suggesting a widening gap in favour of the experimental group. The sum of ranks for the experimental group also increased significantly from 2044.500 to 2517.500 while the control group's sum of ranks decreased slightly from 1836.500 to 1754.500.

Research Question 2: What is the difference between the mean achievement scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional method?

Table 2: Mean Achievement Scores of Students in Experimental and Control Group

Group		Pretest		Posttest		Mean gain
	N	$\bar{x}$	SD	$\bar{x}$	SD	
Experimental	70	31.55	4.842	55.94	6.716	**24.39**
Control	50	30.89	4.795	38.92	5.098	**8.03**
Mean Difference		**0.66**		**17.02**		

In table 2, the mean achievement scores of students taught Mathematics using Virtual Technology Teaching Strategy (VTTS) is 31.55 and 55.94 for the pretest and posttest respectively, and mean gain score is 24.39 while the mean achievement scores of students taught Mathematics using conventional teaching method is 30.89 and 38.92 for the pretest and posttest respectively and mean gain score is 8.03. Also, the mean difference for the posttest is 17.02 in favour of the experimental group. This indicated that students taught Mathematics using VTTS achieved higher than those taught Mathematics using conventional teaching method in senior Secondary Schools Abuja, Nigeria.

Research Question 3: What is the difference between the mean interest scores of male and female senior secondary school students taught mathematics using virtual technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?

Table 3: Mean Rank and Sum of Ranks of Interest Scores of Male and Female Students taught with VTTS

Group	N	Mean Rank	Sum of Ranks
Male	44	27.97	656.00
Female	26	25.88	599.00
Mean Rank Difference		2.09	
Total	**70**		

Table 3 reveals the mean rank and sum of ranks of interest scores of male and female students taught Mathematics using VTTS. The sample consisted of 44 male and 26 female students. The mean rank for male students was 27.97 with a sum of ranks of 656.00. The mean rank for female students was 25.88 with a sum of ranks of 599.00. Therefore, the mean rank difference in interest score between male and female students in experimental group is 2.09 in favour of male students.

Research Question 4: What is the difference between the mean achievement scores of male and female students taught mathematics using virtual technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria?

Table 4: Means Achievement Scores of Male and Female Students taught Mathematics using VTTS

Groups	N	Mean	Standard Deviation
Male	44	48.27	8.53
Female	26	47.61	7.72
Difference		**0.66**	

The result in table 4 shows the mean achievement scores of male and female students taught Mathematics using VTTS as the male students had a mean achievement score of 48.27 with a standard deviation of 8.53, while the female students had a mean achievement score of 47.61 with a standard deviation of 7.72. Due to the comparative low difference in the means achievement scores of the two groups, this indicated that the means achievement scores of male and female students was not influenced by students' gender [14], [15].

Test of Hypotheses

H_{O1}: There is no significant difference between the mean interest scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional teaching method in the FCT, Abuja.

Table 5: Mann-Whitney U Test of Interest Scores of Experimental and Control Group

Test Statistics[a]	INTEREST
Mann-Whitney U	685.000
Wilcoxon W	2428.000
Z	-2.145
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Teaching Methods

Table 5 reveals Mann-Whitney U test of interest scores of students taught Mathematics using VTTS and those taught using conventional teaching method. The results indicate a statistically significant difference between the interest scores of experimental and control groups ($z = -2.145$; $p < .05$). This implies that there is significant difference between the mean interest scores of students in the experimental and control group in senior secondary schools in the FCT, Abuja.

H_{O2}: There is no significant difference between the mean achievement scores of senior secondary school students taught mathematics using V.T instructional strategy and those taught using conventional teaching method in the FCT, Abuja.

Table 6: Analysis of Covariance (ANCOVA) of Respondents' Scores in Mathematics Achievement Test (Method)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4214.443[a]	2	2107.222	225.840	.000	.794
Intercept	686.568	1	686.568	73.582	.000	.386
Pretest	2357.098	1	2357.098	252.620	.000	.683
Group	30.163	1	30.163	3.233	.002	.027
Error	1091.682	117	9.331			
Total	182023.000	120				
Corrected Total	5306.125	119				

a. R Squared = .794 (Adjusted R Squared = .791)

The result in Table 6 shows that $F_{(1,117)} = 9.331$; Sig = 0.002 < 0.05. This significant value of 0.002 is less than the alpha value of 0.05 level of significance. Hence, the null hypothesis is not accepted. This implies that there is statistically significant difference in the Mathematics achievement mean scores of students in the experimental and control group. It therefore implies that the mean achievement scores of students in Mathematics do differ significantly between the experimental and the control group in favour of experimental group.

H_{O3}: There is no significant difference between the mean interest scores of male and female students taught mathematics using virtual technology teaching strategy in senior secondary schools in FCT Abuja, Nigeria.

Table 7: Summary of Mann-Whitney U Test Results of Interest Score of Students taught Mathematics Using VTTS

Groups	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	Sig.	Remark
Male	44	27.97	656.00	325.000	-1.216	.494	Not Sig.
Female	26	25.88	599.00				

Table 7 summarizes the results of Mann-Whitney U test conducted to compare the interest scores of male and female students in experimental group. The results of Mann-Whitney U test yielded no statistically significant difference between the two variables ($z = -1.216$; $p > .05$). Therefore, null hypothesis three is accepted. This implies that there is no significant difference between male and female students' interest mean score in mathematics who were taught using virtual technology teaching strategy in senior secondary schools in the FCT Abuja, Nigeria.

H_{O4}: There is no significant difference between the mean achievement scores of male and female students taught mathematics using virtual technology teaching strategy in senior secondary schools in the FCT Abuja, Nigeria.

Table 8: Analysis of Covariance (ANCOVA) of Respondents' Scores in Mathematics Achievement Test (Gender)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4200.685[a]	2	2100.342	222.301	.000	.792
Intercept	725.230	1	725.230	76.758	.000	.396
Pretest	2909.474	1	2909.474	307.939	.000	.725
Gender	16.404	1	16.404	1.736	.190	.015
Error	1105.440	117	9.448			
Total	182023.000	120				
Corrected Total	5306.125	119				

a. R Squared = .792 (Adjusted R Squared = .788)

The result in table 8 shows that $F_{(1,117)} = 1.736$; Sig = 0.190 > 0.05. This significant value of 0.190 is greater than the alpha value of 0.05 level of significance. Hence, the null hypothesis which states that there is no significant difference between male and female students' achievement score in Mathematics who were taught using virtual technology teaching strategy in senior secondary schools in FCT Abuja was not rejected. Thus, it indicates that there was no significant difference in the mean achievement scores of male and female students taught Mathematics using the virtual technology teaching strategy.

7. Discussion

The first finding of the study revealed that there was a significant difference in the mean interest scores of students in the experimental and control groups in favour of experimental group.

This finding is consistent with the study of Radianti et al. (2020), which reported that virtual reality-based instruction significantly enhanced students' interest and engagement as well as their conceptual understanding in science-related subjects when compared with conventional teaching methods using a quasi-experimental design. This finding also agrees with that of Ityavzua (2019) who found that students taught circle geometry using Virtual Mathematics Laboratory had significant higher interest in circle geometry than those taught with Traditional Mathematics Laboratory.

The second finding made by this study revealed that there was significant difference in the mean achievement scores of Mathematics students in the experimental and control group. This finding agrees with the earlier finding made by Sam-Kayode who revealed that there was a significant difference in the achievement of students in Applied Mathematics when exposed to virtual learning. This finding also concur with the finding of Anaduaka et al. (2025) that students taught mathematics using multimedia technology had higher mean achievement score than their counterparts taught using conventional method.

The third finding of this study showed that there was no significant difference in the mean interest scores of Mathematics students taught using virtual technology teaching strategy across Gender. This finding agrees with that of Ityavzua (2019) who found that gender did not significantly influence students' interest in the teaching of circle geometry using Virtual Mathematics Laboratory. However, this finding contradicts the study by Radianti et al. (2020), who reported that virtual reality-based instructional environments significantly enhanced learners' interest and engagement, with evidence that learner characteristics, including gender, could moderate the affective outcomes of immersive learning experiences.

The last finding made by this study revealed that there was no significant difference in the mean achievement scores of Mathematics students taught using virtual technology teaching strategy across Gender. This finding agrees with that of Ajai and Imoko (2015) whose assessment on gender differences in mathematics achievement and retention by using Problem-Based Learning (PBL) revealed that male and female students taught algebra using PBL did not significantly differ in achievement and retention scores, thereby revealing that male and female students are capable of competing and collaborating in mathematics. On the contrary, this finding disagrees with that of Sam-Kayode who found a significant difference in the achievement of male and female students taught Applied Mathematics using virtual learning in favour of male students.

8. Conclusion

The findings of this study discovered the effectiveness of the Virtual Technology Teaching Strategy (VTTS) over the conventional teaching method in enhancing students' interest and achievement in Mathematics. The VTTS also proved to be gender-friendly as it enhanced students' interest and achievement equally in mathematics without differences between males and females.

9. Recommendations

Based on the findings, the following recommendations were made:

1. The virtual technology teaching strategy (VTTS) should be adopted by the teachers as it appeared to have a positive effect on students' interest in Mathematics compared to conventional method used in the control group.
2. Teachers should adopt and integrate the virtual technology teaching strategy more widely in Mathematics classes to improve students' achievement.
3. Mathematics educators should continue using the virtual technology teaching strategy since it engages both male and female students equally, promoting gender-inclusive learning.
4. Stakeholders in education should encourage teachers on the use of virtual technology teaching strategy as an equitable approach that supports balanced achievement outcomes across genders.

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