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Impacts of Multimedia Technology Instruction on Public Secondary School Students' Motivation and Achievement in Mathematics in Federal Capital Territory Abuja, Nigeria

U. S. Anaduaka, I. A. Ojelade, S. K. Wahab
Department of Science and Environmental Education, Faculty of Education, University of Abuja, Abuja Nigeria
uche.anaduaka@uniabuja.edu.ng
nike.ojelade@uniabuja.edu.ng
wahab.saheed@uniabuja.edu.ng

Abstract. *This study investigated the impacts of Multimedia Technology Instruction on public secondary school students' motivation and achievement in Mathematics in Federal Capital Territory, Abuja, Nigeria. Three research questions and hypotheses guided the study. The research design employed was quasi-experimental design of pre-test, post-test non-randomized and control group. The population of the study was made up of 10,936 SS II students. Multi-stage sampling technique was used to select 125 SS II students comprising both experimental (60) and control (65) groups. The research instruments used for data collection were Students' Motivation (SMQ) and Mathematics Achievement Test (MAT). The instruments were validated and subjected to reliability test and internal consistency of 0.799 and 0.859 were obtained for SMQ and MAT using Cronbach Alpha and Kuder-Richardson formula 21 (K-R21) respectively. Data collected were analysed using mean rank for research questions one, mean and standard deviation for research questions two and three while Mann-Whitney U test was used to test hypothesis one and ANCOVA was used for testing of hypotheses two and three at 0.05 levels of significance. The findings revealed that mean motivation scores of students in experimental group were higher than those in control group, there was significant difference between the mean achievement scores of students taught Mathematics using MTI and those taught using conventional method; female students performed better than the male students in terms of achievement in the experimental group. Based on the findings, it was recommended among others that implementation of experimental intervention used in this study should be implemented in all schools since it improves students' motivation; secondary schools should adopt MTI as a primary teaching approach in Mathematics as it significantly enhances students' achievement compared to conventional method of teaching; teachers and curriculum developers should design gender-responsive teaching strategies within MTI to further support and enhance the performance of male students.*

Key words: *Multimedia Technology Instruction, Students' Motivation, Achievement, Mathematics*.

Introduction

Mathematics is a specific sphere of knowledge that includes the topics of numbers, formulas and related structures, shapes and the spaces in which they are contained, quantities and their changes. Mathematics is the device scientists use to explain, predict and make reference in all phenomenon. It is the beam for scientific and technological breakthrough. Mathematics as defined by Adigun (2023)

is a tool for scientific and technological advancement. According to Anaduaka and Hassan (2017), mathematics is the bedrock upon which scientific knowledge rests. Hence, they stressed that for a modern existence, apart from rapid technological stride, a good knowledge of Mathematics is necessary. Mathematics offers a large educational value apart from its technological relevance and variety of structures such as numbers, shapes, ratios and functions that are very useful in understanding our physical setting (Isa, 2017).

It is part of everyone's life because people deal with mathematics in one way or the other every day. This useful nature of mathematics carries with it the assumption that the knowledge of mathematics is essential for all members of the society (Enikanolaye, et. al., 2018). This made it one of the compulsory and core subjects in both primary and secondary schools as enshrined in National Policy on Education (FRN, 2013). Despite the impact of Mathematics in our daily activities as well as in our educational system and with all the efforts made by researchers and mathematics educators to enhance performance in mathematics, it is very disturbing that students' performance in mathematics is still low (Chief Examiner Report, 2018-2022).

Several factors have been identified for students' poor performance in mathematics such as family background, peer pressure, inadequate practice, students' poor mathematical background, parental influence on career choice, poor pedagogical approaches, students' lack of participation in hands-on classroom activities, teachers' incompetence in teaching challenging mathematics concepts, students' poor study habits, and teachers' failure to connect mathematical concepts to real-world activities (Salman et. al., 2022). Also, researchers such as Ibok, et. al. (2020), Ntibi and Ibok (2021); Ibok and Unoh (2022) attributed the low achievement in mathematics to students' attitude towards mathematics, self-concept, anxiety, lack of motivation for both staff and students, poorly resourced teaching and learning environment, poor mathematical ability, poor teaching strategies, textbooks used, and phobia for the subject. There is no doubt that all these factors individually and collectively contribute to a great extent for students' low achievement in mathematics in schools.

The poor achievement of students in mathematics leaves one in doubt of the effectiveness of instructional strategies employed by mathematics teachers for teaching and learning (Abimbola, et. al., 2022). This disheartening achievement in mathematics at the senior secondary school level has been attributed to series of factors majorly centred on instructional delivery strategies by the Mathematics teachers (Anaduaka & Hassan, 2017). This ugly situation is not different in Federal Capital Territory Abuja public senior secondary schools. Olive and Makar (2010) posited that if mathematics is considered as a knowledge of fixed body to be learned, so the position of technology in this process would be mostly that of an efficacy tool, i.e, assisting students in solving mathematics in an efficient way.

The 21st century is marked by the widespread adoption of Multimedia Technology (MT). Teachers, researchers, and students increasingly recognize the value of audio-visual resources, not merely as supplementary teaching aids but as essential tools for delivering knowledge through visual and experiential learning (Ojelade et al., 2020). The Multimedia Technology Instruction (MTI) has revolutionized conventional methods of teaching and learning mathematics, transforming it into a more engaging process. MTI facilitates seamless collaboration and activity execution. With advancements in multimedia technology and features such as portability, usability, and internet connectivity, technological tools have gained broad acceptance. These tools have transcended the conventional classroom setting, expanding educational opportunities beyond physical and institutional boundaries (Borba et al., 2016).

According to Lindstrom (1994, as cited in Enikanolaye, 2021), students retain 40% of what they see and hear, 20% of what they see, and approximately 75% of what they see, hear, and do. Multimedia-based learning occurs when students use information presented in multiple formats, such as virtual and animated narrations, to construct knowledge (Chapman, 2019). This highlights the potential of Multimedia Technology Instruction (MTI) to enhance mathematics teaching and learning by creating technology-driven, student-centered learning environments.

Integrating Multimedia Technology Instruction (MTI) into mathematics teaching and learning has the potential to bring about a significant transformation in the traditional education system, as technology integration in education is now a permanent feature. Supporting this view, recent studies by researchers such as Sabitu and Khalid (2024), Okafor and Samuel (2024), Hassan (2024), and Adeyele (2024) have demonstrated the effectiveness of instructional methods like Computer Animation Instructional Packages, Computer-Assisted Instructional Techniques, Flipped Classroom Strategies, Simulation Games, Blended Learning, and Interactive Multimedia.

Students' motivation in mathematics plays a crucial role in their engagement, performance, and persistence in the subject. Motivation is influenced by both intrinsic factors, such as personal interest and enjoyment of mathematics, and extrinsic factors like grades or career goals. A study by Arthur et al. (2022) emphasizes that students' motivation, along with their interest in mathematics and the quality of teaching, is directly linked to enhanced academic performance. The research revealed that students with higher intrinsic motivation and greater interest in the subject showed better academic results, suggesting that nurturing both interest and motivation can increase student engagement and achievement in mathematics. Additionally, research by Ben-Eliyahu (2019) shows that various motivational factors, such as goal orientation and task value, can greatly influence self-regulated learning behaviours, which are critical for mastering challenging subjects like mathematics.

Olojede, et. al. (2017) carried out a study on the effects of Information Communication Technology on Senior Secondary School students' geometry retention and performance in Bauchi state Nigeria and found that students who were taught using ICT method of teaching showed significant improvement in their performance in geometry than the students who received instruction through the traditional lecture method. Onyepunuka and Ozioko (2020) conducted a study on effect of Multimedia Video Projection on undergraduate students' achievement and found that multimedia projection approach is more efficacious in enhancing students' achievement in Economics than lecture method.

Gambari, et. al. (2016) on effects of video instructional packages on achievement of Senior Secondary School students in mathematics found that there was a significant difference between male and female students taught Trigonometry using Text + Animation + Narration (TAN). In separate studies conducted by Egboka et al. (2021), Sabitu and Khalid (2024) and Hassan (2024) found no significant difference between male and female students taught mathematics using Computer Assisted Instruction (CAI). The practical applications, skills, and competencies offered by mathematics are invaluable. Many students struggle with motivation in Mathematics, often viewing it as a challenging and intimidating subject. This lack of motivation can stem from negative past experiences, limited understanding of foundational concepts, or a perceived inability to succeed in the subject as this may be as a result of poor method of instruction by the teachers.

Research consistently supports the use of learner-centered teaching strategies, where students are given a reasonable level of autonomy to explore their potential, with the teacher acting as a guide. Multimedia Technology Instruction (MTI) could play a significant role in this area. Therefore, to improve students' ability to solve mathematical problems, this study aimed to investigate the impacts of MTI on public secondary school students' motivation and achievement in mathematics in the Federal Capital Territory, Abuja, Nigeria. Specifically, the objectives of the study are to:

1. ascertain the difference between the mean rank motivation scores of students taught Mathematics using MTI and those taught using conventional method;
2. investigate the difference between the mean achievement scores of students taught Mathematics using MTI and those taught using the conventional method;
3. find out the difference between the mean achievement scores of male and female students taught Mathematics using MTI.

Research Questions

The following research questions were raised to guide the conduct of this study:

1. What is the difference between the mean rank motivation scores of students taught Mathematics using MTI and those taught using conventional method?
2. What is the difference between the mean achievement scores of students taught Mathematics using MTI and those taught using the conventional method?
3. What is the difference between the mean achievement scores of male and female students taught Mathematics using MTI?

Hypotheses

The following null hypotheses were formulated to guide the study and will be tested at 0.05 level of significance:

Ho_1: There is no significant difference between the motivation scores of students taught Mathematics using MTI and those taught using conventional method;

Ho_2: There is no significant difference between the mean achievement scores of students taught Mathematics using MTI and those taught using the conventional method;

Ho_3: There is no significant difference between the mean achievement scores of male and female students taught Mathematics using MTI.

Methodology

This study employed quasi-experimental design. Specifically, the study applied the pre-test, post-test non-randomized and control group design. The population of this study comprised ten thousand nine hundred and thirty six (10,936) SS II Mathematics students in public Senior Secondary Schools in Federal Capital Territory, Abuja. A sample size of 125 Mathematics students was drawn through multi-stage sampling technique. At first stage of sampling, simple random sampling technique was used to select one Area Council from the six Area Councils in FCT Abuja. At the second stage of sampling, purposive sampling technique was used to select two co-educational public Senior Secondary Schools. The choice of co-educational schools is due to the fact that gender is one of the variables considered in this study. At stage three of sampling, one intact class each was selected from the two co-educational Senior Secondary Schools and was assigned to experimental and control groups by tossing a coin. There were 60 students in experimental group and 65 in control group.

The instruments used for data collection were Students' Motivation Questionnaire (SMQ) and Mathematics Achievement Test (MAT). The instruments were validated by two secondary school Mathematics teachers and two lecturers in the Department of Science and Environmental Education, University of Abuja. The test items were constructed in line with the learning objectives and cognitive levels as specified in the table of specification. A pilot test was conducted using one intact class of thirty (30) Mathematics students in a school that was not part of the sampled schools selected for this study. The reliability of SMQ and MAT were determined using split half method and internal consistency of 0.799 and 0.859 were obtained using Cronbach Alpha and Kuder-Richardson formula 21 (K-R21) respectively.

Lesson plans were prepared separately for both experimental and control group. Those in experimental group were taught Mathematics using Multimedia Technology Instruction (MTI) while those in control group were taught using conventional method of teaching. Data collected were analysed using mean rank for research question one, mean and standard deviation were used to analyse research question two and three while Mann-Whitney U test was used to test hypothesis one and Analysis of Covariance (ANCOVA) was used to test hypothesis two and three at 0.05 level of significance.

Results

Research Question 1: What is the difference between the mean rank motivation scores of students taught Mathematics using MTI and those taught using conventional method?

Table 1: Mean Rank Motivation Scores of Students in Mathematics for Experimental and Control Group

Groups	N	Mean Rank	Mean Difference	Sum of Ranks
MTI	60	95.50	62.50	5730.00
Conventional Method	65	33.00		2145.00
Total	**125**			

Table shows mean rank motivation scores of students in Mathematics for both experimental and control group. The mean rank scores of students taught Mathematics using Multimedia Technology Instruction (MTI) is 95.50 and sum of ranks is 5730.00 while those taught Mathematics using conventional method of teaching is 33.00 and sum of ranks is 2145.00. The difference in the mean rank is 62.50 in favour of experimental group. The result implies that students taught Mathematics using Multimedia Technology Instruction (MTI) have higher mean rank in terms of motivation than those taught with conventional method of teaching.

Research Question 2: What is the difference between the mean achievement scores of students taught Mathematics using MTI and those taught using the conventional method?

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

Groups	N	Pre-test		Post-test		Mean gain
		$\bar{x}$	SD	$\bar{x}$	SD	
MTI	60	36.33	4.053	64.17	6.960	27.84
Conventional Method	65	33.38	4.582	46.62	4.137	13.24

Table 2 shows that the experimental group has a pre-test mean score of 36.33, a post-test mean score of 64.17 and mean gain of 27.84 while the control group has a pre-test mean score of 33.38, a post-test mean score of 46.62 and mean gain of 13.24. The experimental group has a higher mean gain than control group as the difference in mean gain is 14.60. This shows that the group taught Mathematics using Multimedia Technology Instruction (MTI) have higher achievement score than those taught with conventional method of teaching.

Research Question 3: What is the difference between the mean achievement scores of male and female students taught Mathematics using MTI?

Table 3: Mean Achievement Scores of Male and Female Students Taught Mathematics Using MTI

Variables	N	Pre-test		Post-test		Mean gain
		$\bar{x}$	SD	$\bar{x}$	SD	
Male	26	35.62	4.867	62.08	8.551	26.46
Female	34	36.88	3.273	65.76	5.015	28.88

In table 3, the mean achievement scores of male students taught Mathematics using MTI is 35.62 and 62.08 for the pre-test and post-test respectively, and mean gain score is 26.46 while the mean achievement scores of female students taught Mathematics using MTI is 36.88 and 65.76 for the pre-test and post-test respectively and mean gain score is 28.88. This implies that female students achieved slightly higher than the male students taught Mathematics using MTI.

Test of Hypotheses

Ho_1: There is no significant difference between the motivation scores of students taught Mathematics using MTI and those taught using conventional method.

Table 4: Mann-Whitney U Test of Motivation Scores of Experimental and Control Group

Test Statistics[a]	MOTIVATION
Mann-Whitney U	93.000
Wilcoxon W	2145.000
Z	-9.711
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Teaching Methods

Table 9 reveals Mann-Whitney U test of motivation scores of students taught Mathematics using MTI and those taught using conventional method of teaching. The results indicate a statistically significant difference between the motivation scores of students taught Mathematics using MTI and those taught using conventional method of teaching ($z = -9.711$; $p < .05$). This implies that the null hypothesis one is not accepted.

Table 5: Analysis of Covariance (ANCOVA) of Respondents' Scores in Mathematics Achievement Test (Method*Gender)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Square
Corrected Model	10390.888[a]	4	2597.722	98.215	.000	.766
Intercept	2776.524	1	2776.524	104.975	.000	.467
Pretest	522.826	1	522.826	19.767	.000	.141
Teaching Method	6959.416	1	6959.416	263.123	.000	.687
Gender	14.565	1	14.565	.551	.459	.005
Method*Gender	174.411	1	174.411	6.594	.011	.052
Error	3173.912	120	26.449			
Total	392240.000	125				
Corrected Total	13564.800	124				

a. R Squared = .766 (Adjusted R Squared = .758)
b. Computed using alpha = .05

Ho_2: There is no significant difference between the mean achievement scores of students taught Mathematics using MTI and those taught using the conventional method.

Results in Table 5 show there is a significant difference in treatments (MTI and Conventional Teaching methods) on students' achievement in mathematics ($F_{(1,120)} = 263.123$; $p < 0.05$). Hence, null hypothesis two is not accepted. To determine the mean achievement difference between the two groups, table 5 shows a difference of $\bar{x}=14.60$ in favour of the experimental group (students exposed to MTI). This implies that there is statistically significant difference between the mean achievement scores of students taught Mathematics using MTI and those taught using the conventional method.

Ho_3: There is no significant difference between the mean achievement scores of male and female students taught Mathematics using MTI.

Results in Table 5 shows significant difference between the mean achievement scores of male and female students taught Mathematics using MTI ($F_{(1,120)} = 6.594$; $p=.011$). This implies that female students achieved slightly higher than the male students taught Mathematics using MTI as described in table 3. Therefore, null hypotheses three is not accepted.

Discussion of Findings

There was a significant difference in the mean motivation scores between students in the experimental group and the control group, with the experimental group showing higher motivation. This finding underscores MTI's role in engaging students and enhancing their intrinsic and extrinsic motivation to learn Mathematics, which is vital for sustained academic achievement. The result is in line with the finding of Arthur et al. (2022) who reported that higher intrinsic motivation in Mathematics demonstrated better academic achievement. Also, Ben-Eliyahu (2019) revealed that different motivational constructs such as MTI, goal orientation and task value can significantly impact self-regulated learning behaviours which are essential for mastering subjects like Mathematics.

The study found a statistically significant difference in the mean achievement scores between students taught Mathematics using the Multimedia Technology Instruction (MTI) and those taught using the conventional method. The results favoured the experimental group, suggesting that the MTI approach is more effective in enhancing students' mathematics achievement compared to conventional method of teaching. The result was in accordance with the finding of Olojede et al. (2017) who found that students taught geometry using ICT method of teaching showed significant improvement in their performance than those who received instruction through conventional method. The result concur with the finding of Onyepunuka and Ozioko (2020) who found that multimedia projection approach was more efficacious in enhancing students' achievement in Economics than lecture method.

The analysis also revealed a significant difference between the mean achievement scores of male and female students taught using MTI, with female students outperforming their male counterparts. This finding indicates that MTI may be particularly effective in addressing gender disparities in mathematics achievement, potentially fostering a more inclusive learning environment for female students. The result is in line with the finding of Gambari et al. (2016) who discovered that there was a significant difference between male and female students taught Trigonometry using Text + Animation + Narration (TAN). The result disagreed with the findings of Egboka et al. (2021), Sabitu and Khalid (2024) and Hassan (2024) who revealed no significant difference between male and female students taught using Computer Assisted Instruction (CAI).

Conclusion

The findings of this study underscore the impacts of Multimedia Technology Instruction (MTI) over the conventional method of teaching in improving students' motivation and achievement in Mathematics. The MTI proved to augment students' motivation, further validating its potential as a transformative instructional strategy. Additionally, the experimental group consistently outperformed the control group in achievement, with significant advantages in favour of female students. These results highlight the importance of innovative teaching methodologies in improving Mathematics education outcomes across varied student groups.

Recommendations

The following recommendations were made based on findings:

1. Implementation of experimental intervention used in this study should be implemented in all schools as it has shown to significantly improve students' motivation.
2. Secondary schools should adopt the Multimedia Technology Instruction (MTI) as a primary teaching approach in Mathematics, as it significantly enhances students' achievement compared to conventional methods. This can be implemented through curriculum reforms and teacher training programmes.
3. Teachers and curriculum developers should design gender-responsive teaching strategies within MTI to further support and enhance the performance of male students, ensuring balanced academic outcomes across genders.

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