Effect of Interactive Materials' Intervention on Senior Secondary School Students' Academic Achievement in Set Theory in Oyo South Senatorial District, Oyo State

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Set Theory as a topic in Mathematics in Senior Secondary School has been viewed as an unclear topic to students due to the unavailability of appropriate instructional materials to teach the topic, which in succession leaves students with limited or no understanding of the topic. This study was carried out on the Effect of Interactive Materials' Intervention on Senior Secondary School Students' Academic Achievement in Set Theory in Oyo South Senatorial District, Oyo State. A quasi-experimental design which involved pre-test and post-test with two intact groups was used for the study. Eighty-five SSS2 Students from two Senior Secondary Schools participated in the study. One school was used for treatment and the other school for control. One research question and one research hypothesis that was tested at 0.05 level of significance guided the study. Data were analyzed using ANOVA. The results revealed a significant effect of interactive materials' intervention on the academic achievement of students in Mathematics Set Theory at the Senior Secondary Schools in Oyo South Senatorial District ($t= -6.981$, $p < 0.05$). It was recommended that Mathematics teachers should make use of interactive materials as much as possible in teaching set theory at the senior secondary schools. It was also recommended that they should motivate students to actively engage with the interactive materials during lessons and allow them to manipulate objects, solve problems using visual aids, or collaborate in group activities. This approach fosters active learning and promotes a deeper understanding of set theory.

Keywords: Interactive Materials, Intervention, Mathematics Set Theory, Senior Secondary School Two

Introduction

Mathematics is a precise and logical branch of science that involves numbers, calculations, problem-solving, and proof. It plays a vital role in our daily lives, ranging from counting family members to managing money. Mathematics brings order and can be found in various aspects of life, such as timekeeping, cooking, and measurements. The idea of creativity promotion, problem-solving, critical

and abstract thinking, and effective numerical communication are all imbedded in Mathematics. The branches of Mathematics encompass Arithmetic, Geometry, Algebra, Trigonometry, Number theory, Mathematical Analysis, Topology, Calculus, Statistics, and Probability (Sunita, 2020; Imed, 2023).
Set Theory is a fundamental branch of Mathematics that deals with well-defined collections called sets. It has broad applications in topology, data structure, and discrete structures. Sets are utilized in everyday life, such as organizing items in a home, where kitchenware is grouped into separate compartments for wine glasses, water glasses, mugs, and plates. Categorizing and organizing objects into sets is a common human behavior (Imed, 2023). In bedrooms, clothing items are organized in wardrobes, with separate sections for different types of clothing. Similarly, school libraries categorize books by subject, and marketplaces arrange items into sets for easy access.

The ideas of numbers, real objects, diagrams, visualization, and other items that can be grouped are all concepts of set theory. These examples demonstrate how humans instinctively apply Set Theory in their daily lives for efficient organization. The concept of set theory is a foundational topic in Mathematics, taught from elementary to senior secondary levels. An understanding of Set Theory enhances students' performance in exams such as WAEC, NECO, and JAMB. This concept involves definitions, symbols, notations, illustrations, and calculations (Nusir, Izzat, Mohammed & Fatima, 2013; Roxana, 2019; Caetana & Zaro, 2018).

Studies on students' Mathematics achievement in the West Africa Senior Secondary Certificate Examinations (WASSCE) revealed irregular variations, especially in certain topics which consistently pose challenges to students (WAEC, 2017; 2019). This could possibly be due to teaching methods employed by teachers, students' levels of understandings in such topics and other factors which include available resources and class size, the difficulty level of topic andage of students(Ibaan& Nduka, 2017; Cardino & Cruz, 2020; Iliya, 2020). Various methods, such as lecture, inductive, deductive, problem-solving, project, discovery, analytic, and laboratory methods, are used in classroom instruction to facilitate learning.

To ensure thorough comprehension, teachers must employ effective teaching approaches and strategies. The selection of appropriate teaching methods is crucial for meaningful learning that promotes easy comprehension, and for students' motivation towards active participation in classroom. Effective teaching of set theory requires self-motivated, creative, and knowledgeable teachers. This could be imbibed through the use of interactive materials in teaching and learning of set theory as effective tools positive learning outcomes (Nusir, Izzat, Mohammed & Fatima, 2013; Roxana, 2019; Caetana & Zaro, 2018). Unlike the traditional methods, these materials promote active students' participations in the classroom. Interactive materials in teaching and learning are those items, real objects students can see, touch and manipulate in order to make decisions and solve problems (Faiz 2021). The use of interactive materials in teaching and learning situation might lead to: deeper understanding, motivation to learn, increased engagement, helps to reinforce what is learned. This also creates an opportunity for group work leading to exchange of ideas between students and the teacher(

Roberto, 2019). Examples of interactive materials for teaching Mathematics include dice, games, cards, counters (for probability), measuring scales, weights (for mass, weight, and volume), wall clocks, stopwatches (for telling time), abacus, pebbles (for counting and arithmetic), edibles, musical notation (for fractions), protractors, ruler, compass, set square (for measuring angles), 2D and 3D shapes (for geometry), notes, coins (for money), and makeshift Venn diagrams for Mathematics games (*Sharna, Sharma, Doyle, Marcelo & Kumar, 2021*).

Academic achievement measures the level of attainment of educational objectives by students in teaching and learning processes. It is evaluated through assessments and provides important information about students' proficiency. Theses measurements of students' learning outcomes can be done on a weekly, monthly, yearly or/and terminal basis to assess learning assimilation and identify areas for improvement (Abubakar, 2020; *Munna & Kalam, 2021*).

According to the WAEC Chief Examiners' reports 2017 and 2019, questions on sets theory and Venn diagrams in the West African Senior Secondary Certificate Examinations were poorly attempted or ignored by candidates (WAEC, 2017; 2019).This could be as a result of the inappropriate teaching methods used by teachers to teach the topic, which may contribute to the low achievement in Set theory and Venn diagram questions. It is therefore, necessary to carry out a study that can address this dearth in the teaching and learning of set theory by using a student-centered approach such as the use of interactive instructional materials, hence, this study on the effect of interactive materials' intervention on academic achievement of Senior Secondary School students in set theory (Paula, 2020).

Statement of the Problem

Many Mathematics teachers still rely on traditional teaching methods to pass instructions to students as studies have shown.Likewise, WAEC Chief examiners' reports in Mathematics have identified Set Theory as a topic which students have weaknesses (WAEC, 2017; 2019).Students' inability to provide correct answers or completely avoiding questions on set theory, indicate difficulties in understanding and answering questions on the topic. In the same vein, poor performance in Mathematics may result from ineffective teaching methods employed by teachers. Several studies have investigated the effects of interactive whiteboard-supported teaching and multimedia interactive programs on students' mathematical achievements. To the researcher's best knowledge, no previous study has examined the impact of interactive materials on students' academic achievement in Set Theory. This study investigated the effect of interactive materials' intervention on Senior Secondary School Students' Academic Achievement in Set Theory in Oyo South Senatorial district, Oyo State.

Research Questions

What is the difference in the mean achievement scores of students taught set theory using interactive materials and those taught set theory using conventional method at the Senior Secondary School Students in Oyo South Senatorial District, Oyo State?

Hypothesis

H0: There will be no significant effect of interactive materials' intervention on Senior Secondary School Students' academic achievement in Set Theory in Oyo South Senatorial District, Oyo State

Methodology

This study adopted a quasi-experimental design which involved pre-test and post-test with two intact groups comprising an experimental group and a control group. The treatment group which is the experimental group were exposed to the use of interactive materials after the pre-test while the control group were only taught using the conventional teaching methods. The dependent variable is learners' achievement measured in Mathematics Achievement Test (MAT) through pre-test and post-test assessments, while the independent variable is the use of interactive material in teaching set theory.

Table 1: Research Design Layout

Group	Pre-test	Treatment	Post-test
Treatment	Q_1	X	Q_2
Control	Q_3	-	Q_4

Keys:

Q_1: Pre-test for experimental group
Q_2: Post-test for experimental group
Q_3: Pre-test for control group
Q_4: Post-test for control group
X: Treatment for the experimental group

The population of the study was 26,710 SSS 2 students from public secondary schools in Oyo South Senatorial District, Oyo State. Two intact classes of eighty-five (85) students making up of thirty-eight (38) students in the control group and forty-seven (47) students in the treatment group from two (2) senior secondary schools participated in the study and the schools were purposively selected using based on the selection criteria of at least fifteen (15) consecutive years of presenting candidates for the Senior Secondary School Certificate Examination and having a minimum of two (2) Mathematics teachers, with one teaching SSS 2 Mathematics. Three research instruments were used for the study: (i) Mathematics Achievement Test (MAT); (ii) Structured Lesson Plan; and (iii) Constructed Venn diagram. The research instruments underwent face, content, and construct validity checks by three experts in Mathematics and Science Education at Lead City University, Ibadan. All necessary corrections were made before administering the final draft. Instrument was tested for reliability using

two intact classes of SSS2 students from two public secondary schools not involved in the main study with a reliability of 0.75 using Kuder Richardson formula (Kr20). The results from the pre-test and the post-test of the students in the two groups were collated, marked, analyzed. Frequency counts and arithmetic mean and standard deviation were used for the research question raised, while ANOVA was used to test the hypotheses formulated for the study at 0.05 level of significance.

Results

Research Question: What is the difference in the mean achievement scores of students taught set theory using interactive materials and those taught set theory using conventional method at the Senior Secondary School Students in Oyo South Senatorial District, Oyo State?

Table 2: The mean scores and standard deviation of students in the experimental and the control group

Group	N	Mean	Std. Deviation	Mean Gain
Control (Pre-test)	38	15.987	4.777	
				14.539
Control (Post-test)	38	30.526	11.348	
Experimental (Pre-test)	47	16.160	7.256	
				35.595
Experimental (Post-test)	47	51.755	15.437	

Table 2 displays the mean gain of 14.539 of the control group in the pre-test and post-test, while the standard deviations, of the control group in the pre-test and the post-test were 4.777 and 11.348 respectively. Also, the mean gain of the experimental group in the pre-test and the post-test is 35.595, while the standard deviations of the experimental groups in the pre-test and the post-test were 7.256 and 15.437 respectively. This shows that the experimental group obtained a higher mean-scores than the control group in the tests. The result showed that the experimental group performed better than the control group. Hence, the use of interactive materials in teaching set theory in the experimental group produced higher mean post-test scores than the conventional method used in the control group.

$H_0$1: There will be no significant effect of interactive materials' intervention on Senior Secondary School Students' academic achievement in Set Theory in Oyo South Senatorial District, Oyo State.

Table 3: The t -test Computation of Experimental and Control Groups in Mathematics Achievement Test

Group	N	Mean	Std. Deviation	Df	t_{cal}	t_{tab}	α level
Control (Pre-test)	38	15.987	4.777				
				1	24.575	6.314	
Control (Post-test)	38	30.526	11.348				
							0.05
Experimental (Pre-test)	47	16.160	7.256				
				1	17.909	6.314	
Experimental (Post-test)	47	51.755	15.437				

In Table 1, the calculated t-value of the control group indicated 24.575, while the table value for the control group was 6.314. Also, the calculated t-value for the experimental group 17.909 and the table value was also 6.314. However, since the calculated t-values in the two groups are greater than the tabulated t-values the null hypothesis was rejected. This means that the intervention of interactive material has a significant effect on academic achievement in Set Theory in Oyo South Senatorial District, Oyo State.

Discussion of Findings

From the preceding analysis of the study, the outcome of the research question raised for the study indicated that, the experimental group obtained a higher mean-scores than the control group in the tests, which showed in the result that the experimental group performed better than the control group. This however depicted that the use of interactive materials in teaching set theory in the experimental group produced higher mean post-test scores than the conventional method used in the control group. This result is in line with the findings of Putri and Prabawanto (2019) who reported that in a high school, students who have been performing poor in Mathematics and were able to achieve better result as a result of an audio-visual intervention used to teach them Mathematics before another test was carried out on them. The study is also in line with the research outcome of Anjali (2018) of an improved result from a previous poor achievement in Mathematics which was an issue of concern for Fiji in South Pacific.

The result of the hypothesis also indicated that the intervention of interactive material has a significant effect on academic achievement in Set Theory in Oyo South Senatorial District, Oyo State. This result is tailored in the same vein with the submission of Abubakar (2020) it was reported that the impact of instructional materials on students' academic performance in Physics in Sokoto, Nigeria improved students' academic performance. Students taught with instructional materials were found to be of improved performance compared to those taught without instructional materials.

Conclusion

From the findings, it is concluded that the intervention of interactive materials in the process of teaching and learning of set theory has a positive impact on the academic achievement of students in the topic. The study also concluded that, the use of interactive materials in teaching and learning set theory have higher chances of producing better results in students than the conventional method of teaching the set theory in Mathematics.

Recommendations

Based on the findings, the following are recommended:

1. Mathematics teachers should make use of interactive materials as much as possible in teaching set theory at the senior secondary schools; and
2. Mathematics teachers should motivate students to actively engage with the interactive materials during lessons. Allow them to manipulate objects, solve problems using visual aids, or collaborate in group activities. This approach fosters active learning and promotes a deeper understanding of set theory.

References

Abubakar, M. B. (2020).Impact of Instructional Materials on Students' Academic Performance in Physics, in Sokoto-Nigeria. IOP Conference Series: *Earth and Environmental Science,* 47(6), https://doi.org/10.1088/1755-1315/476/1/012071.

Anjali, G. (2018). "An investigation of disruptive behaviours in Fiji classrooms: a case study of a rural primary school." PhD diss., Thesis, MA Education, University of the South Pacific, Suva.

Caetana, G. A. & Zaro, M. (2018). *The impact of using the interactive multimedia book on mathematics learning:* A focus on 7th Grade Students.

Cardino, J. M. & Cruz, R. A. (2020). Understanding of learning styles and teaching strategies towards improving the teaching and learning of mathematics. *Lumat General Issue* 8(1), 19-43.

Ibaan, Z. & Nduka, W. (2017). *Comparative Analysis of student Mathematics Achievement in West African Senior Secondary Certificate Examination in Nigeria*. January 2017.

Schoolings, *20 compulsory WAEC Topics for Mathematics Examination (WASSCE)*. Shoolings.gr /20-compulsory-waec-topics-for-Mathematics-examination-wassce/

Iliya, B. J. (2020). The Mathematics Teachers Shift from The Traditional Teacher-Centered Classroom to a More Constructivist Student-Centered Epistemology, *Open Access Library Journal*, 7(5).

Imed, B. (2023). *Why is education important to individuals and society*: https://research.com/education/why-is-education-important/2023.

Munna, A. S. &Kalam, M. A. (2021). Teaching and Learning Process to Enhance Teaching Effectiveness. International Journal of Humanities and Innovation (IJHI) 4(1), 1-4.

Nusir, S., Izzat, A., Mohammed, A. N. & Fatima, S. (2013). *Studying the impact of using multimedia interactive programs on children ability to learn basic math skills. Sage Journal*, 10(3).

Faiz T.(2021). The use of educational technology for interactive teaching in lectures. Annals of Medicine and Surgery, 62, 231-235.

Roberto(2019). Home Best Practices/Interactive Learning materials for Engagement, E learning industry.com.

Paula, P. T. B. (2020). Developments and Validation of Interactive Learning Material in Mathematics, *International Journal of Science and Research (IJSR)*, 11(5), 2022.

Putri, W. &Prabawanto, S. (2019). *"The analysis of students' self-efficacy in learning mathematics. Journal of Physics: Conference Series*, 1157 (3), 1742-1752. https://doi.org/10.1088/1742-6596/1157/3/032113.

Roxana, R. (2019). Traditional and Modern Teaching Methods in Mathematics.*Journal of Innovation in Psychology*, Education and Didactics; Bacau. 20(2), 133-140

Sharna, S., Sharma, S., Doyle, P., Marcelo, L. & Kumar, D. (2021). Teaching and learning probability using games: a systematic review of research from 2010-2020. Waikato Journal of Education. 26(2).

Sunita, Y. (2019). Role of mathematics in the development of society. *International Journal of Research and Analytical Reviews* 6(4).

West Africa Examinations Council (WAEC) (2017). General Mathematics Paper 2, WASSCE(PC), 2017. http://www.waeconline.org.

West Africa Examinations Council (WAEC) (2019). General Mathematics Paper 2 WASSCE (SC), , 2019