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Teachers' and Students' Perceptions on the use of Instructional Materials for Enhancing Senior Secondary Students' Performance in Mathematics

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Abstract

This study comprehensively examined both teachers' and students' perceptions on the use of instructional materials in enhancing the academic performance of senior secondary school students in mathematics within Port Harcourt Metropolis, Rivers State, Nigeria. Despite mathematics being a core subject and a fundamental tool for scientific, technological, and economic advancement, students' performance at the secondary level has remained consistently poor, prompting the need for innovative instructional strategies. Instructional materials have been shown to bridge the gap between theoretical abstractions and practical understanding by providing visual and tactile learning experiences. This study sought to explore the extent to which instructional materials—such as charts and three-dimensional models affect student comprehension and performance in key mathematical concepts like the Pythagorean Theorem and the areas and volumes of plane and solid shapes. The study was guided by two research questions and two hypotheses, and adopted an analytical survey research design. The population comprised all senior secondary school mathematics teachers and Senior Secondary Two (SS2) students across selected public schools in Port Harcourt Metropolis. Census sampling was used to select all 150 mathematics teachers from both Obio/Akpor and Port Harcourt Local Government Areas. In addition, Taro Yamane formula was applied to determine a sample of 320 SS2 students, who were selected through a multistage random sampling technique. Data were collected using a structured 10-item questionnaire titled Rating Scale for Mathematics Teachers and Secondary School Students (RSMTSSS), divided into three sections, and constructed on a 4-point Likert scale. The instrument was validated by three experts in mathematics education and yielded a high reliability coefficient of +0.93 using the test-retest method with Pearson Product Moment Correlation. The study concluded that instructional materials are indispensable tools in the teaching and learning of mathematics and can substantially contribute to students' academic success when appropriately utilized. It recommended that mathematics teachers adopt the use of instructional materials regularly and creatively, and that school administrators and government agencies provide the necessary resources and training to facilitate their integration into classroom instruction. The findings serve as empirical evidence to support educational policy changes aimed at promoting activity-based and resource-supported teaching methodologies to improve learning outcomes in mathematics.

Keywords: Mathematics, Performance, Instructional Material, Perception

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INTRODUCTION

In every nation, there is need to lay a solid foundation in mathematics as to reach any level of scientific and technological growth. This is because mathematics is tagged the gateway of science and the key to science and technology. Salman (2005) as cited in Abakpa and Iji (2019) described mathematics as a precursor of scientific discoveries and breakthroughs. In spite of the importance and popularity of mathematics to all aspect of human endeavour, researchers show that there is increasingly poor achievement in the subject among secondary school students (George & Charles-Ogan, 2023; Abakpa & Iji, 2019). Achievement is defined as a measure of learner's level of knowledge, skills or performance. This definition gives credence to the role a high students' achievement play in the development of the society.

Furthermore, achievement in mathematics could be seen as the successful accomplishment of goals and how students are able to demonstrate their intellectual abilities in mathematical concepts through testing over a period of time. Research report shows that students have consistently low achievement as less than 42% of registered candidates obtained credit pass in mathematics (Uwadiae, 2010) as cited in (Oguche & Usman 2019). Many reasons account for students' poor achievement in mathematics as reported by researchers. These include shortage of instructional materials and non-usage of instructional material for mathematics classroom delivery, poor methods of teaching (Harbour-Peters, 2015), poor interest in mathematics (Badmus, 2012). The method used by the teacher can either motivationally force a student who has made up his mind not to learn mathematics to begin to learn mathematics or even distance further from learning the subject.

Ade (2015) opined that one of the means of imparting and motivationally making the students to learn mathematics is by proving and making available an instrument which the students like to manipulate. In addition, part of the problem is that most teachers still believe that the most effective means of communicating knowledge is via the conventional 'talk and chalk' strategy. With all these problems facing the students, the solution may lie in exposing students to active participation approaches during teaching and learning such as: Target task approach, laboratory method approach, delayed formalization approach, heuristic method (Obodo, 2014); Mathematical games, models and simulation (Agwagah & Ezeugo, 2020); and concept mapping technique in teaching mathematical concepts (Imoko & Agwagah, 2006). Obodo (2014) held a view that lack of interest is one of the factors responsible for poor achievement of students in mathematics.

Interest is a crucial element in learning because when someone becomes interested in something, they are likely to engage in it more deeply (Imoko & Agwagah, 2006). Obodo (2014) defined interest as the attraction which forces or compel a child to respond to a particular stimulus. Interest simply means the likes and dislike or one's reference and aversion (George, 2018). It can be defined as an aspect of affective domain which has to do with one's readiness to like or dislike something. It is a subjective feeling of concentration or persisting tendency to pay attention and enjoy some activity or content. In this sense, interest is a source of motivation. Moreover, it is advocated that teaching of mathematics concepts should be concretized to enhance the students' motivation in teaching and learning. No course in science and Mathematics can be considered as complete without including some practical work. Gambari and Ghana (2012) as cited in (Oguche & Usman, 2019), emphasized that the use of instructional materials stimulates learning and assist the teachers to properly convey the topic content to the learner in order to obtain greater knowledge and performance.

Afolabi (2018) maintained that achievement of objectives depends largely on the use of improvised instructional materials in mathematics teaching and learning. Offorma (2017) stressed that teachers should be able to create simple and inexpensive materials such as charts, posters, maps, pictures, drawings and models for effective teaching and learning. The usage of instructional resources could improve students' performance in senior high school mathematics, as evidenced by the preceding. Many professionals and modern research in mathematics have also observed the fallen educational standard and student's poor performance in secondary school mathematics and suggested problem solving, demonstration as good and effective methods of teaching mathematics (Odili, 2006). Doreen (2017) remarked that learners' interest, capabilities, aptitudes, learning styles and ages should be considered before planning and implementing classroom instructions.

Hence, it is necessary for teachers to utilize new knowledge so as to aid the children to learn effectively. They should be able to utilize the psychological competencies so far acquired to make teaching-learning process effective and interesting and emphasize activity and class participation and make use of instructional materials to provide alternative channels of communication with learners.

A mathematics teacher should develop a suitable method of teaching Pythagoras theorem and apply same in teaching secondary school mathematics. A synchronization of visual inputs from slides and sound from audio- tapes can be used in revision of trigonometric ratios and identities to enhance retention and recall of concepts among secondary school students. Areas and volumes of plane and solid shapes can be effectively taught using models of cuboids, cone, prism and

cylinders. Teachers are now facing the task of improving mathematics instructions and attitude of students towards mathematics in secondary schools. Odili (2006) asserted that mathematics is one of the subjects which most students do not give attention to when studying. Hence, audio visuals such as educational television programmes in mathematics can enhance students' interest in studying mathematics if they watch such programmes and see the performance of their peers.

Education today demands the use of modern materials and methods to assist in solving the complex problems of stimulation and direction of interest and the development of skills (Wodi & Dokubo, 2006). Instructional materials develop continuity of thoughts, offers a reality of experience which stimulate self-activity on the part of the students. It also supplies concrete basis for conceptual thinking and reduces meaningless word responses by students. Isola (2010) asserted that if science learning is to be seen as something which is more than reading and writing, the teacher and the learner are obliged to take inquiry observation and experimentation as important integral parts of science teaching and learning. Wodi and Dokubo (2006) opined that, for a school to conduct an effective teaching and learning of sciences in which mathematics is one, laboratory equipment and resource materials must be procured for the teacher who himself must be professionally competent in handling the materials. Regrettably, it seems that many of our secondary schools do not have enough qualified mathematics teachers who can utilize these materials to enhance learning.

It is important for the mathematics teachers in secondary schools to develop competent skills for the development and use of instructional materials in order to enhance students understanding of mathematics and other science subjects. Instructional materials such as posters, slide projector and audio-tape recorders could be useful for effective instructional delivery of various concepts in secondary school mathematics such as Pythagoras theorem, trigonometric ratios and identifies plane and solid shapes. If this is true, it could be assumed that the use of instructional materials for effective instructional delivery can influence students' performance in senior secondary school mathematics hence, a study of this nature is necessary to put records straight. Mathematics plays a major role in national and technological advancement and development. It is a necessary instrument for scientific and technological progress.

Statement of the Problem

Senior Secondary School Certificate mathematics covers a vast area of subject content. Major aspects of the subject content require the use of instructional materials to make the concepts meaningful to the learner or students. In Port- Harcourt metropolis, students who enrolled and sat for the senior secondary school certificate mathematics examinations did not perform well (West African Examinations Council, 2011). Experience has shown that inability of the students to perform well in the senior secondary school certificate mathematics examinations was due to lack of special facilities to enhance mental operations. But a critical examination of the available literature has revealed the fact that little work has been done in the area of investigating relationship between the use of instructional materials and students' performance in senior secondary school mathematics. Consequent upon this, there is need for a study such as this to be carried out so as to empirically document the fact concerning the extent to which the use of instructional materials can affect performance of students in senior secondary school mathematics. Such study is direly needed particularly at this time so as to fill the existing gap in knowledge that already existed.

If this is the case, it means that poor performance of students in the senior secondary school certificate mathematics examinations due to lack of special facilities to enhance mental operations has become a problem subject to investigation. That being so, this study is an attempt to investigate the issue in order to empirically document the fact whether or not the use of instructional materials such as posters, slide, projectors, audio-tape recorders and players and television in effective instructional delivery in senior secondary schools can enhance students' performance in senior secondary school mathematics in Port Harcourt metropolis, Rivers State.

Objectives of the Study

The aim of this study was to investigate teachers' and students' perception on the use of instructional materials for enhancing senior secondary students' performance in mathematics in Port- Harcourt metropolis of Rivers State. Specifically, the objectives of the study were to:

1. Determine the perception of teachers and students on the use of charts in teaching Pythagoras theorem for enhancement of secondary school students' performance in mathematics.
2. Ascertain the perception of teachers and students on the use of models such as cuboids, cone, and cylinders in teaching areas and volume of plane/solid shapes and enhancement of secondary school students understanding of mathematics.

Research Questions

1. What is the perception of teachers and students on the use of charts in teaching Pythagoras theorem and enhancement of secondary school students' performance in mathematics?

2. What is the perception of teachers and students on the use of models such as cuboids, cone, cylinders in teaching areas and volumes of plane/solid shapes and enhancement of secondary school students' performance mathematics?

Hypotheses

The following null hypotheses were formulated and were tested at 0.05 significant level.

H_{O1}: There is no significant difference between the perception of teachers and students on the use of charts in teaching Pythagoras theorem and the enhancement of secondary school students' performance in mathematics.

H_{O2}: There is no significant difference between the perception of teachers and students on the use of models such as cuboids, cone, and cylinders in teaching aras and volumes of plane/solid shapes and the enhancement of secondary school students' performance in mathematics.

METHODOLOGY

Research Design

This study adopted analytical survey design to investigate the perception of teachers and students on the use of instructional materials for enhancing senior secondary students' performance in mathematics in Port Harcourt metropolis.

Population of the Study

The population of the study comprised of all senior secondary school mathematics teachers and students in Port-Harcourt metropolis. Specifically, there are eighty mathematics teachers in 20 senior secondary schools in Obio/Akpor L.G.A and seventy mathematics teachers in 18 senior secondary schools in Port- Harcourt Local Government area. Furthermore, there are 1,601 SS2 students in Port- Harcourt metropolis out of which 837 in Port Harcourt L.G.A and 764 in Obio/Akpor L.G.A. Data obtained from (Rivers State Secondary School Board, 2020).

Sample and Sampling Technique

Census sampling technique was used to select all the 80 Mathematics teachers in Obio/Akpor L.G.A and 70 in Port-Harcourt metropolis making a total of one hundred and fifty(150) Mathematics teachers in Port- Harcourt city local government area. Taro Yamene formula was used to obtain a sample size of three hundred and twenty (320) SS2 students out of a population of 1601 SS2 students in Port-Harcourt metropolis. The sample of 320 SS2 students were selected through simple random sampling. Five schools were simple randomly selected in each Local Government Area while 32 SS 2 students were randomly selected in each of the ten (10) sampled schools.

Instrument for Data Collection

The research instrument used to collect data for this study was i10-item questionnaire designed for mathematics teachers and SS 2 students in the sampled schools. The questionnaire named Mathematics Teachers and Secondary School Students (RSMTSSS), was designed in sections A –C. Section A was the preliminary Section, while section B focused on use of charts and students understanding of Pythagoras theorem, while Section C focused on Development and Use of models (cuboid, cone and cylinder) and students understanding of areas and volumes of plane and solid shapes. The instrument was a 4-point rating scale with response options of Strongly Agree (4), Agree (3), Disagree (2) and Strongly Disagree (1).

Validity of the Instrument

The face and content validity of the research instrument was confirmed by three experts in mathematics education. The flaws pointed out by the experts were used to effect corrections on the instrument before administering to the sample.

Reliability of Instrument

The reliability of the nstrument was established using the test retest method. The nstrument was administered to ten mathematics teachers and ten students who were not part of the main study. The instrument was re – administered to the same group of ten teachers and students after a time interval of two weeks. The Pearson product moment correlation statistics was used to establish a reliability coefficient of +0.93.

Method of Data Collection

The instrument (RSMTSSS) was administered to the mathematics teachers and students with the help of four research assistants. The instrument was given on a face – to – face made and also retrieved on the same day from the respondents to avoid / reduce instrument damage. All the 150 and 320 instruments administered to teachers and students were retrieved respectively. The collated instrument was subjected to statistical analysis.

Method of Data Analysis

The data obtained from the research questions were analyzed using mean and standard deviation, while the

Table 1: Mean and standard deviation on teachers' and students' perceptions on the use of posters in teaching Pythagoras theorem and enhancement of secondary school students' performance in mathematics

S/N	Perception of Teachers and Students on use of posters in teaching Pythagoras theorem	Teacher N=150		Students N=320	
		Mean	S.D	Mean	SD
1	Use of posters in teaching Pythagoras theorem enhances drawing a right-angled triangle	3.17	0.81	3.18	0.83
2	Use of posters helps in identifying the hypotenuse, opposite and adjacent sides of a right-angled triangle.	3.21	0.84	3.16	0.84
3	Using posters aid in recall and retention of relevant formula in calculating the missing sides and angles of a given triangle.	3.07	0.81	3.14	0.81
4	Posters help in solving problem on applications of Pythagoras theorem.	3.05	0.88	3.23	0.78
5	Use of posters help in demonstrating that the square of the hypothen use side is equal to the sum of square of the other two sides.	3.07	0.83	3.11	0.81
	Grand Mean	3.11	0.84	3.16	0.80

Standard reference mean X = 2.50

Table 2: Mean and standard deviation on teachers' and students' perceptions on the use of models such as cuboids, cones, cylinders in teaching volumes of solid shapes and enhancement of SS2 students' performance in Mathematics.

Perception of Teachers and Students on use of models such as cuboids, cones, cylinder in teaching area and volumes of plane and solid shapes in Mathematics	Teacher N=150		Students N=320	
	Mean	SD	Mean	SD
Models help students' in finding area of rectangle easily	3.28	0.65	3.28	0.82
Models aid in calculating volume of a cuboid	3.21	0.61	3.20	0.83
Use of models aid in finding the volume of a cylinder	3.12	0.60	3.26	0.75
Use of models aid in finding the volume of a cone	3.10	0.77	3.33	0.80
Surface area of a cylinder can be determined using models	3.33	0.83	3.35	0.66
Grand mean	3.21	3.38	3.28	0.77

Standard reference mean X = 2.50

hypotheses were tested using z-test at 5% level of significance. A standard reference mean of 2.50 was used.

RESULTS

Research Question 1

What is the perception of teachers and students on the use of posters in teaching Pythagoras theorem and enhancement of secondary school students' performance in Mathematics?

Table 1 shows that mean ratings of 3.17, 3.21, 3.07, 3.05 and 3.07 respectively which are greater than the standard reference mean of 2.50, indicate that mathematics teachers were of the view that the development and use of relevant posters in teaching Pythagoras theorem enhance students' performance in drawing right-angled triangle (3.17), identifying the hypotenuse, opposite and adjacent sides of a right-angled triangle (3.21), recall of relevant formula in calculating the missing sides and angles of a given triangle (3.07), solving problems on applications of a Pythagoras theorem (3.05) and demonstrating that the square of the hypotenuse side is equal to the sum of the squares of the other sides (3.07). The small values of standard deviations obtained, i.e. 0.81, 0.84, 0.81, 0.88 and 0.83 respectively indicates that the teachers were homogeneous in their response.

Also, Table 1 shows that mean ratings of 3.18, 3.16, 3.14, 3.23 and 3.11 respectively which are greater than the standard reference mean of 2.50, indicate that SS2 students were of the view that development and use of relevant posters in teaching Pythagoras theorem enhance their performance in drawing a right-angled triangle (3.18), identifying the hypotenuse, opposite and adjacent sides of a right-angled triangle (3.16), recall of relevant formula in calculating missing sides and angles of a right angled triangle (3.14), solving problems on applications of Pythagoras theorem (3.23) and demonstrating that the square of the hypotenuse side is equal to other two sides (3.11). The small values of standard deviation obtained, i.e. 0.83, 0.84, 0.81 0.78 and 0.81respectively indicates that the students were homogenous in their response. The grand mean for teachers perception on the use of posters in teaching Pythagoras theorem was 3.11 greater than the standard reference mean of 2.50, it implies that the teachers have a high perception while the students also have a high perception (grand mean =3.16).

Research Question 2

What is the perception of teachers and students on the use of models such as cuboids, cones and cylinders in teaching volumes of solid shapes and enhancement of SS2 student's performance in mathematics**?**

Table 2 shows that mean ratings of 3.28, 3.21, 3.12, 3.10 and 3.33 respectively, which are greater than the standard reference mean of 2.50, indicate that mathematics teachers were of the view that models of cuboids, cone

Table 3: Z-test analysis of mathematics teachers and students on the effects of the use of relevant charts in teaching Pythagoras theorem in Mathematics

Group	Means	Std. Dev	n	df	Std. Error	Z cal	Z table (d=0.-5)	Decision
Teacher	3.11	0.84	150	468	0.082	0.61	1.96	Ho retained
Student	3.16	0.80	320					

Table 4: Z-test analysis of mathematics teachers and students on the effects of the use of model such as cuboid, cone and cylinder in teaching areas and volumes of plane and solid shape in SS2 mathematics

Group	Means	Std. Dev	n	df	Std. Error	Z cal	Z table (d=0.-5)	Decision
Teacher	3.21	0.69	150	468	0.072	0.972	1.96	Ho retained
Student	3.28	0.77	320					

and cylinders enhance students performance in calculations involving area of rectangle, volume of cuboids, volume of cylinder, volume of a cone, and surface area of a cylinder in secondary schools. The small values of standard deviations obtained, i.e., 0.65, 0.61, 0.60, 0.77 and 0.83 respectively indicates that the teachers were homogenous in their response.

Also Table 2 shows that mean ratings of 3.28, 3.20, 3.26, 3.33 and 3.35 respectively, which are greater than the standard reference mean of 2.50, indicate that the students were of the view that models such as cuboids, cone and cylinders enhance their performance in calculations involving area of rectangle, volume of cuboids, volume of cylinder, volume of a cone, and surface area of cylinder, in mathematics. The small values of standard deviations obtained 0.82, 0.83, 0.75, 0.80 and 0.66 respectively indicates that the students were homogenous in their response. The grand mean for teachers perception on the use of posters in teaching Pythagoras theorem was 3.21 greater than the standard reference mean of 2.50, it implies that the teachers have a high perception while the students also have a high perception (grand mean =3.28).

H_{O1}: There is no significant difference between the perception of teachers and students on the use of relevant charts in teaching Pythagoras theorem and enhancement of secondary school students' performance in mathematics.

Table 3 shows that the null hypothesis on Z-test analysis of Mathematics teachers and students on the effects of relevant posters in enhancing students performance in solving Pythagoras' theorem related questions in Mathematics was retained at 5% level of significance, where the degree of freedom (468) at infinity (∝). This shows that there is no significant difference in the perception of teachers and students on the impact of posters on students' performance in Mathematics. Recall that the grand mean rating of teachers is 3.11, while the grand mean rating of students is 3.16 which are greater than the standard reference mean of 2.50. This means that the use of posters in teaching Mathematics contributes to students understanding of the subject, although teachers and students' perception of the relevance of posters in teaching Mathematics are the same.

H_{O2}: There is no significant difference between the perception of teachers and students on the use of models such as cuboid, cone and cylinder in teaching areas and volumes of plane and solid shapes and enhancement of SS2 students' performance in mathematics.

Table 4 shows that the null hypothesis on Z-test analysis of Mathematics teachers' and students' on the effects of models of cuboid, cone and cylinder on SS2 students' performance in problems related to areas and volumes of plane and solid shapes in Mathematics, was retained at 5% level of significance, where the degrees of freedom (468) is at infinity (∝). Hence, there is no significant difference in the views of teachers and students on the effects of use of models of cuboid, cone and cylinder in enhancing students' performance of areas and volumes of plane and solid shapes. Recall that the mean ratings of teacher (3.21) and the mean ratings of students (3.28) are greater than the standard reference mean of 2.50, this means that teachers and students agreed that models of cuboid, cone and cylinder enhance students' performance of areas and volumes of plane and solid shapes in SS2 Mathematics.

DISCUSSION

Analysis of research question 3 and research hypothesis 3 show that the use of model such as cuboids, cylinder, cones etc enhance students' performance in problems related to plane and solid shapes, especially in calculating areas and volumes of cuboids, cylinder and cone, This is because an object in three-dimension illustrates clearly the concept of size and proportions. The z-test of null hypothesis on the differences in the views of teachers and students b virtue of the grand mean was retained. Furthermore, grand mean of 3.21 for teacher and 3.28 for student, showed that the use of models enhanced students performance in mathematics.

Conclusion

Based on the findings of this study, it was concluded that both teachers and students perceived that the use of instructional materials such as charts and models to teach mathematics concepts improves the academic performance of students in mathematics. The use of visuals and manipulatives enhances students' academic performance in mathematics.

RECOMMENDATIONS

In light of the findings of this study, the following recommendations become necessary.

1. Mathematics teachers should ensure that they use relevant instructional materials in teaching and illustrations.
2. Teachers should learn to improvise instructional materials that are not available in their instructional resource centers and Government should also provide well equipped instructional centre in secondary schools.
3. Teachers should ensure that relevant models, realia and other materials resources are regularly used to teach mathematical concepts.

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