EFFECT OF TWO STRATEGIES IN TEACHING SOLID SHAPES ON STUDENTS' ACADEMIC PERFORMANCE IN SECONDARY SCHOOL MATHEMATICS IN IMO STATE.

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Abstract
The aim of the study was to investigate the effect of two strategies in teaching solid shapes on students' academic performance in secondary schools in Imo State. Two research questions and one hypothesis were formulated to guide the study. Multi-stage sampling technique which involves cluster sampling and simple random sampling technique were used to select 200 Jss2 students(100 males and 100 females) from the three Education Zones of Imo State. A 38-item researcher-made essay instrument titled Solid Shapes Treatment Questionnaire (SSTQ) was used for data collection. The instrument was validated by two experts, one from Mathematics Education and the other from Measurement and Evaluation, to ensure its face and content validity. Test-retest method was used to establish the reliability of the validated instrument which a reliability coefficient of 0.86. The research questions were answered using descriptive statistics (mean and standard deviation) while the hypothesis was tested using ANCOVA F-ratio a*t* $p<0.05$ level of significance. The study adopted a quasi-experimental research design with pre-test-post-test control group design with ANCOVA as a post hoc control. The findings of this study revealed that the mean score of male students taught solid shapes using charts/pictures and models does not differ significantly from the mean score of female students taught solid shapes using charts/pictures and models. Based on the findings, the researcher recommended that mathematics teachers are free to use either charts/pictures or models in teaching their students.

Keywords: Strategies, Teaching, Solid shapes, Students' Academic performance

Introduction

Mathematics is one subject that is an integral part of everyone's life and affects virtually every field of human endeavor. Every individual needs mathematical knowledge to function intelligently and efficiently in the world. It is a compulsory subject that must be credited by students before gaining admission into any tertiary institution especially the University to study any course such as medicine, engineering, accountancy, business administration, management, economics, science and others (Ugorji, King-Agboto & Okpara, 2021).

Mathematics plays a crucial role in shaping the future of individuals and nations and teachers in any educational system have the good intention of achieving the national educational aims and objectives. These aims and objectives are stipulated in the National Policy on Education (FRN, 2014).

In order to achieve these aims and objectives in the secondary school level, the Federal Ministry of Education in 1984 increased secondary education period to 6 (six) years making it 3 (three) years of Junior secondary and 3 (three) years of Senior secondary. Also in 1999, the 9-3-4 system of education was introduced as part of the Universal Basic Education (UBE) which replaced the earlier 6-3-3-4 system. It was structured to give 9 years of basic education (6 years primary, 3years junior secondary), 3 years of senior secondary education and 4 years of tertiary education. All these changes in the system of education still conveyed Mathematics as one of the core subjects being studied both at the Junior and senior levels.

However, most mathematics teachers at the junior level cannot boast of achieving these aims and objectives considering the way they teach (Uzomah & Ugorji, 2011).

Observations show that most junior secondary school mathematics teachers in our schools hardly give adequate attention to the subject, so it is difficult to say that the students learn effectively (Adebayo, 2017). Only the dedicated and resourceful teacher uses different strategies and resources in this early stage to introduce certain topics such as cone and cylinder (National Council of Teachers of Mathematics, 2024). The use of charts/pictures and models is an example of such strategies.

Realizing the need for teachers to help learners to concrete ideas, Federal Ministry of Education (FME) states:"Modern educational techniques will be increasingly used and improved at all levels of education system" (FRN, 2024:9). Mathematics in general and solid topic such as cone and cylinder in particular are among the areas in Mathematics that can hardly be taught meaningfully without the use of charts/pictures and models. Charts/pictures such as still pictures, cartoons, posters, charts, etc, are teaching materials that have only length and breadth. Models include molk-ups, models, real-life situations etc. and they are teaching materials that have length, breadth and depth. In teaching and learning of topic in mathematics such as cone and cylinder, well prepared colourful charts attract and hold the attention of students and help to register the information gathered at that point in the young mind of the learners, but in the case of models, the eyes are attracted but because it is representation of what it has been seeing, the mind takes over and does the processing of the information. Therefore, teaching should be done using improvised materials or aids like charts/pictures and models in addition to the use of the blackboards. Uzomah and Ugorji (2011:142) say:

> *Concerned as I am with mathematics, I would like to put in a strong plea for proceeding black board (white board) work which is the order of the day in mathematics teaching by the use of improvised learning aids (materials) to provide the experience for the emergence of concepts in students mind.*

Both charts/pictures and models are the improvised aids (materials) referred to by Uzomah and Ugorji above.

The interest of the researcher in embarking on this study is the conviction that the use of charts/pictures and models in the teaching and learning of Mathematics in the junior secondary schools will help to demystify the study of topics like cone and cylinder. As an old Chinese proverb informs us; (as cited in Odili 1990:5), "I hear and I forget, I see and I remember, I do and I understand".

The use of charts/pictures and models in teaching such topics like cone and cylinder will emancipate both the teachers and the learners from the lassitude of theoretical Mathematics. It will also be a panacea to the problem of forgetfulness by the students. The researcher argues that the use of charts/pictures and models in teaching Mathematics topics such as cone and cylinder in the junior classes will make the students to see cone and cylinder as an essential part of the study of Mathematics at any level and vital catalyst for effective use or study of any branch of Mathematics and this will equip them to live accomplished life in our modern age of science and technology.

According to Uzomah and Ugorji (2011) Charts and graphs like maps and books, have unlimited flexibility and can be used in a school subject such as arithmetic or spelling, the number of books read and like. This implies that a good chart of a cylindrical object could be used in teaching how to calculate height, radius, curved surface areas or total surface area of a cylinder. According to Ejim in Uzomah and Ugorji (2011: 142), "In an experiment, a picture of an object was presented and the picture stipulated the child's thought patterns and helped him to make appropriate responses". A teacher labours to bring a behavioural change in the learner. Ejim,

therefore says that such teacher should endeavour to make good use of charts/pictures which according to him, serve as stimulant towards such behavioural change of the learner. Models are basically those materials that help the child to learn the concrete level first before moving to abstract level. Ike in Uzomah and Ugorji (2011) writes that models are those materials that have thickness. In other words, they have length, breadth and height. They have volume unlijke the chart/pictures that have only length and width and are flat. Solid shapes deal with areas and volumes and may well be taught using teaching materials that have length, width and depth .

Mathematics looks abstract to many but a good model removes such abstractness and replaces it with vivid concrete sense. Furthermore, if a diagram of a cone is on the chalkboard and the total surface area is to be calculated, somehow, learners can understand it but by producing the curved of a cone and the circle, the learner will quickly learn the total surface area which is, "the area of the curved surface added to the area of the circle ($rl+r^2$) or r(l+r)". As soon as the abstractness of any solid shapes like cone and cylinder is reduced greatly, by the use of learning materials, there is the conviction that the learner will learn effectively. Solid shapes subsume cylinders, cones, cuboids, prism, frustum, pyramid, etc. Some areas in university mathematics may not be easily understood without the knowledge gained from solid shapes in the secondary school level.

Certain topics in Mathematics like solid shapes cannot be taught meaningful without the use of charts/pictures and/or models. Yet many teachers in the field continue to teach these topics relying only on the whiteboard thereby causing the students to learn and forget. The problem of learning and forgetting according to Obianwu (1994) is caused by too much theoretical expression by teachers while the learners are passive learners.

Similarly, Uzoma and Ugorji (2011:142) stressed that "Mathematics is dreaded by many student as symbolic learning is introduced too early in the learning process". These observations along with others underscore the importance of the use of instructional materials in teaching/learning of Mathematics topics particularly in the junior secondary school. The effect of non- useof instructional materials in teaching/learning such shapes like cone and cylinder is not felt only in the junior secondary school. It cuts across the senior secondary, even up to the University level. Careful perusal of the West African Senior School Certificate Examination (WASSCE) questions papers set over the years depict that out of 12 questions given to the students to answer 10 questions, more than two questions come from solid shapes. Some of the students do not do well in answering those questions. Others attempt such questions haphazardly either because, they were not grounded very well in those topics like cone and cylinder in their junior classes or that they were not taught at all using charts/pictures or models.

It is glaring that the technological advancement which this nation wants to achieve, is dependent upon proper development and mastery of Mathematics of which solid shapes are integral parts of it. And if we allow this trend of lack of proper teaching/learning of solid shapes such as cone and cylinder to continue unchecked, it will certainly make the dream of technological advancement of this nation to be a mere mirage. Also the hope of the future generation in taking and furthering Mathematics as a course of study in the institution of higher learning will be dashed to the wall. And this nation will find it extremely difficult to compete favourably with other countries of the world in all ramifications of life–industrially, educationally, technologically etc.

Therefore, there is need for teachers to apply appropriate strategy by using charts/pictures and models to demystify such shapes like cone and cylinder and help the students to improve in these shapes. Then following these needs, it becomes necessary to ascertain which of the readily available teaching materials charts/pictures or models can better enhance the teaching and learning of solid shapes in the junior secondary school.

Research Question1: What are the mean scores of students who were taught solid shapes using charts/pictures?

Research Question 2: What are the mean scores of students who were taught solid shapes using models?

Hypotheses 1: The mean score of students that were taught solid shapes using pictures/charts does not differ significantly from the mean score of students that were taught solid shapes using models ($P<0.05$).

Methodology

The study adopted a quasi-experimental research design. It compared the effect of two strategies in teaching solid shapes on students' academic performance in secondary school mathematics in Imo State. It is quasi experimental design in the sense that there were some extraneous variables that were not totally controlled by the use of intact classes. The design adopted is pre-test-post-test, control group design i.e.

Int. Group i	$O_i X_i O_i$
Int. Group ii	$O_i X_2 O_2$
Int. Group iii	$O_i X_2 O_3$

Where O_1 and O_2 represent the pre-test and post-test respectively, while X represents the treatment and I.G shows intact groups.

The study which lasted for seven months was carried out in six Education Zones of Imo State. Imo State is bounded in the East by Ebonyi and Abia States, in the West by Delta state in the North by Anambra and Enugu states and South by Rivers State. It is one of the states that make up the South Eastern geopolitical zone of Nigeria. It has a good number of public secondary schools, therefore, it is appropriate to generalize a study done here for the entire nation. The residents of Imo State comprise of civil servants, traders, artisans, farmers and students. This area is chosen because; it houses many secondary schools, as education is the biggest industry in Imo State. So, there is need to ascertain the effect of two strategies in teaching solid shapes on students' academic performance in secondary school Mathematics in Imo State.

The population of the study comprised all the 20,000 JSS2 students in the 312 public secondary schools in the six education zones of Imo State (SEMB, 2024). The junior secondary school class two was used because; the solid shape topics in Mathematics are introduced first in this class.

Multi-stage sampling technique which involves cluster sampling and simple random sampling techniques was used for the study. The first stage involved the use of simple random sampling technique to select 3 education zones (Orlu zone 1, Owerri zone 2 and Okigwe zone 2) out of the 6 clusters in Imo State Education zones.

In the second stage, proportionate random sampling technique was used to select 8 secondary schools from Orlu zone 1, 6 secondary schools from Owerri zone 2 and 6secondary schools from Okigwe zone 2 since the zones do not have equal number of secondary schools. This gave total 20 secondary schools selected from the three zones out of 312 public secondary schools in Imo State.

In the final stage, simple random sampling technique was used to select 10 students from each of the 20 secondary schools which gave 80 students from Orlu zone 1, 60 students from Owerri Zone 2 and 60 students from Okigwe zone 2 which also gave a total sample size of 200 students for the study, who were separated into male and female.

The instrument that was used for data collection is a researcher made instrument titled “Solid Shapes Treatment Questionnaire (SSTQ)”. The questionnaire which has two sections A and B was used to collect information from the respondents.

Section A elicited information on the personal data of the respondents such as name of the school and gender while

Section B constituted a 38-item essay questionnaire on solid shapes (Cone and Cylinder). The respondents were expected to solve the items in the questionnaire and show

their workings in the pre-test and post-test treatment.

The instrument was validated by two experts from Imo State University Owerri, one from Mathematics Education and the other from Measurement and Evaluation to ensure both face and content validity of the instrument.

A test-retest method was used to ascertain the reliability of the "SST" questionnaire. The validated questionnaire was distributed to 10 JSS2 students in Owerri West Local Government Area who were not part of the study sample. After two weeks, the same instrument was re-administered to the same group of respondents and the two sets of scores were correlated using the Pearson Product Moment Correlation Coefficient (PPMCE) which gave a high correlation coefficient of 0.86, showing that the instrument was reliable.

The students were taught in three (3) periods of 45 minutes per period per week. Junior secondary school class two students were used and were treated in groups I, II and III. Group I was taught solid shapes using charts/pictures of both cone and cylinder because, it was a control group. Group II was taught solid shapes using models of both cone and cylinder and Group III was taught solid shapes using both models and charts/pictures of both cone and cylinder because, they were the experimental groups. The researcher with the help of two research assistants administered the post-test instrument of 38-items to 200 JSS2 students in the three education zones of Imo State. The research assistants were trained by the researcher on the purpose of the study and how to administer the questionnaire and the easiest method of collection immediately it is completed. The use of research assistants resulted in high response rate as all the copies were duly completed and retrieved.

The data from the three groups I, II, and III, were collected for answering research questions and testing hypotheses. Research questions were answered using mean and standard deviation while analyses of covariance (ANCOVA) was used to test the hypotheses. This is because, it will partial out initial differences in their pre-test scores.

The questions were answered by difference between the mean performance scores of intact group 1 and intact group II, intact group I (Male only) and intact group II (Male only), intact group I (female only) and intact group II (female only), intact group I (Male and female) and intact group II (Male and female).

Results:

Table 1: Mean and standard deviation scores of control and treatment Groups.

Statistics	**Treatment**		**Diff mean**	**Treatment**		**Diff mean**
	Pre-test	Post-test		Pre-test	Post-test	
Total Score	170	210	-	113	201	-
Maximum Score	9	12	-	7	10	-
Mean Score	5.6	7.0	1.4	3.80	6.70	2.9
Standard Deviation	2.01	2.94		1.46	1.84	-

Table 1 above shows that the mean score of students in group 1 is 7.0 while their pre-test mean is 5.6. The mean score of those in group II is 6.7 as against their pre-test mean score of 3.8. The finding therefore, shows that the differential mean of students taught solid shapes using charts/pictures is 1.4 while that of students taught using models is 2.9.

Hypothesis 1: The mean score of male students taught solid shapes using charts/pictures, and models does not differ significantly from that of the female students taught solid shapes using charts/pictures and models ($p<0.05$).

Table 2: ANCOVA Summary table for Hypothesis 1.

Sources of Variation	Sum of Squares	Df	Ms	F-ratio	F-tab	Decision
Adjusted Mean	6.78	1	6.78	0.63	4.67	Accept Ho
Error	139.75	13	10.75			
Total		14				

Table 2 shows that the calculated F-ratio value of 0.63 is less than the table value (Criterion Value) of 4.67 at 0.05 level of significance. The null hypothesis is therefore accepted.

Discussion

Table 1, shows that the difference between the pre-test and post-test mean performance scores of students taught solid shapes using charts /pictures and models is low when compared to that of those taught using models. The result is in agreement with Uzomah and Ugorji (2011) as well as Adeyemo (2020) who states that "models and specimen have a distinct appeal to children and attract their close attention than chart. Three dimensional character, they observed gives a better conception of reality than charts/pictures". Table 2 shows that there is no significant difference between the effect of charts/pictures and models is the teaching and learning of solid shapes on male and female students in junior secondary school classes. The teachers in these classes should therefore use any of the two strategies in teaching their students both male and female.

In other words, female students in junior secondary school classes do not discriminate between the use of charts/pictures and models in learning solid shapes.

Conclusion and Recommendations

In conclusion, the following, recommendations are hereby put forward:

- That strategies such as charts/pictures and models be used in teaching/learning of solid shapes to remove abstractness.
- Teachers should endeavour to teach solid shapes with models other than mere charts/pictures as the former concretizes the lesson more than the latter. That where charts/pictures and models required to learn a particular shape is not readily available, teachers of Mathematics should try to improvise them in order to assess students' achievements in solid shapes properly.
- Workshops should be organized to train the teachers of Mathematics to gain the competencies for developing or constricting solid shapes is each Education Zone in Nigeria. Above all, the Zonal Education Board in each Zone, even their state counterparts should organize a forum for interaction between experts and classroom teachers to expose their students to some courses and/or lectures in geometry (solid shapes) to enable such students erase phobia about solid shapes from their minds.
- In teaching solid shapes, it is advisable to use both charts and models irrespective of gender since there was no significant difference in the mean performance scores of male and female students taught using charts and models.

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