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EFFECT OF SCAFFOLDING INSTRUCTIONAL STRATEGY ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS IN OTUOCHA EDUCATION ZONE

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ABSTRACT
The effect of scaffolding instructional strategy (SIS) on secondary school students' Academic achievement in Mathematics in Otuocha Education Zone of Anambra State, Nigeria was investigated. Two research questions guided the study and three null hypotheses were tested at 0.05 level of significance. Quasi-experimental research design was adopted, specifically a non-randomized pretest-posttest control group design was used. The population was 797 senior secondary two (ss2) students offering Mathematics in the Zone. A sample of 210 students drawn from four out of 26 secondary schools was involved in the study. The instrument for data collection was Mathematics Achievement Test (MAT) which was validated by three experts and one experienced Mathematics teacher. The reliability of MAT was established using Kudder-Richardson Formula 20 and reliability index of 0.79 was obtained. The data obtained were analyzed using mean, standard deviation and analysis of covariance. The findings of the study revealed among others that the use of SIS in teaching mathematics enhanced achievement scores of students more than the use of conventional method in favour of males. Also, gender had a significant influence on academic achievement of students taught with SIS in favour of males. It was recommended that school authorities and other professional Organizations such as STAN and MAN should organize seminars and workshops from time to time for in-service mathematics teachers to acquaint them with conferences, innovative teaching methods and strategies such as SIS for effective teaching and learning of mathematics in secondary schools.

Keywords: Scaffolds, Instructional Strategy, Achievement, Mathematics.

Introduction

Mathematics is at the heart of science and technology which hold the key to the development of any nation. It is on this premise that it could be predicated that for a nation to have enhancement in science and technology geared towards national development, requisite knowledge of mathematics is required at all levels of the education system including secondary education. According to Joshua cited in Njoku and Okigbo, (2020), mathematics is a discipline that trains the human mind to understand the world by symbolically and systematically performing reasoning and computation on abstract structures. It is an interdisciplinary language which explains the relationships, structures, quantities, properties and forms of objects, constructs, time and space. According to Duru and Okeke, (2019), it predisposes scholars in the scientific field to the skills of numeracy, measurement, calculation and construction without which the learning of science and science-related subjects may become difficult to apply. In other words, Mathematics is the study of relationship which revolves around the elementary practice of writing, measuring and describing of shapes and objects. Mathematics is studied at all levels of education secondary education inclusive. Mathematics is a core and

compulsory school subject at secondary education level. Mathematics as a secondary school subject has some laudable and lofty objectives thus: mathematical thinking is important for all members of a modern society as a habit of mind for its use in the work place, business, finance and personal decision makings; mathematics is fundamental to national prosperity in providing tools for understanding science, engineering, technology and economics, it is essential in public decision making; and children who are functional in mathematics are capable of independent thinking, abstract thinking and critical thinking towards problem solving Odili cited in Olalekan (2016). In addition, the relevance of mathematics in science and technology enhancement and individual and national development has placed it in position of all important subject all over the world.

Despite the relevance of mathematics in different areas of academic decision taking in the life of the individuals, it has been observed that students' performance in the subject declines over the years. Stressing on the poor performance of students in mathematics, Okigbo and Agu (2011) averred that it is very disappointing that students' achievement in mathematics at both internal and external examinations has remained consistently poor. Students' achievement in mathematics in West African Senior School Certificate Examination have not improved even in recent time. WAEC Chief Examiners' reports of 2016 to 2019 still described students' performance to be below average. Ale cited by Olalekan (2016) also revealed that at both internal and and external examinations, students' performance in WASSCE has remained consistently poor when compared with other school subjects. In a more recent study, Ahmed and Okigbo (2021) lamented that the situation of poor achievement of students in mathematics at all levels had remain almost unchanged nationwide.

A great deal of research (Ahmed and Okigbo, 2021; Okeke, 2013; Okigbo and Ezeanyi, 2020) had revealed that achievement of students in could be influenced by methods, instructional strategies and techniques adopted in teaching such subjects. Okeke stated that students' achievement has close link with teachers' strategy. The author reiterated that, teaching strategy adopted by teacher could either enhance or deter students' achievement in any subject. Specifically, Ahmed and okigbo found that instructional technique such as use of prior knowledge of mathematical language in teaching enhanced secondary school students' achievement in that area.

The dominant instructional strategy for teaching in Nigeria is the conventional lecture method. Lecture instructional strategy according to Aguokagbue (2016) is very good for a large number of students and class; it makes for easy coverage of the syllabus, saves time, exposes students to wider knowledge and thus makes them to work harder. Despite the importance of the lecture instructional strategy, it has certain disadvantages. According to Anu (2012), it encourages rote memorization of ideas. This implies that the lecture instructional strategy does not allow the learners to capture comprehensively any part of the information he/she is exposed to for better internalization. Nonetheless, it has not been statistically established whether lecture instructional strategy influences students' achievement in mathematics more than the scaffolding instructional strategy in Otuocha Educational Zone of Anambra State.

Scaffolding is one of the participatory instructional strategies for teaching and learning mathematics. According to Olota (2015) a scaffold is a temporary learning support, help or assistance given to the learner to enhance learning which when removed after students have mastered the task would create mental framework that would help them to continue remembering the way the task was performed. Some scaffolds that could be

provided in teaching and learning mathematics include resources/instructional materials, a compelling task, templates and guides, outlines, recommended documents and story boards or key questions. Unachukwu and Ebenebe (2009) noted that in scaffolding instruction, when the students' competence increases, less support or guidance is given. The relative efficacy of the scaffolding instructional strategy is explained by the Chinese proverb which states: tell me I forget, show me I remember, but involve me, I understand (Anu, 2012). According to Nzewi and Ibeneme (2011), just as scaffolds help workers to complete difficult jobs, instructional scaffolding helps students to build solid understandings of challenging academic tasks.

Carrying out scaffolding instruction requires certain steps or procedure. According to Tumbull, Tumbull, Shank and Leal cited by Chukwuagu (2016), the three major levels of scaffolding instruction include the content, task and material scaffolding. At the content level, the teacher breaks instructional plans to lead the students from what they already know to a deep understanding of what they do not know. Scaffolding instructional plans must be written such that each bit of information that the students learn serves as a logical link to the next step or bit of information. The teacher prepares the instruction in such a way that prior knowledge will be connected to new information so that the previous knowledge would act as a scaffold to the current learning materials. In the second level of the instructional scaffolding which is task scaffolding, the teacher provides support to the learners at every step of the learning process according to Tumbull *et al* in Chukwuagu. By the end of properly executed scaffolding plan, the students perform the entire task with little or no support (scaffolds) from their teacher. This form of hand- on -task learning that promotes students' involvement in the teaching and learning processes is what is advocated by the Vygotsky's theory of cognitive development (Vygotsky, 1978) and Bruner's view of discovery learning (Bruner, 1966) that seem to believe that reasoning emerges through practical activity in a social environment and participatory learning. In essence, when students are seriously engaged in tasks as teaching and learning processes progress they seem to learn better than when the instruction is dominated by the teacher.

At the third level of the scaffolding instructional plan which is material scaffolding, the teacher uses manipulative, verbal or physical prompts or cues to help the learner perform a task. The cues and prompts must be phased out over time as learners master the steps of the task or strategy. The teacher's aim in using scaffolding instructional strategy is to offer enough assistance to guide the students towards independent and self-regulated learning irrespective of students' gender.

Gender is an important variable that could influence students' achievement in different subject areas. According to Tukura, (2015), gender refers to masculine and feminine roles associated to males and females in the society. Also Onuh and Okigbo, (2020) refers to it as the roles and responsibilities of men and women that are created in families, societies and culture. There is controversy on research findings of scholars on the influence of gender on students' achievement, interest and retention. According to Gambari in Onuh and Okigbo, gender has no influence on academic performance of students while Adigun *et al* in Nwoye, Okeke and Nwosu, (2020) identified gender as a strong influencing factor in the retention and performance of students in science subjects and their understanding of difficult science concepts. Adesina, Adigun, Irunokhali, Onihuna and Sada, (2015), reported that no significant difference between mathematical skills acquisition and gender. On the contrary, Hyde and Mertz in

Nkanyimo and Okeke (2020) reported that the gender gap in mathematics achievement is smaller in countries with greater gender equality.

From the foregoing, it becomes clear that inconclusive reports exist on influence of gender on secondary school students' achievement in mathematics when taught using scaffolding instructional strategy and other instructional strategies. This study therefore seeks to determine the effect of scaffolding instructional strategy on secondary school students' achievement in mathematics. Also, relative effectiveness of scaffolding instructional strategy on students' achievement in mathematics in Otuocha Education Zone of Anambra State has not been established, hence the need for this study in the area.

Research Questions

The following research question guided the study:

1. What are the pretest and posttest mean achievement scores of secondary school students taught mathematics with scaffolding instructional strategy (SIS) and those taught with conventional lecture method (CLM)?
2. What are the pretest and posttest mean achievement scores of male and female students taught mathematics SIS?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the mean achievement scores of secondary school students taught mathematics with scaffolding instructional strategy (SIS) and those taught with conventional lecture method CLM).
2. There is no significant difference between the mean achievement scores of male and female students taught mathematics using SIS.
3. There is no interaction effect of treatment and gender on students' achievement in mathematics.

Research Method

The design adopted for the study is quasi-experimental research design, specifically a non-randomized pretest, posttest group design was used. The study was conducted in Otuocha Education Zone of Anambra State, Nigeria. The population consists of 797 senior secondary year two (SS 2) students offering mathematics in the area. The sample size was 208 SS2 students drawn from four out of 26 secondary schools in the zone through multi-stage sampling procedure. The instrument for data collection was Mathematics Achievement Test (MAT). MAT consisted of 50-item multiple choice questions with four options A-D adapted from the West African Examination Council (WAEC) compiled past questions on mathematics. A table of specifications (Test-blue print) was used to draw up the 50-item MAT. This is to ensure content validity of the test items. Instructional plans known as scaffolding instructional strategy lesson plans on geometry (SISLPG) was also developed on the concept taught. The MAT was validated by three experts. Two from the Departments of Science Education and Educational Foundations (measurement and evaluation), Nnamdi Azikiwe University Awka and one expert from the Department of Mathematics Education, Federal College of Education (Technical) Umunze. Also, one secondary school experienced Mathematics teacher from the research area validated the MAT. The reliability of the MAT was establish using Kudder-Richardson Formula 20. The coefficient of internal consistency obtained was 0.79.

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The experimental aspect of the study was conducted in four stages. The first stage was briefing of the research assistant who were the regular Mathematics teachers of the selected four secondary schools. The regular mathematics teachers of the selected schools were used to avoid faking of behaviours on the part of the students. The regular mathematics teacher were given one (1) week briefing by the researcher to ensure uniformity of instructional delivery for a better experimental outcome. The second stage was pre-testing and familiarization when both groups (Experimental and Control) were given pretest before the commencement of the experiment. The third stage was teaching of students by the regular Mathematics teachers. The Mathematics teachers taught the experimental group four (4) lesson (each a week) using the scaffolding instructional strategy lesson plan on geometry (SISLPG). On the other hand, the contact group was taught the same four (4) lessons (each a week) using conventional method lesson plans on geometry (CMLPG). After teaching the students for four (4) weeks, the final stage (stage 4) was post-testing. Here, both the experimental and control groups were given post test and using MAT. The scores of the experimental and control groups in both the pretest and post-test were recorded .Research questions were answered using mean and standard deviation. The analysis of covariance was used to test the null hypotheses at 0.05 level of significance. Decision rule for the hypothesis is that null hypothesis is rejected when the probability value is less than or equal to the significant value of 0.05 ($p \leq 0.05$) otherwise the hypothesis is accepted.

Presentation of Results

Table 1: pretest and posttest mean achievement scores of students taught mathematics using SIS and CLM

Group	N	Pretest		Posttest		Mean gained
		$\overline{\chi}$	S.D	$\overline{X}$	S.D	
SIS	106	42.53	10.21	56.88	12.29	14.35
CLM	102	42.19	8.25	50.78	10.08	8.59

From table 1, mean pretest and posttest scores of 42.53 and 56.88 was obtained for students taught with SIS respectively while mean pretest and posttest scores of 42.19 and 50.78 respectively were obtained for students taught using CLM. A mean gain of 14.35 was obtained for students taught with SIS while a mean gain of 8.59 was obtained for students taught with CLM. From the mean gain the students taught with SIS has higher mean gain than students taught with CLM.

Table 2: pretest and posttest mean achievement scores of male and female students taught mathematics with SIS

Group	N	Pretest		Posttest		Mean gained
		$\overline{\chi}$	S.D	$\overline{\chi}$	S.D	
Male	56	43.13	10.80	58.86	13.62	15.73

Female	50	41.86	9.57	54.66	10.38	12.8

From table 2, the mean pretest and posttest scores of male students are 43.13 and 58.86 respectively while the mean pretest and posttest scores of female students are 41.86 and 54.66 respectively. The mean gain scores of 13.62 and 10.38 were obtained for male and female students respectively. From the mean gain, the male students taught mathematics with SIS has higher mean gain than their female counterparts taught mathematics using SIS.

Table 3: Analysis of covariance (ANCOVA) test of significant difference between the mean achievement scores of students taught mathematics with SIS and CLM

Source of variation	Type III sum of square	df	Mean of square	F	Sig
Corrected model	19678.321[a]	2	9839.16	228.74	.000
Intercept	1922.45	1	1922.45	44.70	.000
Pretest	153.80.37	1	15380.37	357.63	.000
Method	2448.37	1	2448.37	56.93	.000
Error	8816.289	205	43.01		
Total	600011.00	208			
Corrected total	28494.61	207			

Table 3 is on the significance of the mean difference between students taught using scaffolding instructional strategy and those taught using conventional lecture method. From the table $F(1, 205) = 56.93$, $P = 0.000 < \alpha = 0.05$ means that there is a significant difference between the mean achievement scores of students taught using SIS and those taught using CLM in favour of SIS group. Therefore the null hypothesis is rejected

Table 4:ANCOVA test of significant difference between the mean achievement scores of male and female students taught with SIS in mathematics

Source of variation	Type III sum of square	df	Mean of square	F	Sig
Corrected model	9648.45[a]	2	4824.23	79.85	.000
Intercept	1803.55	1	1803.55	29.85	.000
Pretest	9183.12	1	9183.12	151.99	.000
Gender	242.59	1	242.59	4.02	.043
Error	6222.95	103	60.42		
Total	358785	106			
Corrected total	25871.41	105			

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Table 4 shows the test of difference in the mean achievement scores of students taught mathematics using SIS. From the table $F(1, 103) = 4.02$, $P = 0.043 < \alpha = 0.05$ shows that there is a significant difference between the mean achievement scores of male and female students taught mathematics using SIS in favour of male students. Therefore the null hypothesis that there is no significance difference between the mean achievement scores of male and female students taught mathematics using scaffolding instructional strategy is rejected

Table 5: Test of interaction effect of treatment and gender on the achievement of students in mathematics

Source of variation	Type III sum of square	df	Mean of square	F	Sig
Corrected model	5216.69[a]	3	1738.89	15.24	.000
Intercept	558591.95	1	558591.95	4895.32	.000
Method*Gender	5216.69	3	1738.89	15.24	.000
Error	232677.91	204	114.11		
Total	600011	208			
Corrected total	28494.61	207			

Table 5 is on the interaction effect between gender and method on the achievement of the student taught mathematics. From the table $F(3,204) = 15.24$, $p = 0.00 < \alpha = 0.05$ was obtained. This means that there is statistically significant interaction of gender and method on the achievement of students taught mathematics. Therefore null hypothesis is rejected.

Discussion

The findings of the study showed that these is a significant difference between the mean achievement scores of secondary schools students taught Mathematics using scaffolding instructional strategy and those taught using conventional lecture method (CLM) in favour of scaffolding instructional strategy group. The students in SIS group performed better than those in conventional lecture method group because SIS is a sort of realistic teaching approach where the students were given opportunity to exercise their mastery over the content of the learning materials and to ensure they were able to make progress in each phase of learning based on the established knowledge they have in the previous phase. Scaffolding instructional strategy help the students develop in them appropriate mastery skills that will enable them successfully migrate from one level of knowledge to the other in a given learning process thereby improving their achievement in the subject matter.

The finding in this study agreed with the work of Casem and Olivia, (2013) who found out that students taught mathematics using instructional scaffolding approach had better achievement than their counterparts taught using the traditional approach. Also in the work of Chukwuagu (2016) students who were taught chemistry using instructional scaffolding showed a significant improvement in their achievement. Aditi (2017) found out that students exposed to Scaffolding instructional Strategy developed a positive attitude towards science generally.

Gender was also significant in the achievement of students based on the

instructional approach. There was a significant difference in the achievement of male and female student who were taught mathematics using scaffolding instructional approach. The finding of the study is contrary to that of Okereke and Okigbo, (2019) whose study revealed that gender is not a factor in students' achievement in mathematics when instructional scaffolding approach is applied in teaching. Also Van de Pol, Volman, Oort and Beishuizen (2015) observed that when students were taught with it instructional scaffolding in mathematics it increased their level of task effort because of the appreciation of the support in which they were given.

The interaction effect of teaching approaches and gender was examined on achievement of the students in mathematics. It was observed that gender and treatment has significant interaction on students' achievement. This implies that male and female students react differently to the treatment in terms of their academic achievement in mathematics. In other words, the teaching strategies used in the study imparted differently on male and female students based on their academic achievement in mathematics.

Conclusion

Based on the findings, it was concluded that the use of SIS in teaching mathematics was more effective than the use of CLM. However the use of SIS was gender bias since it favour males more than females in learning of mathematics.

Recommendations

From the findings of the study, it was recommended that:

1. The school authorities, those in business of education and professional bodies like STAN and MAN should organize seminars and workshops from time to time for in-service mathematics teachers to acquire skills in the use of innovative teaching strategies such as SIS so as to ensure effective mathematics curriculum delivery.

2. Teachers of mathematics should adopt the use of SIS in teaching to improve students' learning outcomes.

3. Teacher Education Institutions should include and introduce the use of SIS in teaching mathematics method class.

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