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IMPACT OF SCAFFOLDING ON SENIOR SECONDARY STUDENTS' ACHIEVEMENT IN MATHEMATICS IN NIGER STATE, NIGERIA

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Abstract

The study was on, impact of scaffolding on senior secondary students' achievement in mathematics in Minna Metropolis. It was an attempt to ease students' difficulties in comprehending Mathematics (Plane Geometry). The study used randomized pre-test, post-test control group design.120 students (60 for experimental group and 60 for control group) were used. The experimental group was taught using scaffolding strategy, while the control group was taught using conventional method. The instrument used for collecting data was Mathematics Achievement Test (MAT) with a reliability coefficient of 0.76. Three hypotheses were formulated and tested at 0.05 level of significance. t-test was used to test hypothesis 2 while ANCOVA was used for hypotheses 1 & 3. The findings were that there was significant difference in the achievement of students taught with scaffolding strategy and those taught with conventional method and there was no significant difference in the achievement of male and female students taught with scaffolding strategy. It was recommended that teachers should try as much as possible to always use scaffolding strategy for teaching and learning of mathematics in the senior secondary schools and that training and workshops should be organized to create awareness and techniques required in implementing scaffolding strategy in Nigeria.

Introduction

Most developed countries of the world such as China, Japan and United States of America are rated high for effective and efficient utilization of both human and material resources at their disposal to better the life of humanity. Today more than ever, the field of knowledge are dependent on Mathematics for solving problems, stating theories and predicting outcome. Keith (2000) and Odili (2006) said that today, scarcely any aspect of one's life is not affected often in fundamental and far-reaching ways by the product of mathematics. When one thinks of technological and communication infrastructure that under girds one's life, it means fact in a Mathematics universe. Over the years, students' achievement in Mathematics has continued to be un-impressive as revealed by so many writers (Olusi, 2008; Anyamene, 2012). There are so many factors influencing students' achievement in mathematics in Nigeria. These include: teachers' qualification, teaching methods, students' study habits, students' parents' economic status, urban/rural area disparity, peer group influence, school curriculum/timetable and students-teacher ratio, hence the need for urgent solutions to check the situation.

According to Olusi (2008), the most outstanding and pressing factor is the teacher teaching method. This is partly occasioned by the fact that the teaching and learning of mathematics is characterized by rote-memorization of some basic facts. There are so many teaching methods and the teacher that knows his subjects should be able to devise appropriate teaching method to carry along his students. Teachers should therefore, strive to design a learning activity involving students actively to construct information and experience so that it can be understood as meaningful. Some of the activities that teachers can do to create these conditions include: selecting mathematical tasks so as to motivate students' interest and enhance the intellectual skills of students,. providing an opportunity for students to deepen their understanding of mathematics as well as product and process implementation, creating a classroom atmosphere that encourages achievement discovery and development of mathematical ideas, using and assisting students' understanding, technology tools and other sources to enhance the discovery of mathematics and helping students to explore the relationship between new and earlier knowledge to lead individually, in groups and in the classical style (Depdiknas, 2007 in Machmud, 2011) . These efforts may be performed by presenting a draft of learning mathematics in accordance with the tradition of socio-constructivism.

Constructivism Theory of Cognitive Development

Constructivism is a theory of cognitive development that emphasizes on the active role of students in building their own understanding of the knowledge learned. Slavin (1997) in Machmud (2011) revealed that constructivism in educational history was born from the idea of Piaget and Vigotzky. Both pointed out that cognitive development occurs only if the conceptions that have been previously understood and later processed through an imbalance process in order to understand new information. Thus, individual is viewed to construct knowledge when he could assimilate and accommodate continuously towards new and earlier information. In other words, someone studying knowledge means he is basically learning to construct science. Viewed from the socio-cultural context, Vygotsky states that learners who are in the process of constructing a social concept need to look at the environment. There are two important concepts in the theory of Vygotsky

(Slavin, 1997), the Zone of Proximal Development (ZPD) and scaffolding. The Zone of Proximal Development (ZPD) is the distance between the actual developmental levels defined as the ability of solving problems independently and the level of potential development that is defined as the ability of problem solving under adult guidance or in collaboration with more capable peers.

Role of Scaffolding Strategy in Learning Mathematics

Scaffolding is a term in education that exists in modern constructivist theory of learning. In learning, scaffolding takes a very important role in the development of students' learning. Each time the students reach certain developmental stage in learning which is characterized by the fulfillment of indicators in certain aspects, the students will require scaffolding. Vygotsky (Nur, 2004) suggests that scaffolding is the concept of learning with an assistance (assisted learning). According to Vygotsky, the functions of higher mental, including memory and the ability to direct attention to specific goals and the ability to think in symbols, is a behavior that requires assistance, especially in the form of media. When the interaction process is taking place, scaffolding might be required simultaneously and is integrated in the physical, intellectual and emotional aspects.

The presence of scaffolding is closely related to the nearest development zone or Zone of Proximal Development (ZPD) of students. According to this view, a successful learning depends on when the students work on learning tasks which are in their ZPD, so the role of a teacher is very important in their development tasks. In this case, the teacher must intervene to prevent the decreasing in learning and working together in the ZPD. Then, all forms of assistance is reduced gradually with increasing ability and confidence of students (Rodgers &Rodgers, 2004; Walqui, 2006).

Scaffolding is relevant to the view that in mathematics learning needs of multi-way interaction, teacher - student, student-student, student-teaching materials so that students -based on experience- can develop mathematical knowledge and strategies to respond to mathematical problem given. Scaffolding is the provision of some assistance to students during the early stages of learning, then reducing the assistance and provide the opportunity to take over greater responsibility after he or she can do it (Slavin, 1997).

Another form of scaffolding is also expressed by Roehlar and Cantlon (1997) in their research which include inviting students' participation, offering explanation, verifying and clarifying students' understanding. What is meant by inviting students' participation is a form of scaffolding that is given with a view to inviting students to participate actively in learning through teachers' efforts to lure student participation. Offering explanation is a form of scaffolding that refers to a statement corresponding to the understanding of the emerging concept of what students are learning, why and when the concept was used and how the concept was used. Verifying and classifying students' understandings is a form of scaffolding related to the verification of the understanding that emerged from the students. If the comprehension occurring makes sense, then the teacher should verify the response, but if the comprehension does not make sense, then the teacher must also clarify to the students.

Scaffolding strategies in order to achieve the desired goals, Speer and Wagner (2009) in Machmud (2011) suggested to the teachers to do the following things:

1. Recognize or figure out students' mathematical reasoning (correct or incorrect);
2. Recognize or figure out if how student' ideas have the potential to contribute to the mathematical goals of the discussion;
3. Recognize or figure out if how students' ideas (either correct or incorrect) are relevant to the development of students'

understanding of the mathematics,
4. Prudently select which contributions to pursue from among all those available.

Teachers are very instrumental in planning and implementing scaffolding in teaching and learning in the classroom so that the scaffolding provided is truly functional and effective. In this case, the presence of the teachers who really have the competence and sensitivity as well as all students is required. With competence, sensitivity and good introduction to students, teachers can plan appropriate scaffolding and reduce it gradually. This study is therefore focused on the impact of scaffolding strategy on senior secondary school student's mathematics achievement.

School Type and Achievement in Mathematics

Proponents of school choice and school reform often claim that different school types will produce better academic outcomes for students than does the traditional public school model. Schools found in many societies where the formal learning of mathematics started are categorized into the single school boys only and girls only especially in the northern part of Nigeria (Hassan, 2014). The bringing of boys into girls was adopted over time due to civil pressure and advocacy for the recognition of equal rights of the girl child education (Benjamin, 2006; Barmo, Mondoh & Bosire, 2008). However, co-education became a normal system in education structures because it aroused intent interest among, not only educators but also thepublic at large. Lubienskietal *(2006) studied the demographic difference between students in public and private school more than account for the relatively high raw scores ofprivate schools. Indeed, after controlling for these differences, the presumably advantageous "private school effect" disappears, and even reverses in most cases.* In another study by Enukoha and Meremikwu (2010) conducted an investigation on instructional aids, school variables and pupil's Mathematics achievement in Primary schools in Cross-River State, Nigeria. The aim of the study was to determine the effects of the use of instructional aids and school variables on pupils" mathematics achievement in both public and private schools.

Purpose of the Study

The purpose of this study was to find out the effect of scaffolding strategy on senior secondary school students' achievement in Mathematics. It sought to specifically find out:

(1) The effect of scaffolding strategy and conventional teaching method on senior secondary school students' achievement in Mathematics.

(2) The way gender difference in achievement in Mathematics using scaffolding strategy.

(3) The effects of school type on senior secondary school students' achievement in Mathematics.

Research Questions

1. What are the impacts of scaffolding strategy on senior secondary school students' Mathematics achievement.?
2. What are the effects of gender on students' achievement in Mathematics using scaffolding method?
3. What are the effects of school type on student's achievement in Mathematics?

Hypotheses

$H0_1$: There is no significant difference between the mean achievement scores of students taught Mathematics using scaffolding and those taught using conventional teaching method.

$H0_2$: There is no significant difference in the mean achievement scores of male and female students taught Mathematics using scaffolding.

$H0_3$: There is no significant difference on mean achievement score in mathematics based on school type.

METHODOLOGY

The study adopted a randomized pre-test, post-test control group design which entails the use of two groups of subjects with both groups being measured or observed twice. The first measurement serves as the pretest, the second as the post-test. Random assignment is used to form experimental group and control group. The measurement or observations are collected at the same time for both groups.

The total population of the study was one thousand seven hundred and twenty six (1,726) SS I students from Four government schools in Minna during 2015/2016 session. (**Source:** Ministry of Education, Minna, 2015). The schools chosen preferably mixed schools and single gender. A two-stage sampling procedure was used for this study. First, a purposive random sampling was used to obtain 120 subjects from the four schools drawn from two local government areas in Minna Metropolis of Niger State (Bosso and Chanchaga Local Government Areas). At the second stage, a simple random sampling procedure was adopted to arrive at 30 students from each school using hat and draw methods. Two schools were used as experimental groups comprising 60 students. The other two schools for control group were made up of 60 students. The instrument used for data collection was Mathematics Scaffolding Achievement Test (MSAT). It was a multiple-choice objective question. The MSAT was face and content validated by four specialists, two from Science Education, FUT, Minna and the other two in Mathematics Department of the sampled schools, to ensure clarity of items, their arrangement and suitability in addressing the purpose of the study. The data collected for the study were used for the computation of the reliability of the Mathematics Scaffolding Achievement Test (MSAT) using Pearson Product Moment Correlation Coefficient (PPMC). A reliability coefficient of 0.76 was obtained at the end of the computation. The instrument was administered by the researcher and the research assistant to the two groups at the same time. In each of the four schools sampled, each class was divided into two groups, treatment and control groups. The respondents answered the questions to the best of their knowledge. The research questions were answered using mean and standard deviation, while the hypotheses were tested using Analysis of Co-variance (ANCOVA) and t-test at 0.05 level of significance.

RESULTS

Table 1: Mean and Standard Deviation of Experimental and Control Groups

GROUP	Mean	Std. Deviation	N
Experimental	61.75	1.694	60
Control	34.75	6.194	60

Table 1 revealed that the experimental group has higher mean score of 61.75 and standard deviation of 1.694, the control group has lowest mean score of 34.75 and standard deviation of 6.194.

Table 2: Mean, Standard Deviation by School Type

SCHOOL TYPE	N	Mean	Std. Deviation
Boy's school	30	61.80	1.769
Girl's school	30	61.60	1.714
Mixed school	60	44.85	10.444

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Table 2 revealed that mixed school had the lowest mean score of 44.85 and standard deviation of 10.444. Boy's school has the mean score of 61.80 and standard deviation of 1.714 and girls school only with mean score of 61.60 and standard deviation of 1.714. Thus the Boys only school has the highest mean score.

Table 3: Mean, Standard Deviation by Gender of Experimental Group

GENDER	N	Mean	Std. Deviation
Male	30	61.80	1.769
Female	30	61.60	1.714

Table 3 revealed that males had the highest mean score of 61.80 and standard deviation of 1.769 and females with lowest mean score of 61.60 and standard deviation of 1.714.

Hypothesis 1: There is no significant difference between the mean achievement scores of students taught Mathematics using scaffolding and those taught using conventional teaching method.

Table 4: ANCOVA Post-test on Experimental and Control Groups

Source	Type I Sum of Squares	df	Mean Square	F	Sig.
Intercept	340587.075	1	340587.075	5955.135	.000
Covariate (Pre- test)	22.951	1	22.951	.401	.528
Main effect(Treatment)	8004.568	1	8004.568	139.959	.000
School Type	525.306	2	262.653	4.592	.012
Model	8552.826[a]	4	2138.206	37.386	.000
Residual	6577.099	115	57.192		
Total	355717.000	120			
Corrected Total	15129.925	119			

*: Significant at $P < 0.05$

Table 4 reveals that an $F(1, 115) = 139.959$, $p = 0.000$ for the main effect (treatment) was significant, this indicates that the method of instruction produced a significant effect on the post-test achievement scores of students when covariate effect (pre-test) was controlled. The results indicate that the treatment, using scaffolding accounted for the difference in the post-test achievement scores of the students.

Hypothesis 2: There is no significant gender difference on the mean achievement scores of students taught Mathematics using scaffolding

Table 5: Summary of t-test Analysis of Males and Females of Experimental Group

GENDER	N	Mean	S.D	df	t	P
Male	30	61.80	1.769	58	0.445^{NS}	0.619
Female	30	61.60	1.714			

^{NS} Significant at $P < 0.05$

Table 5 shows that male students had a mean score of 61.80 with S.D= 1.769 while the female students had a mean score of 61.60 and Standard deviation (S.D) of 1.714 the t-calculated is 0.445 with df= 58 and P-Value of 0.619. This shows that P>0.05, Hence Ho_2 is not rejected. Therefore, there was no significant difference in the mean achievement score of male and female students taught Mathematics using scaffolding strategy.

Hypothesis 3: There is no significant difference on school type and students' achievement in Mathematics.

Table 6. Scheffe's post-hoc analyses of the School type mean scores

Groups	Boy's School	Girls School	Mixed School
Boy's school		0.20	16.95*
Girls school	-0.20		16.95*
Mixed school	-16.95*	-16.95*	

* The mean difference is significant at the 0.05 level.

Table 6 reveals that an F (2, 115) = 4.592, p = 0.012 for the School type was significant; this indicates that the school type produced a significant effect on the students achievement scores. The results indicate that the school type, using scaffolding accounted for the difference in the post-test achievement scores of the students. Based on the established significant difference in the achievement scores of the groups, Scheffe's test was used for post-hoc analysis. The results of this post-hoc analysis are as shown in Table 6. The result in Table 6 indicates that there was no significant difference in the mean scores of students exposed to scaffolding strategy, boys' schools to girls' schools (X = 0.20) and significant between Boy's school to mixed school (X = 16.95*). Significant difference was not established in the mean scores of students girls to boys (X =-20) and significant difference exists between girls to mixed schools (X = 16.75*). Significant difference was established between mixed school to boys' school (X=-16.95*) and mixed school to girls schools (X=-16.75*).

Discussion of Findings

The results of hypothesis one reveals that was significant difference in the mean achievement of the Experimental group and Control group, the results indicate that the treatment, using Scaffolding accounted for the difference in the post-test achievement scores of the students. The findings as regards better performance of students in mathematics using scaffolding strategy agrees with findings of Casem (2013) and Simons &Clein (2007) which established better performance of students taught in Scaffolding strategy compared to students using the conventional teaching methods. It also agrees with the findings of Alake and Ogunseemi (2013) which reported that students taught using Scaffolding strategy in integrated science performed better than those taught using conventional method. Furthermore, these findings are supported by the van de Pol Volman&Beishuizen (2010) in their study tittle Scaffolding in Teacher–Student Interaction: A Decade of Research.

The results of the analyses related to the hypotheses two indicated no significant difference in the performance of male and female students taught physics using Scaffolding strategy. The findings as regards the performance of male and female students in the Scaffolding strategy agree with the earlier findings of Casem (2013), Simon & Clein (2007) and Ogunseni (2013) which found no significant difference between male and female students' performance when taught mathematics using Scaffolding strategy. However, it disagrees with the findings of Olson (2002) which found that

female students taught mathematics using cooperative learning outperformed their male counterparts.

The results of the analyses related to the hypothesis three indicate that the school type produced a significant effect on the students' achievement scores. The results indicate that the school type, using Scaffolding accounted for the difference in the post-test achievement scores of the students. The findings agree with the earlier findings of Lubienski*etal* (2008), Esposito (2010) and Doris; O'Neill & Sweetman (2012) which found that the school type determine the students mathematics achievement. It also found that boys perform better in mathematics than girls, particularly at the upper end of the distribution.

These findings have strong implications for teaching and learning of Mathematics in secondary schools in Nigeria using Scaffolding strategies. Major implication of these findings is that students taught with Scaffolding strategy performs better than those taught with conventional method. Furthermore, the findings provide sound empirical basis which indicate that male and female students performance in mathematics when taught using scaffolding strategy is impressive. School type is a dominant factor of students' achievement in mathematics.

Conclusion

The study has critically examined the impact of scaffolding on senior secondary students' achievement in mathematics. The influence of gender and achievement levels as it affects students' achievements in Mathematics using scaffolding strategy were also reported in this study. The author views that use of scaffolding is an innovative teaching strategies in Nigeria. Its adoption into Nigeria classroom will answer the poor performance students in mathematics at senior secondary school in Nigeria. Therefore, scaffolding strategy was more effective in teaching the concept of Plane geometry in Mathematics.

Recommendation

It is recommended that Mathematics and science teachers should expose their students to scaffolding instructional strategies in order to improve their performance in Mathematics, Teachers should use scaffolding strategy in combination with some traditional methods in teaching mathematics. Since constructivism recognizes that students are at different levels of understanding and presents a variety of ideas, teachers should start encouraging more student-centered learning in their teaching methodologies like the use of scaffolding teaching strategy. Administrators should support and provide avenues for teacher advancement especially on the use of instructional technologies and software. Training and workshop should be organized to create awareness and techniques required in implementing scaffolding strategy in Nigeria.

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