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EFFECT OF INQUIRY-BASED INSTRUCTIONAL STRATEGY ON STUDENTS' INTEREST AND ACHIEVEMENT IN MATHEMATICS IN DELTA NORTH SENATORIAL DISTRICT

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Abstract

This study focused on the effect of inquiry-based instructional strategy on students' interest and achievement in Mathematics. Quasi-experimental design was adopted for this research. Pre-test was administered to intact class of both experimental and control groups. Post-test was also administered to both groups after the treatment in which the experimental group was exposed to inquiry-based instructional strategy and the control group was taught with the traditional teaching method. The instruments were validated by two expert Mathematics educationists and one in measurement and evaluation. The reliability coefficient of the Mathematics Achievement Test was 0.80. The result of the study showed that the inquiry-based instructional strategy improved students' achievement in Mathematics. The inquiry-based strategy also helped to arouse the students' interest in the learning of Mathematics in secondary schools in Delta North Senatorial District. It was recommended that inquiry-based instructional strategy should be used to teach Mathematics in secondary school.

Introduction

The importance of Mathematics to humanity has generated interest among scholars in the field of education. Mathematics is the abstract science of number, quantity and space. Mathematics affects every facet of human activities such as politics, economy, science and technology. The learning of Mathematics has become imperative in every society if the citizens are to cope with the fast technological development of our society. Following the importance of Mathematics to humanity, it has been made a compulsory subject in Nigeria (FRN, 2013). This requires that every child attending school in Nigeria is expected to develop appropriate Mathematical skills that will enable him to cope with the challenges in life due to the advancement in technology.

Mathematics being a core subject at the secondary school level was incorporated through story, rhyme, picture page and others which were so designed to make Mathematics interesting and relevant to the children. From class I to class IV, new textbooks were designed and developed in a new approach and involving teacher, teacher educator, child psychologist, illustrator in workshop mode. More emphasis was given on the presentation of Mathematical concept to link with children's life. Each concept was introduced in such a manner that children can understand and practice the learning with curiosity. Mathematics learning is not only for higher studies, but also for use of the knowledge and skills of mathematics in their life long process, to make one self-sufficient, efficient, confident and dependent. With these aims the curriculum was developed in our state by making it more realistic, practical, useful, suitable, justified up to the learner's mental ability of that stage rather than stereotype, theoretical and traditional approach (Campbell, 2006).

To make Mathematics more understandable, enjoyable and permanently retained in the mind, more use of practical work and project work were reflected in the curriculum specifically which need Mathematics Laboratory and club in each school. For this, teaching-learning strategies were suggested as activity based, child-centered, load-free, stress-free, enjoyable, interesting and effective. However, the theme of this study is on Mathematics teaching and learning in the secondary school system. Although, some teachers have advocated a return to more traditional method of teaching and assessment, others feel inquiry method is important in teaching science to students than the lecture method (FRN, 2013).

In line with the National Policy on Education, the objectives of teaching mathematics include (FRN, 2013): "To apply Mathematical knowledge and skills to familiar and unfamiliar situations; identity, concretize, and symbolize Mathematical relationships in everyday life, think and reason precisely, logically and critically in any given situation; and communicate Mathematical ideas. Others are: to acquire knowledge and skills for further education and training; perform Mathematical operations and manipulations with confidence, speed and accuracy as well as to develop willingness to work collaboratively". The teaching and learning of Mathematics in school system must therefore, take into consideration some of these important objectives so that students can acquire the necessary knowledge and skills as provided by the National policy based on the need of the child and the society they belong to.

Inquiry-based instructional strategy for learning is a form of active learning in which one starts by asking a series of questions, problems or scenarios. Unlike the traditional teaching, this generally is student-centered. The inquirer researches issues and questions to acquire knowledge and finding solution to problems. The inquiry-based learning increases students' engagement in teaching and learning as well as help students to develop hands-on and minds-on skills for teaching (Ali, 2014). In this process, one can also develop the skills and strategies needed to implement inquiry- based instruction in the classroom situation. Inquiry-based teaching

strategy is a student-centered approach in which the teacher guides the students through questions posed, methods designed and data interpretation. Through inquiry, students get actively involved in teaching and learning and discover knowledge by themselves to support their investigation (Ogundola, 2014). Teaching and learning is the process of imparting knowledge skills, values and attitude. The process of teaching and learning involves many variables which interact together towards achieving goals and incorporating new knowledge, behaviors and skills. Such variables include subject matter content knowledge, instructional skills and strategies used by practicing teachers during the instructional processes as well as knowledge of learners learning difficulties (Ijeh, 2013). Others are: students' age, topic, time, instructional materials, students and teachers' activities carried out during teaching. The evaluation procedures adopted by the teacher to determine the extent to which the students understood what he or she has taught and which the students are expected to learning is also part of the teaching process.

The lecture method involves in most cases, oral presentation of ideas during which the teacher does most of the activities in form of talking, while the students are passive listeners in the teaching process (Omwirhiren, 2015). This kind of method may lead to rote learning and memorization which may not also promote meaningful learning and retentive quality.

Interest simply means the state of wanting to know or to learn something. It is a state of curiosity or concern about something. Interest is a motivating factor in the teaching and learning process. The interest of a student can be determined by carrying out a survey through discussion and observing some of his or her activities. Interest is a very crucial factor in teaching and learning. In selecting learning experiences, it is natural for students not to engage in what they are not interested in. A teacher has to consider the interest of the students to enable him or her organizes and select activities for the attainment of the objectives of the lesson. Offoma (2006) noted that when learning experiences are based on the interest of the learner, learning becomes more significant, meaningful and enjoyable during classroom practice. Inquiry instructional strategy when used in teaching mathematics could help to motivate students' interest and enable them retain what is learnt.

Students' interest and achievement in any learning activity is sustained by the active involvement of the learners in all aspects of the learning process. Ogundola (2014) emphasized that unless the teacher stimulates students' interest in learning, students' achievement will be minimal. Hence, it is essential that in science education, Mathematics teachers should use teaching methods such as inquiry-based instructional strategy which ensure students' active involvement in learning, stimulate and arouse interest and at the same time improve achievement in the subject. The research question that would guide this research is: What is the effect of inquiry-based instructional strategy on students' interest and achievements in Mathematics?

Research Questions

Two research questions were raised and answered:

1. Is there any difference in the mean Mathematics achievement scores between students taught using inquiry-based instructional strategy and those taught using lecture method?
2. Is there any difference in the mean interest scores of students taught Mathematics using inquiry-based instructional strategy and those taught with lecture method?

Hypotheses

The following hypotheses were formulated to guide the study and were tested at probability level of 0.05 significance:

1. There is no significance difference between the mean Mathematics achievement score of students taught Mathematics using inquiry-based

instructional strategy and those taught using lecture method.

2. There is no significance difference between the mean interest score of students taught Mathematics using inquiry-based instructional strategy and those taught using lecture method.

Research Method

The design of the study was quasi-experimental research design of the pre-test, post-test non-equivalent control group design. This design was considered appropriate for this study because intact classes were used and no possibility of randomization of the research participants. Ali (2006) noted that quasi-experimental design is an alternative and appropriate to experimental design when randomization of sample is impossible. The design for the study is illustrated below.

While O_1 represent the pre-test of the inquiry-based instructional strategy of the experimental group; O_2 represent post-test of the inquiry-based instructional strategy of the experimental group, O_4 represent post-test of lecture method of control group, X_E represent treatment for inquiry-based instructional strategy of Experimental group and X_C represent treatment for lecture method of the control group.

Two instruments were used for data collection. They are Mathematics Achievement Test (MAT) and Mathematics Interest Inventory Scale (MIIS). The 50 multiple choice items were adapted from West Africa Senior School Certificate Examination (WASSCE) 2000 to 2018 question papers and Mathematics textbooks based on the content that were taught in the lesson. The Mathematics Interest Inventory Scale (MIIS) consisted of 20 positive interest statements measured on a four point Likert type interest rating scale developed by the researcher. The four point Likert type rating scale was used to enable students indicate their level of interest. The scale with the scoring guide was as follows: SA=Strongly Agree (4); A=Agree (3); D=Disagree (2) SD=Strongly Disagree (1). Both the MAT and MIIS were used for pre-test and post-test respectively. The MAT question items were reshuffled before it was administered for the post-test after treatment.

The research instruments were face and content validated using experts in Mathematics education and one expert in measurement and evaluation. The reliability of the instrument was estimated using Cronbach Alpha. The reliability coefficient was 0.87.

Adopting 2.50 as cut-off point, any item with mean value of 2.50 and above was interpreted as "Agreed" and items with mean values less than 2.50 were interpreted as "Not Agreed". The hypotheses of no significant difference was accepted when the t-calculated (t-cal) value was less than the t-critical (t-tab) value of 1.96 at 0.05 level of significance and hypotheses of no significant difference was rejected when the t-calculated (t-cal) value was greater than the t-critical (t-tab) value of 1.96 at 0.05 level of significance.

Results

This section presents the analysis of the data gathered from students through Mathematics Achievement Test (MAT) and Mathematics Interest Inventory Scale (MIIS). The results of the analysis are presented in the tables with the interpretation of the results immediately after the tables. The results of the data analysis are presented in accordance with the research questions with the corresponding hypothesis raised to direct the study.

Research Question 1

Is there any difference in the mean achievement scores of students taught Mathematics using inquiry based instructional strategy and those taught using lecture method?

Table 1: Mean Pretest and Posttest Achievement Scores between Students taught Mathematics using Guided Inquiry Instructional Strategy and Lecture Method

GROUP	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gain
Guided Inquiry	**182**	**21.98**	**9.57**	**58.91**	**13.08**	**36.93**
Lecture	**177**	**21.41**	**9.20**	**49.92**	**13.48**	**28.51**

Table 1 indicates that the two groups were at the same level of achievement with a pre-test mean achievement scores for 21.98 and 21.41 for inquiry-based instructional strategy and lecture method respectively. This implies that the experimental and control groups were equivalent on the knowledge of the concepts taught before treatment by mere comparison of means. For the posttest, the experimental group (Inquiry instructional strategy) achieved higher mean score of 58.91 with a standard deviation of 13.08. The control group (Lecture method) obtained a mean achievement score of 49.92 with a standard deviation of 13.48. Table 1 indicated that students in the guided instructional strategy group out-performed their counterpart in the lecture group.

Hypothesis 1

There is no significant difference in the mean achieveme scores of students taught mathematics using inquiry based instructional strategy and lecture method.

Table 2: ANOVA Comparison of pre-test Scores of Inquiry Instructional Strategy (experimental) and Lecture (Control) Groups

	Sum of square	Df	Mean Square	F	Sig.
Between Groups	**28.705**	**1**	**28.7805**	**.325**	**.569**
Within Groups	**31498.805**	**357**	**88.232**		
Total	**31527.510**	**358**			

The ANOVA comparison of the groups as shown in Table 2 indicated non-significant difference, $F(1, 357) = 0.325$, $P(0.569) > 0.05$. This implies that there is no significant difference in the pre-test scores of the two groups compared. Hence, Analysis of Variance (ANOVA) was used to test hypothesis 1.

Table 3: ANOVA Comparison of posttest Scores of Guided Inquiry Instructional Strategy (experimental) and Lecture (Control) groups

	Sum of square	Df	Mean Square	F	Sig.
Between Groups	**7254.107**	**1**	**7254.107**	**41.117**	**.000**
Within Groups	**62983.486**	**357**	**176.424**		
Total	**70237.593**	**358**			

A significant difference was found between the inquiry-based instructional strategy and lecture method group as indicated in Table 3, F(1, 357) = 41.117, P(0.000) <0.05. Therefore, the null hypothesis was rejected. Thus, there is a significant difference between the mean achievement scores of students taught Mathematics using inquiry-based instructional strategy and lecture method.

Research Question 2

Is there any difference in the mean interest scores of students taught Mathematics using guided inquiry instructional strategy and lecture method?

Table 4: Mean Pretest and Posttest Interest Scores between Students taught Mathematics using Inquiry-based Instructional Strategy and Lecture method

GROUP	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Guided Inquiry	182	41.22	9.23	62.69	9.88	21.47
Lecture	177	33.45	8.36	58.04	9.82	24.59

Table 4 indicates that the two groups were not original at the same level of interest with a pre-test mean interest scores 41.22 with a standard deviation of 9.23 and 33.45 with a standard deviation of 8.36 for inquiry-based instructional strategy and lecture method respectively. This implies that the experimental and control groups were not equivalent on interest in Mathematics for the posttest. The experimental group (Inquiry-based instructional strategy) achieved higher mean interest score of 62.69 with a standard deviation of 9.88. The control group (Lecture method) obtained a mean interest score of 58.04 with a standard deviation of 9.82. Table 4 indicated that students in the inquiry-based instructional strategy group obtained higher mean interest score as compared to students in the lecture group.

Hypothesis 2

There is no significant difference in the mean interest scores of students taught mathematics using guided inquiry based instructional strategy and lecture method

Table 5: ANOVA Comparison of pre-test Scores of Inquiry Instructional Strategy (experimental) and Lecture (Control) groups

	Sum of square	Df	Mean Square	F	Sig.
Between Groups	5422.232	1	5422.232	69.860	.000
Within Groups	27708.949	357	77.616		
Total	33131.181	358			

The ANOVA comparison of groups as shown in Table 5 indicated significant difference, F(1,357)=69.860, P(0.000) < 0.05. This implies that there is a significant difference in the pretest scores of the two groups compared. Hence, analysis of Covariance (ANCOVA) was used to test hypothesis 2.

Table 6: ANCOVA Comparison of Mean Interest (Post with Pre) Scores of Inquiry-based Instructional Strategy (experimental) and Lecture (Control) groups

Source	Type III Sum of square	df	Mean Square	F	Sig.
Corrected Model	**3555.310[a]**	**2**	**1777.655**	**19.162**	**.000**
Intercept	**49658.486**	**1**	**49658.486**	**535.280**	**.000**
Pre-interest	**1617.349**	**1**	**1617.349**	**17.434**	**.000**
Methods	**575.504**	**1**	**575.504**	**6.203**	**.013**
Error	**33026.523**	**356**	**92.771**		
Total	**1346078.000**	**359**			
Corrected Total	**36581.833**	**358**			

a. R Squared =.097 (Adjusted Squared =.092)

Significant difference was found between the group taught with inquiry-based instructional strategy and group taught with lecture method of teaching Mathematics on interest as shown in Table 6, F(1, 356) =6.203, P(0.013) < 0.05. Thus the null hypothesis was rejected. Therefore, there is a significant difference between the mean interest scores of students taught mathematics with inquiry-based instructional strategy and lecture method

Discussion of Findings

The findings of this study showed that there is a significant difference between the mean achievement scores of students studying Mathematics using inquiry based instructional strategy (experimental) and lecture method (Control). The variations in achievement scores among the groups may be due to the variation in the instructional strategies adopted in each of the groups. This study revealed that all students taught with inquiry-based instructional strategy outscored those taught with lecture method. This suggests that the students in the inquiry-based group may have been more active in the learning process than those in the lecture group and thus have contributed to their higher achievement scores. This is hinged on the fact that you learn better by doing based on a better teaching and learning strategy (Ajaja, 2013). Benett (2003) noted that the transmission view implies that pupils' role in the learning process is largely passive, and that a pupil's mind is sometimes called "Tabula rasa".

This finding is also in line with Wilson, Taylor, Kowalski and Carlson (2009); and Ibe (2013) who observed that students taught with inquiry-based instruction reached significantly higher levels of achievement than students taught with lecture method. They further stated that the mean achievement scores for the inquiry-based group were significantly higher than the mean achievement scores for the lecture method.

The finding of the study also showed that there is a significant difference between the mean interest scores of student taught Mathematics with inquiry-based instructional strategy (experimental) group and their counterparts in the lecture (control) group. This may be attributed to the fact that there is active involvement and interaction

among students, between students and teachers, and between students and learning environment as well as self- discovery of knowledge by the students in the experimental group. The low interest scores as found among the students taught with lecture (control) method may not be unconnected with the fact that they were not actively involved in the teaching-learning process which hinders self-discovery of knowledge (Ajaja, 2013).

This finding corroborates with that of Obiekwe (2008) who observed that constructive instructional approach (inquiry-based instructional strategy) was more effective in facilitating students' interest in science concepts than the lecture method.

Conclusion

The study therefore concludes that inquiry-based instructional strategy is an effective instructional strategy for improving students' interest and achievement in Mathematics.

Recommendations

Two recommendations are made.

1. Inquiry-based instructional strategy should be used to teach Mathematics for enhanced achievement.
2. Mathematics teachers should ensure that their students' interest should be aroused in the learning of Mathematics.

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