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EFFECTIVENESS OF INQUIRY TEACHING METHOD ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS IN AWKA EDUCATION ZONE OF ANAMBRA STATE, NIGERIA

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ABSTRACT

The study dealt with the investigation of the effectiveness of the inquiry teaching method on senior secondary school students' academic achievement in Mathematics in Awka South Local Government. Two research questions and two hypotheses were formulated to guide the study. The study utilized two co-educational schools randomly selected from Awka South Local Government Area. The study utilized two intact classes using a simple random sampling method by balloting to select the classes for the study. The study sample comprised ninety-six SS1 Mathematics students. The instrument for data collection was the Mathematics Achievement Test (MAT) made up of twenty-five multiple-choice items, which was first validated and later administered to twenty SS1 students in another school, not among the school used for the study, to determine the reliability index which was found to be 0.86. The reliability of the instrument was computed using Pearson's product-moment correlation coefficient (r). The instrument was then administered to students as a pre-test at the beginning of the study before the treatment. Then after the pre-test, the researchers administered the treatment using the intact class teachers, the teaching lasted for two weeks. After the teaching, the same test was reshuffled and administered as a post-test. The results were collected and analyzed. The research questions were answered using mean and standard deviation while the hypotheses were analyzed using a t-test at 0.05 level of significance. The t-test analysis of gender revealed that there is a significant difference between male and female students taught Mathematics with the inquiry teaching method in favour of the male students in addition the t-

test results between the experimental group (Inquiry teaching method) and control group (Lecture method) revealed that there is a significant difference between the experimental and control group in favour of the experimental group. The study among others recommended that the inquiry teaching method should be used in teaching Mathematics to solve the problem of poor academic achievement in Mathematics.

Keywords: Effectiveness, Inquiry teaching method, academic achievement, and Mathematics.

Introduction

The key purpose of education has been the development of the complete individual. The expectation of every parent is that the school will be able to transform the child's potency in life. The only way to achieve this is by giving the child education that is of superior quality and standard. Education comprises the total exertions of the community to raise its political, social, and economic standard of living (Ogumah et al 2020). The implication of this is that education is an unavoidable device for overcoming illiteracy, disease, and poverty, and producing functional individuals who have positive attitudes toward the growth and development of society. The development of any nation depends largely on the level of its Mathematical, scientific, and technological literacy. Mathematics is one of the sciences which are indispensable to technological advancement. It has helped in the development of modern technology through the application of its principles to the modern invention (Lorch, 2015). The study of Mathematics has been and will remain of tremendous importance to mankind because it is capable of explaining natural phenomena and everyday occurrences (Anne, 2019). The implication is that Nigeria cannot develop technologically if the subject of Mathematics is not taught effectively in secondary schools. Mathematics educators worldwide have strived so hard to adopt suitable methods of teaching to deliver different concepts to students at all levels of education, having identified numerous benefits derived from the acquisition of such Mathematical knowledge (Peter, 2014). It is common in recent times, to find Mathematics teachers holding firmly to only lecture methods of teaching, which result in unproductivity due to its inability to foster problem-solving, critical thinking, and creative thinking. (Ibrahim et al, 2018). The poor achievement of students graduating from secondary schools can be ascribed to the teaching method used by the teachers since the teaching and learning in many of the schools in Nigeria are lecture methods (Stokke, 2015). There is a need to use students centered teaching methods, however, this study is focusing on one of the student-centered teaching methods called the inquiry teaching method.

The inquiry teaching method is a research-based scientific teaching method through experimentation by learners. Inquiry as explained by Hamby (2014) includes investigation of a problem, finding truth or knowledge that requires thinking critically, making observations, asking questions, doing experiments, drawing conclusions, thinking creatively, and using intuition. In the inquiry method of teaching, the teacher's role in the classroom shifts from an information provider to a facilitator and a guide who create a conducive environment where learners themselves

create their knowledge (Shinde, 2020). Cetal (2016) stated that students have a clear chance to make use of pre-existing knowledge, encounter findings, and conceptions to construct new concept formation which is in sharp contrast to the behaviorists who support the acquisition of concepts through direct teaching. The inquiry method of teaching is of numerous benefits to the total development of students because learning occur at its best when students take active roles and practice what they have learned. It also improves students' attitudes toward mathematics and enhances interest, curiosity, and liking for the subject (Nurshamshida et al 2012). Inquiry-based teaching places the student at the center of the learning and the teacher serves as the guide.

Academic achievement is the extent to which a student has attained short or long-term educational goals. It is commonly measured through examination or continuous assessments. It is considered to be the center around which the whole education system revolves. Baker et al (2013) opined that the academic achievement of students determines the success or failure of any academic institution. Brown (2012) also argued that the academic achievement of students has a direct impact on the social-economic development of a country. According to Bhat et al (2016), academic achievement is the knowledge gained which is assessed by marks awarded by a teacher, educational goals set by students and teachers to be achieved over a specific period of time and these goals are measured using examination results. These factors contribute to the academic achievement of students

- Proper guidance from parents and teachers.
- Proper teaching methods
- Communication skills
- Learning facilities.

In an attempt to solve the problem of poor academic achievement of students in Mathematics, the researchers investigated the effectiveness of the inquiry teaching method on senior secondary school students' academic achievement in chemistry in Awka Education Zone.

Statement of the problem

Poor academic achievement of students in Mathematics examinations is worrisome to the researchers. It has been observed that for many years, there is a massive failure in their Mathematics examination both terminal and senior school certificate examinations (S.S.C.E). Could these failures be attributed to poor teaching techniques, and lack of construction facilities or could we say that the government is a major contributor by not encouraging Mathematics teachers which led to this poor academic achievement of students in the subject? It is for this purpose of redressing this trend that this study is being carried out. The statement of the problem, therefore, is: will the inquiry teaching methods generate interesting results or solve the problem of poor academic achievement in Mathematics at the senior secondary schools in Awka Education Zone.

Purpose of the study

The purpose of this study is to investigate the effectiveness of inquiry teaching method on senior secondary school students' academic achievement in Mathematics in Awka Education Zone**.** Specifically, the objectives of this study are to find out:

1. The difference in the mean achievement scores of students taught Mathematics with inquiry teaching method and those taught with lecture method.
2. The difference between the mean achievement scores of male and female students taught Mathematics using inquiry teaching method.

Research Questions

The following research questions were used to guide the study:

i. What is the difference in the mean achievement score of students taught Mathematics with inquiry teaching method and those taught with lecture method?
ii. What is the difference between the mean achievement score of male and female students taught Mathematics using inquiry teaching method?

Hypothesis

The following hypotheses were formulated for the study:

HO_1: There is no significant difference between the mean achievement score of students taught Mathematics with inquiry teaching method and those taught with lecture method.

HO_2: There is no significant difference between the mean achievement score of male and female students taught Mathematics using inquiry teaching method.

Research Method

Research Design: The study employed a quasi-experimental research design, specifically, the non-equivalent control group design. A quasi-experimental research design is a type of research design that does not provide for full control of extraneous variables primarily because of the lack of random assignment of subjects to a group (Ali, 2006). A quasi-experimental research design is considered appropriate for the study because intact classes were used to avoid disruption in normal classrooms. Therefore, the specific design that was employed for the study was a pre-test, post-test non-equivalent group design.

Area of the Study: The study was carried out in Awka South Local government of Anambra State.

Population of the Study: The population of this study consisted of all SSS 1 students in 18 government senior secondary schools in Awka South L.G.A. of Anambra state. At the time of the study (2019/2020 academic session), There were one thousand eight hundred and eleven (1811) SS1 students. (Source zonal post-primary schools Board Awka Education Zone).

Sample and Sampling Techniques: Intact classes which comprised a total of ninety-six (96) SS1 students formed the sample for the study. A simple random technique was used to select two (2) senior secondary schools in Awka South L.G.A in which one school was used as an Experimental and the other school was used as the control group. A further simple random sampling technique was used to select one arm of SS1 class in each selected school. The experimental group consists of sixty-one (61) students made up of twenty-eight (28) males and thirty-three (33) females while the control group consists of thirty-five (35)

students made up of fifteen (15) males and twenty (20) females.

The instrument for Data Collection: The instrument for data collection was the mathematics achievement test (MAT). The MAT is made up of twenty-five (25) items drawn from the SS1 scheme of work (Third term) which are all multiple-choice questions.

Validation of the Instrument: To ensure the validity of the instrument, the MAT was subjected to both face and content validation. The face validation was done by administering the instrument to one expert from the department of science Education, one expert from measurement and evaluation all from the faculty of Education Nnamdi Azikiwe University, Awka, and one experienced mathematics teacher in senior secondary school, to check the clarity of items, its suitability, and appropriateness of the language used in order to suit the learners involved. After validation, some modifications were made by the experts on the content and the corrections were affected by the researchers.

Reliability of the Instrument: Trial testing of the MAT was done by administering twenty (20) copies of the instrument to SS1 Mathematics students in one of the senior secondary schools, not within the area of study. This was done to determine the time it will take to complete the test and how reliable the items in the instrument are. The data was used to estimate the reliability of the instrument using person's product-moment correlation coefficient (r). The reliability index was found to be 0.86.

Experimental Procedure: The researchers visited the selected schools and trained the class teachers of the experimental and control group class as research assistants. They taught their class for two weeks; the experimental group was taught using the inquiry teaching method while the control group was taught using the lecture method. Copies of the Mathematics Achievement Test (MAT) were given to each group. Pre-test was given before the treatment and was collected on the spot. The teaching lasted for two weeks after which a post-test was given to the two groups and was collected on the spot. The Mathematics Achievement Test (MAT) was marked and scored. The scores were collected and subjected to analysis.

Method of Data Collection: The researchers administered the mathematics achievement test (MAT) to the students and their scores were obtained and recorded.

Method of Data Analysis: The research questions posed were answered using mean and standard deviation while a t-test was used to test the hypotheses.

Presentation of Results

Research question 1: What is the difference in the mean achievement scores of students taught Mathematics with inquiry teaching method and those taught with lecture method?

Table 1: Mean ($\bar{X}$ and standard deviation (SD) of scores of students taught Mathematics using inquiry teaching method and those taught with lecture method.

Group	Number of Students	Pre-test $\bar{X}$	Pre-test SD	Post-test $\bar{X}$	Post-test SD	Mean gain score
Experimental group (Inquiry method)	61	14.29	2.95	21.26	3.04	6.97
Control group (Lecture method)	35	10.51	3.67	15.05	2.50	4.54

From the above table, the data on the student's achievement revealed that students taught Mathematics with the inquiry teaching method had mean achievement scores of 14.29 in the pre-test and 21.26 in the post-test while those taught Mathematics with the lecture method had mean achievement scores of 10.51 in pre-test and 15.05 in post-test. Therefore, students taught with the inquiry teaching method had a mean gain score of 6.97 while those taught with the lecture method had a mean gain score of 4.54. So, students taught Mathematics with the inquiry teaching method achieved better than those taught with the lecture method.

Research question 2: What is the difference between the mean achievement scores of male and female students taught Mathematics using the inquiry teaching method?

Table 2: Mean ($\bar{X}$) and standard deviation (SD) scores of male and female students taught Mathematics with inquiry teaching method.

Group	**Number of Student**	**Pre-test $\bar{X}$**	**Pre-test SD**	**Post-test $\bar{X}$**	**Post-test SD**	**Mean gain Score**
Male	28	12.32	3.72	20.07	3.06	7.75
Female	33	15.96	1.31	22.27	2.63	6.11

From the table above, the data on students' achievement revealed that the male students had mean achievement scores of 12.32 on the pre-test and 20.07 on the post-test, while female students had mean achievement scores of 15.96 on the pre-test and 22.27 on the post-test. Male students had a mean gain score of 7.75 while female students had a mean gain score of 6.11. Therefore, male students had slightly higher achievement scores in the experimental group than female students.

Research hypothesis 1: There is no significant difference between the mean achievement scores of students taught Mathematics with inquiry teaching method and those taught with the lecture method.

Table 3: Mean scores, standard deviation, and independent sample t-test of experimental and control group.

Groups	Number of students	Mean ($\bar{X}$)	Standard deviation (SD)	t-Calculated	t-Critical	Degree of freedom (df)	Alpha level
Experimental group	61	21.26	3.04	7.66	7.16	94	0.05
Control	35	15.05	2.50				

From the table above, because the computed test statistic value exceeds the critical value (t-calculated = 7.66 > t-critical = 7.16), the researcher concluded that there is a significant difference between the mean achievement scores of students taught Mathematics with the inquiry method and those taught with lecture method of the two groups in the post-test, which is in favour of the experimental group. Therefore, the null hypothesis was rejected.

Research hypothesis 2: There is no significant difference between the mean achievement scores of male and female students taught Mathematics using the inquiry teaching method.

Table 4: Mean score, standard deviation and t-test of male and female students taught Mathematics using inquiry teaching method.

Gender	Number of students	Mean ($\bar{X}$)	Standard deviation (SD)	t-Calculated	t-Critical	Degree of freedom (df)	Alpha level
Male	28	20.07	3.06	1.48	1.63	59	0.05
Female	33	22.27	2.63				

From the above table, because the computed test statistic value is less than the critical value (t-calculated = 1.48 < t-critical = 1.63), the researchers concluded that there is no significant difference between the mean achievement scores of male and female students taught Mathematics using inquiry teaching method. Therefore, the researchers accepted the null hypothesis.

Discussion of the findings

An insight into table 1 revealed that students taught Mathematics with the inquiry teaching method achieved better than those taught with the lecture method. This was evidenced by the scores obtained in both the pre-test and post-test. This could be because the inquiry teaching method provides the opportunity for active involvement of students in their learning process and hence, their thinking ability. Those taught with the inquiry teaching method have achieved better than their fellow counterpart. Also, the result from table 3 shows that there is a significant difference between the mean achievement scores of students taught Mathematics with the inquiry method and those taught with

the lecture method. This led to the rejection of the null hypothesis in favour of the alternative hypothesis having the t-calculated (t-cal) to be 7.66 while the (t-crit) is 7.16. That is to say, there is a significant difference between those taught with the inquiry method and those taught with the lecture method. The difference is in favour of the experimental group. However, this result is in consonance with the result of Baker et al (2013), who carried out research on the effect of the inquiry teaching approach on student's understanding of circle theorems in plane geometry than students in the experimental group achieved better results compared to those in the control group. This observation is also in agreement with that of Ibok and Ntibi (2020) who reported that the inquiry teaching method produces students with significantly higher academic performance in chemistry than the lecture method. This might be possible because students are directly involved in the learning process.

Results from table 2 showed that male students had mean achievement scores slightly higher than their female counterparts. This was evidenced in both pre-test and post-test scores. Also, results from table 4 on the computed test showed that there is no significant between the mean achievement scores of male and female students taught Mathematics using the inquiry teaching method. Thus, this led to why the null hypothesis was accepted having t-calculated (t-cal) to be 1.48 while the t-critical (t-crit) is 1.63. This finding agreed with the finding of Peter, (2014) that gender has no significant effect on students' achievement in social studies. Likewise, Bakke, and Igaro (2013) studied gender factors on the effect of the guided inquiry teaching method on student achievements in logic. The study revealed that there is no significant difference between the mean achievement tests based on gender. The same is the finding of Chinwe and Chikelu (2014) that there is no significant difference between the male and female mean scores on the science process skill acquisition test. Also, Eze (2012) studied the relationship between mathematics anxiety and mathematics achievement of SSS using 500 students randomly sampled from four secondary schools in Rivers state and reported there is no significant gender difference in mathematics anxiety of students but a significant relationship exists between mathematics anxiety and mathematics achievement. The study revealed that there is no significant difference between the mean achievement tests based on gender. This present study is in disagrees with the finding of Odagboyi (2015) which showed that boys achieve significantly higher than girls in their study. However, the finding of Ifeanyi-Uche (2013) stated that girls rather achieve better than boys in school is in disagreement with the present study. This study agrees with the assertions that gender differences may exist but a good method of teaching should be capable of neutralizing the difference.

Conclusion

In conclusion, it has been seen from the result obtained that, students taught Mathematics using the inquiry teaching method achieved better than those taught using the lecture method. Also, there is no significant between the mean achievement scores of male and female students taught Mathematics using the inquiry teaching method. Hence, the study concluded that the inquiry teaching method is a very effective method of teaching that increases

the academic achievement of students in Mathematics.

The implication of the Study

The findings of this study have implications for Mathematics teachers. The results of the study showed that the mathematics teachers might have been using methods that are not favorable to students' understanding of the subject therefore, there is need to move from teacher-centered to student-centered since it could enhance students' understanding of inquiry teaching activities.

Finally, the finding of the study showed that there is no significant difference between the achievement of male and female students. The implication of this is that teachers should actively involve male and female students during classes to promote learning.

Recommendations

Based on the findings of this study and their implications, the following recommendations were made:

i. Curriculum developers should incorporate inquiry teaching methods in curriculum guidelines for the achievement of intended learning outcomes.
ii. There is a need for training of Mathematics teachers by teachers training institutions on the effective use of inquiry teaching methods in the teaching of Mathematics.
iii. Facilities should be provided by the federal and state government as well as PTAs and NGOs for the effective use of inquiry teaching methods.
iv. Teachers need to use inquiry teaching methods so as to improve the achievement of students in Mathematics.

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