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## A STUDY ON THE EFFECTS OF GUIDED INQUIRY TEACHING METHOD ON STUDENTS ACHIEVEMENT IN LOGIC

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### ABSTRACT

This study sought to find the achievement levels of two groups of senior secondary schools students who were taught a difficult concept in Further Mathematics using two different methods; the Guided inquiry teaching method and the Conventional teaching method. A 25-items (20 objectives and 5 essay)- type in mathematics test covering the algebra of logic in the four types of logic statements was administered on a sample of 197 students before and after the teaching. These students were randomly drawn from senior secondary schools in Jalingo Education Zone of Taraba state, Nigeria. The study which lasted for two months generated data that was analysed using mean, standard deviation and analysis of covariance (ANCOVA) with the pre-test scores as covariates at ( $P \leq 0.05$ ) probability level. The results showed that the students who were taught logic using the Guided inquiry teaching method had better achievement scores than students who were taught using the conventional teaching method.

**KEYWORD:** Logic,guided inquiry,covariates, conventional teaching method.

### 1. INTRODUCTION AND LITERATURE

Mathematics can be defined as the communication system for those concepts of shapes, size, quantity and order used to describe diverse phenomena both in physical and economic situation (Ojeride, 1999). He further sees mathematics as a tool for use in science, technology and industries. This definition connotes that all sciences draw their inspirations from mathematics and in fact implies that mathematics is the language of the sciences. Ezeude and Awagah (2000), in their study looked at mathematics as a scientific tool in realizing the nation scientific and technological aspirations. Also Usman (2002), considered mathematics as a subject that encroaches into all aspects of human endeavour and further describe mathematics as the life wire in the studies of various disciplines. It is this importance of mathematics that compelled the Federal Government of Nigeria to make mathematics a compulsory subject from the primary school through to the end of the senior secondary school education.

The mathematics curriculum experienced a lot reforms in light with the high light given during the Edinburgh Conference of the international congress of mathematics in August 1958. The reasons for the suggested reforms were attributed to the great shortage in meeting the technical needs for mathematicians, physicians and engineers (Harbor Peters 1992). Also, amid the various reforms in mathematics curriculum, the Further mathematics curriculum was also developed and put to use in 1985. The purpose of the Further mathematics curriculum was to cater for potential Mathematicians, Engineers and Scientist.

Logic is a major content of the Further mathematics syllabus; logic as a science is important because it has a technical language used for investigation and also for systematic development of principles for determining straight and crooked reasoning (Isidore, 1997). Logic is also important in weighing evidences. Egbeke (1992) pointed out that, with the logical skills the individual can avoid, attempt to mould or shape his beliefs, his buying habits, his political decisions and social behavior as he comes across hidden persuaders, political or religious leaders and advertisers through their flowery rhetoric subtle and beguiling advertisement. To Bosede (1992), the study of logic can make an individual know the difference between persuasions through various psychological techniques and those based on rational arguments and supporting evidences. Hence the need for proper learning of logic.

Despite the recognition accorded mathematics at all levels, it is unfortunate that most students' especially secondary schools students exhibit nonchalant attitudes toward the subject. These attitudes reflect in their in-attentiveness when mathematics class is going on. The results of their attitudes towards the subject, the societal problems (examination malpractice and related syndrome) and government insensitivity to issues reflect in majority of the students who register for general certificate of the education (GCE/ senior secondary certificate of education SSCE) every year to come out with partial or total failure in mathematics and further mathematics.

The problem of mathematics failure at this level has always been attributed to teacher's failure to use appropriate teaching method (Obodo; 1990, Okoro; 1995, Odowu; 1995 and Adebayo; 2001)

Mathematics educators and teachers have tried varieties of teaching method at their disposal, which include the synthetic method, analytic, deductive, inductive, heuristic, laboratory and guided inquiry methods to improve the learning of mathematics (Adebayo 2001). Some of the teaching methods adopted have been criticized and seen not to be effective for the teaching of some aspects of secondary school mathematics.

## 2. THEORETICAL FRAMEWORK OF GUIDED INQUIRY TEACHING METHOD

The Guided inquiry teaching method according to Massialas (1991) is a teaching method that enables students to move step-by step from the identification of a problem defining the problem formulation hypothesis, collection of data, verification of results, and generalization to the drawing of conclusion. Also Harbor Peters (2000) pointed out that the Guided inquiry teaching approach is techno-scientifically oriented. It places the learner's constructive mental ability first in all instructional processes. In other words it is learner centered. Also the guiding inquiry teaching method effectiveness has been investigated in some aspects of the sciences and mathematics. For instance Nwagbo (1997) investigated its effectiveness in achievement and attitude in Biology. Timothy and Awodi (1997) investigated its effectiveness on achievement of high and low achievers in senior secondary school Biology. Dagoli (1999) on student's achievement in geometry which is an aspect of mathematics and Karumeh (1999) conducted her investigation on senior secondary school one (SSS1) achievement in Algebra. In their respective studies the Guided inquiry teaching approach was found suitable and effective in teaching of those aspects of the sciences and mathematics.

Also, Obioma (1992) and Harbor Peter (1992) in their studies in "Teachers Assessment of the difficulty levels of the further mathematics" and "Aspects of further mathematics that present difficulties to graduating senior secondary school students" respectively, identified logic as one of the difficult concepts that mathematics teachers found difficult to teach in further mathematics curriculum. Hence the need to investigate the effectiveness of the Guided inquiry teaching method on students achievement in logic

Therefore, the main purpose of this study was to investigate the effects of guided inquiry teaching method on student's achievement in logic. Specifically, the study intended to find out whether students who are taught logic using the Guided inquiry teaching method will differ significantly in their performance in logic compared to that of the students taught using the conventional teaching method.

The study was delimited to senior secondary school students in Jalingo Education Zone of Taraba State Nigeria. The topics covered was logic with statements, negation of statements, simple and compound statements, conjunction and disjunction of statements, conditional and bi-conditional statements, equivalent statements, tautology and contradiction of statements, and the truth table. This topic was chosen because it is one of the identified difficult concepts, teachers find difficult to teach in further mathematics.

It was hoped that the findings of this study indicated the difference between the Guided inquiry teaching approach and the conventional teaching method on the achievements of students in logic. It might therefore sensitize and provide the mathematics teachers with an alternative method of teaching logic for easier understanding and effective application by students. Furthermore, it might serve as an eye-opener for more research works on guided inquiry teaching method for teaching other identified difficult themes of further mathematics.

The findings might be of use to the curriculum planners, it might aid them in identifying essential elements of logic in further mathematics especially logic skills, concepts, values, application and appreciations that could be included in further mathematics curriculum. It findings might also be used by ministries and department of education, supervisors and other researchers in seminars, conferences and workshops to improve the knowledge of teachers in pedagogy.

This research questions therefore raised were, "to what extent does the mean achievement scores of the experimental group differ from that of the control group as defined by their mean achievement scores?

To answer this question a null hypothesis was formulated and tested at ( $P \leq 0.05$ ) level of significance.

$H_0$  = There will be no significant difference between the mean achievement scores of the students who were taught logic using the Guided inquiry teaching method and those taught logic using the conventional( lecture) method.

### 3. THE RESEARCH DESIGN

A quasi-experimental design was used for this study. According to Ali (1996), this design is mostly used in classroom experiments where the experimental control groups are naturally assembled groups as intact classes which might be similar. Thus, there is no assurance of the equivalences of these groups. The quasi-experimental design was chosen for this study because it controls the internal validity threats of initial group equivalence and researchers selection bias, since there was no randomization of the subjects into groups.

The population of the study consisted 2720 students covering of 17 senior secondary schools in Jalingo Education Zone, in Taraba State of Nigeria. The senior secondary schools were chosen because the logic syllabus is been taught at that level. Stratified random sampling teaching based on the location was applied in the study.

The students in the treatment group (classes) were taught logic using the Guided inquiry teaching method while those in the control groups were taught logic using the conventional teaching method.

### 4. INSTRUMENTATION

The instrument used for the study was the Logic Achievement Test (LAT). The instrument consist of twenty (20) multiple choice question and five (5) essay type questions, after the face validation and trial testing

### 5. VALIDATION OF THE INSTRUMENT

The items in the logic Achievement Test (LAT) instrument were subjected to content and face validation. The content validation was ensured through strict adherence to the test blue print. The LAT items were face validated by two experts in Measurement and Evaluation and three Mathematics Educators, who:

- I. checked the clarity and suitability of the test items,
- II. re-structured any item(s) which is/are not correctly formulate,
- III. added any other item(s) which is/are suitable but had not been included in the instrument, and
- IV. removed ambiguous or redundant statement in other to improve the structure of the test item

The scores obtained from the pilot testing were used to determine the internal consistency and reliability coefficient of the instrument. The cronbach alpha formula was used to estimate the reliability of the instrument. The use of this formula was considered appropriate since the instrument consists of both multiple and essay type items. Using the cronbach Alpha formula, the coefficient of the reliability obtained was 0.78. This was considered well enough for the study.

### 6. CONTROL OF EXTRANEIOUS VARIABLES

The internal validity threats will minimize the direct impact between the independent and dependent variables, such that their effects will not realize. These threats include initial group equivalence of the subject, the researcher selection bias, statistical regression and pre-test sensitization.

The non-equivalence control group design used for this study will not permit randomization of the subjects into treatment and control groups. Therefore the pre-testing of the subjects before the treatment is meant to control the internal validity threat of initial group equivalence and the researchers' selection bias.

The internal validity threat of statistical regression due to pre-test of subjects will also be controlled using the analysis of covariance (ANCOVA). Other extraneous variables such as tea chers' qualification, the school administrative setup, the school environment and infrastructures which may influence this study were minimized through the use of the training programme for mathematics teachers in the sample schools and monitoring of the experimental and control groups by researchers.

The pre-testing of the subjects to obtain a base line data on the subjects may also sensitize students for post-testing, which is a threat to internal validity. Thus threat of pre-test sensitization was checked using different teachers to invigilate the subject in the post-test after the re-shuffling of LAT items. In addition, the question to be administered was retrieved from the subjects immediately after the pre-test. The time interval of four weeks between the two tests also minimized this threat.

## 7. DATA ANALYSIS

The pre-test and post-test scores obtained from the administration of the LAT instrument was analyzed using the mean, standard deviation and analysis of the covariance (ANCOVA) with two factors and the pre-test as covariate. This statistical tool also served as a technique for controlling extraneous variables and experimental contamination of subjects.

## 8. RESULTS

The research question of this study was intended to ascertain the extent of achievement of the experimental group to that of the control group through their mean achievement scores in logic Achieve mean Test (LAT). The pre-test and post-test mean and standard deviation scores are indicated below.

### Pre-test and post-test mean achievement ( $\bar{x}$ ) and standard deviation (SD) scores of students in (LAT) taught logic using guided inquiry approach and conventional method

From the computed result, it was seen that the pre-test and post-test mean achievement scores for the guided inquiry teaching method were 13.96 and 68.72 with standard deviation scores of 6.92 and 17.81 respectively. Similarly, the pre-test and post-test mean achievement scores for control group (i.e. conventional teaching method) were 14.72 and 55.17 with standard deviation score of 8.01 and 12.58 respectively. Therefore, the results of the post-test revealed that the students in the experimental group have higher mean achievement scores more than students in the control group.

## 9. TEST OF HYPOTHESIS

The calculated F-ratio, the adjusted sum of the squares, the mean squares and the significance of the F are presented in the table below. This was obtained using analysis of covariance (ANCOVA) technique, and was used to test to null hypothesis of ( $P \leq 0.05$ ) level of significance. The null hypothesis is stated below as:

There is no significance difference between the mean achievement scores of the students who were taught logic using the Guided inquiry teaching method and those taught using the conventional teaching method. **Analysis of**

Sources of variation	Sum of squares	Degree of freedom	Mean squares	F-ratio	Significance of F
covariates	10.119	1	10.119	0.43	0.836
Pretest	10.119	1	10.119	0.43	0.836
Main effects	8886.372	2	4443.186	18.951	0.000
CONGRP	8821.727	1	8821.727	37.627	0.000
Sex	39.652	1	39.652	0.169	0.681
2-way interaction	278.635	1	278.635	1.188	0.277
(CONGRP/sex)	278.635	1	278.635	1.188	0.277
Explained	9175.126	4	2293.781	9.787	0.000
Residual	45249.081	193	234.451		
Total	54424.207	197	276.265		

**Fig 1:** covariance (ANCOVA) of students Achievement scores in (LAT) taught logic using Guided inquiry and conventional method

The null hypothesis above was tested using the data in the table above. The table revealed that the calculated F-ratio at ( $P \leq 0.05$ ) level of significance is 37.63 and that the probability level is  $P = 0.000$  which is far less than ( $P \leq 0.05$ ). Based on this, the null hypothesis of no significance difference due to teaching method was rejected. This implies that the mean **achievement** scores of students who were taught logic using the guided inquiry teaching method and those students who were taught using the conventional teaching method differed significantly in favor of students taught with guided inquiry teaching method.

## 10. RESULT

On the basis of the result obtained in the presentation of the result, the finding of this study is summarized thus:

Student's cognitive achievement in logic was better when taught using the guided inquiry teaching method than when taught using the **conventional** teaching method. This implies that, the guided inquiry teaching method was significantly better than the conventional teaching method in enhancing students overall cognitive achievement in logic.

#### 11. DISCUSSION OF FINDINGS

The data obtain here were presented in the presentation of result in the previous page. On the basis of the computed results presented in table 2 and 3, teaching method is a significant factor in students' cognitive achievement in logic. This implied that students' achievement in logic is related to teaching method adopted in presenting the concept. This findings is consistent with those of Nwagbo (1997), Timothy and Awodi (1997), Dagoli (1999) and Kurumeh (1999). These researchers concluded from their investigations that students taught using the guided inquiry teaching method performed better than those taught using the conventional (expository/lecture) method respectively in terms of cognitive achievement. The success of the experimental group (i.e. those taught using guided inquiry teaching method) over control group ( those taught using the conventional method) may have been due to the fact that the former were provided with variety of instructions and activities. This could have given them the opportunity to employ investigative processes of learning (i.e. critical thinking and creative abilities) through interaction with the materials and class members. These may have facilitated their understanding and retention of what is being learned.

#### 12. CONCLUSION

Based on the findings and discussions of this study, this conclusion was made. A major conclusion derived from this study is that the guided inquiry teaching method was significantly better than the conventional teaching method in enhancing student's cognitive achievement in logic.

#### 13. EDUCATIONAL IMPLICATION

The findings of this study have implication for the Ministry and department of education, teachers and students.

This implication of these findings to the Ministries and departments of Education is that they should encourage and motivate mathematics teachers by providing mathematics teachers allowance regular payment of salaries, allowances, leave grant and other benefits. They should also sponsor and organize workshops, seminars, conferences and in service training programmer on teaching method that are learner centered and activity oriented (guided inquiry/Discovery), since the teachers are not generally trained in this area. They should also encourage and motivate teachers generally and mathematics teachers particularly through the provision of conducive teaching-learning environment, mathematics laboratories and adequate instructional materials.

The mathematics teachers should endeavour to learn and apply the guided inquiry teaching method for teaching the identified difficult themes in mathematics and further mathematics curricular, such as construction, geometric proof, vectors, logic, (Obioma, 1992). As reveal from the findings of this study, guided inquiry if properly utilized, there will be a great improvement in students' achievement in mathematics and further mathematics. The mathematics teachers should be resourceful, hardworking, creative and with verse initiative in order to use the guided inquiry teaching method effectively. Mathematics teachers should provide students with enough instructional materials and activities that will motivate them to learn and discover concepts and principles for themselves. Another implication is that different or new teaching methods other than the one used could be tried out.

The implication of this study to students is that, since guided inquiry teaching method is activity oriented and learner centered approach; it demands seriousness, practices and hard work on the part of all students. As they interact with the instructional materials and get activity involve in the activities, the problem solving abilities (critical thinking and creative abilities) are developed. Hence, the experience gained could be transferred to a related/similar problem situation.

#### 14. RECOMMENDATIONS

On the basis of the implication of study, the following recommendations are made.

1. The educational ministries/departments should organize and sponsor mathematics workshops, exhibitions, seminars, and conferences on a regular basis for mathematics teachers. In order to update the knowledge of the teachers, expressing and drilling them on the use of innovative or activity oriented teaching methods, such as the guided inquiry teaching method.
2. There is need for general orientation of science and mathematics teachers on the utilization of guided inquiry teaching method.

3. Mathematics teachers should adhere to the use of guided inquiry teaching method in teaching identified difficult themes in mathematics and further mathematics, since this method enhances achievement and has the potentials of developing critical thinking and creative abilities in students.

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