RESEARCH PAPER

GENDER FACTOR ON THE EFFECTS OF GUIDED INQUIRY TEACHING METHOD ON STUDENTS ACHIEVEMENTS IN LOGIC

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ABSTRACT

This study was designed to investigate the gender factor on the effects of guided inquiry teaching method on student's achievement in logic. One research question was posed and answered; and two hypotheses were formulated and tested at ($p \leq 0.05$) level of significance. Logic Achievement Test (LAT) was used as an instrument for the data collection, it consist of 25-items (20 objectives and 5 essay) covering the algebra of logic in the four types of logic statement administered on a sample size of 197 students before and after teaching. These students were randomly drawn from senior secondary schools in Jalingo Educational Zone of Taraba State, Nigeria. The study which lasted for two months generated data that was analyzed using mean, standard deviation and analysis of covariance (ANCOVA) with pre-test scores as covariates. The study revealed that there is no significant difference between the mean achievement scores of male and female students who were taught logic using the guided inquiry teaching approach as measured by mean logic achievement test. Lastly, there is no significant interaction between the guided inquiry teaching approach and gender on students' achievement in logic. Based on the findings, recommendations were made.

INTRODUCTION

Background of the Study

Ojerinde, (1999) in Bakke and Igharo (2013) sees Mathematics as the communication system for the concepts of shape, size, quantity and order used to describe diverse phenomena both in physical and economic situations. He further asserted that mathematics is a tool for use in science, technology and industries. This definition connotes that, all sciences draw their inspirations from mathematics and in fact mathematics is the language of the sciences. Ezeugo and Agwagah (2000) in their study looked at mathematics as a scientific tool in realizing the nation's scientific and technology aspirations. Also Usman (2002) consider mathematics as a subject that encroaches into all aspects of human endeavors and further described mathematics as the life wire in the studies of various disciplines. It is this importance of mathematics that has led the Federal Government of Nigeria to make the subject a compulsory from primary to the end of the senior secondary school. Nevertheless, the mathematics curriculum has experienced a lot of reforms; in line with the highlight given during the Edinburg conference of the International Congress of mathematics in August 1958. The reason for the suggested reforms was attributed to the great shortage in meeting the technical need for mathematicians, physicists, and engineers (Harbor-Peters, 1992). Nigeria was not left out in these reforms. After the approval of the senior secondary school mathematics curriculum, one of the criticisms labeled against the curriculum was that it did not carter for the brighter students who might choose careers in mathematics and mathematical science at the tertiary institutions. Consequently, it was during the critique workshops held at Onitsha and Jos in 1981 and 1984 respectively, that the further mathematics curriculum was developed and put to use in 1985. The purpose of the further mathematics curriculum was to carter for potential mathematicians, engineers and scientists.

Logic happened to be one of the contents of the further mathematics. 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 evidence. Egbeke (1992), Pointed out that, with the logical skills, the individual can avoid, attempt to mold or shape his belief, his buying habits, his political decision and social behavior as he comes across hidden persuaders, political or religious leaders and advertisers through their flowery rhetoric subtle and beguiling advertisements.

To Bosede (1992), the study of logic can make an individual know the difference between persuasion through various psychological techniques and those based on rational argument and supporting evidence. Hence, there is need for proper learning of logic. Despite the recognition accorded mathematics at all levels, it is unfortunate that most students' especially secondary school students exhibit nonchalant attitudes towards the subject. A study conducted by Nigeria Educational Research and Development Council (NERDC, 1997) on the performance of students in public examinations over some years has confirmed students' poor performance in physical sciences (mathematics, physics, and chemistry) which form the foundation of future work in the

technology needed in Nigeria. These attitudes reflect their in-attentiveness when mathematics class is going on. The result 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 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 the teachers' failure to use appropriate method of teaching Obodo (1990), Okoro (1993), Odogwu (1995) and Adebayo (2001).

Mathematics educators and teachers have tried varieties of teaching methods at their disposal which include; the synthetic method, analytic, deductive, inductive, heuristic, laboratory and guided inquiry methods to improve the learning of mathematics (Achele and Reys, 1974). 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.

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, formulating hypothesis, collection of data, verification of results, and generalization to the drawing of conclusions. Also Harbor-Peters (1998) pointed out that the guided inquiry teaching approach is techno-scientifically oriented. It places the leaner constructive mental ability first in all instructional processes. In other words, it is learner-centered. Also Corno and Edelstein (1985) and Joanne (1988) noted that the teacher who adopted the guided inquiry teaching approach uses leading or probing questions and instructional materials to guide the students towards possible solutions.

Also the guided inquiry teaching approach effectiveness has been investigated in some aspects of the sciences and mathematics. For instance, Timothy and Awodi (1997) on achievement of high and low achievers in senior secondary school Biology, Dagoli (1999) on students' achievement in Geometry which is an aspect of Mathematics and Kurumeh (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 the teaching of those aspects of the sciences and mathematics.

Also Obioma (1992) and Habor-Peters (1992) in their studies in, "Teachers Assessment of the difficulty levels of the further mathematics contents" and "Aspects of further mathematics that presents 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 student's achievement in logic is considered paramount. Furthermore, the

issue of parity and disparity in the performance of male and female students in mathematics has formed an important focus of research for some years now. This issue of gender disparity in mathematics performance of secondary school students was detected by Alio and Harbor-Peters (2000); in their studies with Polya's problem solving techniques, they discovered that notwithstanding the improvement in mathematics achievement recorded by the adoption of the technique, there existed a significant difference in the achievement of male and female students in favour of males. Also study conducted by Ezeugo and Agwagah (2000) revealed that male gender performed significantly better than their female counterparts in algebra both in the pretest and posttest of Algebra Achievement Test (AAT) used in concept mapping method. Ugwu (1998) and Olagunju (2001) found out that, the significant difference in performance between male and female students did not exist in their studies in geometric proof and "sex, age and performance in mathematics", respectively. Hence the need to find out whether the male and female students will benefit equally when the guided inquiry teaching approach is used in teaching logic is necessary.

Statement of the Problem
The performance of students in mathematics in Nigerian secondary school has been poor over the years. This problem of failure has always been attributed to the teacher's failure to use the appropriate method of teaching (Obodo: 1990, Okoro: 1995, Odogwu: 1995 and Adebayo: 2001). Olarinoye (1988) in his study established and re-affirmed that creative teaching approach that is learner-centered and problem solving should be adopted as solution to the problem of poor achievement. Would the use of guided inquiry teaching approach be effective in the teaching of logic in further mathematics? Let's confirm.

Since, Alio and Harbor-Peters (2000), Ezeugo and Agwagah (2000) and Jahun and Momoh (2001) in their respective studies ascertained that the male gender performed significantly better than their female counterpart, while Ugwu (1998) and Olagunju (2001) in their respective studies using the Target task and Delayed formalization discovery approach which is learned-centered, observed that the significant differences in performance in mathematics did not exist. Would the significant difference between male and female students not exist, if the guided inquiry teaching method that is learner-centered is used in teaching logic? Let's find out.

Purpose of the Study
The main purpose of this study is to investigate the effects of guided inquiry teaching method on students' achievement in logic.

Specifically, the study intends to:
Find out whether the male and female students will benefit equally when the guided inquiry teaching method is used in teaching logic.

Scope of the Study
The study was delimited to senior secondary school one (SSS1) students in Jalingo Education Zone of Taraba State. The topic covered was logic with statements, negations of statement, simple and compound statements, conjunction and disjunction of statement, conditional and bi-conditional statement, 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.

Research Questions
The following research questions guided the study.
To what extent does the guided inquiry teaching approach affect the mean achievement scores of male students and their female counterparts in logic achievement test?

Research Hypotheses
The following hypotheses were formulated and tested at (P [0.05) level of significance.
1. There is no significant difference between the mean achievement scores of male and female students who were taught logic using the guided inquiry teaching approach as measured by mean logic achievement test.
2. There is no significant interaction between the guided inquiry teaching approach and gender on students' achievement in logic.

Research Design
A quasi-experimental design was used for this study. The quasi experimental design was chosen for this study because it controls the internal validity threats of the initial group equivalence and researchers selection bias, since there is no randomization of the subjects into groups. Thus, the intact classes used were already organized into classes. This did not disrupt the school setting in terms of the seating arrangement and classroom schedules in order to accommodate the study.

Area of Study
The study was carried out in Jalingo Education Zone of Taraba State.

Population of the Study
The population for the study comprises of all SSS1 students in Jalingo Education Zone. The zone is made up of Seventeen (17) secondary schools with a population of 2,720 SSS1 students. One of these schools was a single sex (boys) school, while the remaining sixteen (16) were co-education schools.

Sampling and sampling techniques
The total number of subjects for this study was determined at the end of this study. This is because the actual number of subjects for the study depended on the number of students in each

of the ntact classes used. Therefore, a total of one hundred and ninety-seven (197) students were used in the study.

From the seventeen (17) secondary schools in Jalingo Education Zone, four schools were randomly selected. This was to allow a fair representation of schools in Jalingo Education Zone. These four schools were randomly assigned into experimental and control schools (i.e two experimental schools and two control schools). From the two experimental schools, one intact class was selected randomly from each. Similarly, one intact class each was selected randomly from the two control schools. Finally there were two intact classes from both the experimental and control schools respectively.

The students in the experimental intact classes were taught logic using guided inquiry teaching method, while those in the control intact classes were taught the logic using the conventional teaching method.

Instrument for Data Collection
One instrument was used for the study. This was the Logic Achievement Test (LAT). It consists of twenty (20) multiple choice questions and five (5) essay type questions. This instrument was developed by the researcher using a test blue-print and the unit lesson plans. The initial draft of the Logic Achievement Test instrument consisted of twenty-five (25) multiple choice questions and seven (7) essay type questions. Some of those items were re-structured or removed as a result of face validation and trail testing. A final draft of twenty (20) multiple choice and five (5) essay type items were then considered out of the initial poll.

The researcher was also guided by the objectives of each sub-topic (i.e. sections) on the in-depth the (LAT) items should cover. In each of the five sections, the questions were classified into three cognitive levels, namely; knowledge (k), comprehension (c) and higher cognitive process (HCP). The (LAT) items were used to assess students' cognitive achievement in the logic topics taught, both in pre-test and post-test. The test blue print used in drafting the instrument was developed by the researcher based on the emphasis on each sub-topic in the SSSI further mathematics curriculum.

Validation of the Instrument
The items in the (LAT) instrument were subjected to content and face validations. The content validation was ensured through strict adherence to the test blue print. In other words, the test items reflected all the detail on the test blue print. The (LAT) items were face validated by two experts in measurement and evaluation and three in mathematics education, all from the University of Nigeria, Nsukka.

Reliability of the Instrument
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. Using the Cronbach Alpha formula, the coefficient of reliability obtained was 0.78.

METHOD OF DATA ANALYSIS
The pretest and post test scores obtained from the administration of the (LAT) instrument was analyze using mean, standard deviation and analysis of covariance (ANCOVA) with two factors and the pretest scores as covariate. Borg and Gall (1983) and Ali (1996) stressed that ANCOVA is the most appropriate statistical tool for analyzing data on a pretest-posttest design, such as the design meant for this study. This statistical tool also serves as a technique for controlling extraneous variables and experimental contamination of subjects.

RESENTATION OF RESULTS

RESEARCH QUESTION:
The first research question of this study was meant to determine the main achievement scores of male and female students in the experimental group (i.e. those taught logic using the guided enquiry teaching method) on the Logic Achievement Test (LAT); the computed results for answering this research question is presented below

TABLE: 1
Pretest and Posttest Mean Achievement ($\overline{\times}$) and Standard Deviation (S.D) scores of Male and Female students in (LAT) Taught Logic Using Guided Inquiry Approach

Teaching Method	Type of Test	Male			Female		
		N	$\overline{\text{X}}$	S.D	N	$\overline{\text{X}}$	S.D
Guided	Pretest	66	13.94	6.87	31	14.00	7.16
Inquiry	Posttest		68.29	18.17		69.65	17.26
Conventional	Pretest	66	14.82	7.71	34	14.53	8.68
Method	Posttest		56.35	13.39		52.88	10.64

The result presented in the table above revealed that the pretest and posttest mean achievement scores of the male students in experimental group were 13.94 and 68.29 with standard deviation scores of 6.87 and 18.17 respectively. Furthermore, the pretest and posttest mean achievement scores of the female students in the experimental group were 14.00 and 69.64 with standard deviation scores of 7.16 and 17.26 respectively. The results also revealed that the pretest and posttest mean achievement scores of the female students were higher than that of their male counterparts irrespective of the teaching method use

Hypothesis: 1
There is no significant difference in the achievement scores of male and female students who were taught Logic using the guided inquiry teaching method as measured by mean Logic Achievement Test (LAT).

Hypothesis: 2
There is no significant interaction between teaching methods and gender on students' achievement in logic

TABLE 2:
Analysis of Covariance (ANCOVA) of Students Achievement Scores in (LAT) Taught Logic Using Guided Inquiry and Conventional Methods
Analysis

Source of Variation	Sum of squares	Degree of Freedom	Mean Square	F ration	Significant of F.
Covariates	10.119	1	10.119	0.43	0.836
Pretest	10.119	1	10.119	0.43	0.836
Main effect	8886.372	2	4443.187	18.951	0.000*
CONGRP	8821.727	1	8821.727	37.627	0.681[n.s]
Sex	39.652	1	39.652	0.169	0.277
2-way interaction	278.635	1	278.635	1.188	0.277[n.s]
(CONGRP/SEX)	278.635	1	278.635	1.188	0.000
Explained	9175.126	4	2293.781	9.784	
Residual	45249.081	193	234.451		
Total	54424.207	197	276.265		

* means significant
n.s means not significant

For null hypothesis 1, Table 1 revealed that gender has a computed F value of (0.169) at (P [0.05) level of significance while probability of F was P = 0.681 which is far more than (P [0.05. This is not significant. Based on the above result the researcher fail to reject hypothesis1; because there is no significant difference in the mean achievement of male and female student taught logic with guided inquiry teaching method.

For null hypothesis 2, the data in the Table 2 revealed that the computed F value at (P [0.05) level of significance is 1.188. The probability of F was P = 0.277 which is far more than the significant level of P [0.05. Based on this result, the null hypothesis of no significant interaction is retained. This implies that there was no significant interaction between teaching methods and gender of students on Logic Achievement Test.

SUMMARY OF FINDINGS
On the basis of the obtained data above, the findings of this study are summarized thus:
1. The mean achievement scores of male students were not significantly better than that of their female counterparts, irrespective of the teaching method. Specifically, there was no significant difference in the mean achievement scores of male and female students who were taught using the guided inquiry teaching approach.
2. There was no significant interaction effect between teaching methods and gender on cognitive achievement in logic

DISCUSSION OF RESULTS, CONCLUSION AND SUMMARY
The analysis of the result presented in table 2 shows that the mean achievement scores of the male students and their female counterparts were not significant using the same teaching method. It was found that the male and female students performed equally, when taught using guided inquiry teaching method. This finding is consistent with those of Ugwu (1998) and Olagunju (2001) who found out that the significant difference in performance between male and female students do not exist in their studies in geometric proof and sex, age and performance in mathematics respectively. But it disagreed with the findings of Alio and Harbor-Peters (2000) and Ezeugo and Agwagah (2000) whose investigation showed that the male students performed significantly better than their female counterparts in mathematics irrespective of the method of instruction adopted.

Finding from the study also revealed that there is a non-significant interaction effect between teaching method and gender of students on cognitive achievement in logic. This method implies that method and gender did not produce a combined effect on the mean achievement scores obtained by students in the (LAT); that is neither, the gender of the students nor the teaching method adopted did not make any significant difference in the achievement of (LAT).

CONCLUSION OF THE STUDY
Based on the findings and discussion of this study, the following conclusions were made;
1. There was no significant difference in the mean achievement scores of male and female students taught logic using the same method, either guided inquiry or conventional method. The male and female students performed equally when taught using the guided inquiry teaching method
2. There was no significant interaction between teaching method adopted and gender on achievement in logic.

Educational Implications of the Study
It has been found from this study that, teaching methods are significant factors influencing students' cognitive achievement in logic. The findings also revealed that guided inquiry teaching method promoted students' achievement far more than the Conventional method of teaching logic.
The findings of this study have implications for the government, teachers and students.

The implication of this finding to the government (federal and State ministries of education, teaching service boards and zonal education offices) is that, they should encourage and motivate mathematics teachers by providing mathematics teachers allowance, regular payment of salaries and allowances, prompt payment of leave grant and other benefits. Government should also sponsor and organize workshops, seminars, conference and in-service training programmes on teaching methods that are leaner-centred and activity oriented (guided inquiry/Discovery), since the teachers are not generally trained in this area. Government should also encourage and motivate the teachers generally and mathematics teachers in particular 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 topics in mathematics and further mathematics curricula, such as construction, geometric proof, vectors, logic and dynamics (Obioma; 1992). As revealed, 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 irrespective of their gender. The mathematics teachers should be resourceful, hardworking, creative and initiative in order to use the guided inquiry teaching method effectively. Mathematics teachers should also 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 a student centred approach, it demands seriousness, practice and hardworking on the part of the students. As they interact with the instructional materials and get actively involved in the activities, the problem solving abilities (critical thinking and creative abilities) are developed. Hence, the experienced gained could be transferred to a similar or related problem situation.

Recommendations
On the basis of the implication of the study, the following recommendations were made.
1. The government through the federal and state ministries of education should organize and sponsor mathematics workshop, exhibitions, seminars and conferences on a regular basis. This is to upgrade the knowledge of the teachers; exposing and drilling them on the use of innovative or activity oriented teaching methods, such as the guided inquiry teaching method. Hence there is need for general orientation of science and mathematics teachers on the utilization of guided inquiry teaching method.
2. 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 the students.

3. School authorities in collaboration with the ministries of education and teaching service boards should establish mathematics laboratories in all primary and secondary schools. The laboratories should be well equipped with adequate instructional materials for both teachers and students in their daily mathematics lessons. These will motivate both teachers and students in facilitating the implementation of new innovative or activity oriented teaching methods, especially the guided inquiry teaching method, as well as enhances students' achievement in the subject.
4. Students should be hardworking, serious, initiative and creative to enable them execute independent or group work, such as assignments or projects given to them by the mathematics teachers. These are necessary in guided-inquiry teaching-learning processes.

Limitation of the Study
Certain factors tend to limit the generalization of the findings of this study these factors include:
1. Lack of randomization of the subjects into experimental and control groups. Instead intact classes were used. This might have affected the result.
2. The administration of a test before treatment might have sensitized the students in the posttest. That is, the pretest, regardless of whether there was any treatment or time lapse in between the two test or not. This might have affected the generalization of this study.
3. The mathematics teachers used in the study were the regular mathematics teachers of the sampled schools. In their selection, factors like academic qualification, gender, attitude and personality were not considered. Therefore these might have affected the results of this study.
4. This study was limited to one Education Zone (Jalingo Education Zone) out of the Seven Education Zones of Taraba State. The researcher further limited the sample to four intact classes in four senior secondary schools out of seventeen senior secondary schools in Jalingo Education Zone with a population of 2720 students. Also environmental factors such as school location were not considered. Therefore, different results might have been obtained, if the researcher used other schools or different Education Zones. These might have affected the generalization of the findings of this study.
5. The sample size used for the study was not large enough, only 197 out of 2720 SSSI students were used. This might have affected the result of this study.

SUMMARY OF THE STUDY
The main purpose of this study was to investigate the effects of guided inquiry teaching method on students' achievement in logic. In carrying out this study, two research questions were posed and two null hypothesis were formulated and tested at (P [0.05) level of significance. The first research question was intended to ascertain the extent of achievement of students in the experimental group to that of the control group using the mean achievement scores of students taught logic using guided inquiry and those taught using the conventional method.

The second research question was meant to find out the mean achievement scores of male and female counterparts who were taught logic using the guided inquiry teaching method. The two null hypotheses tested are restated thus:

1. There is no significant difference in the mean achievement scores of male and female students who were taught logic using the guided inquiry teaching method
2. There is no significant interaction between teaching method and gender of students on Logic Achievement Test

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