

## COMPARATIVE EFFECT OF GUIDED, UNGUIDED AND STRUCTURAL INQUIRY TEACHING METHODS ON SENIOR SECONDARY SCHOOL STUDENTS' RETENTION IN TRIGONOMETRY

By

Alio B.C.<sup>1</sup>, Anibueze C.O.<sup>2</sup>, Ayogu D.I.<sup>3</sup>

*Department of Mathematics and Computer Education, Enugu State University of Science and Technology, Enugu, Department of Science Education, University of Nigeria Nsukka  
anibueze.chigozie@yahoo.com*

### Abstract

*The study determined the comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students' retention in trigonometry. The study was guided by two (2) research questions and four (4) research hypotheses. The design of this study was non-equivalent quasi-experimental research. The sample size of the study was Four hundred and fifty-six (456) Senior Secondary School Students One (SSS 1) in the three (3) sampled coeducational secondary schools in Enugu Education zone. Trigonometry Achievement Test (TAT) was the instrument that was used for data collection, which underwent face validation only and was reliable with the K-R20 coefficient of 0.78. Mean ( $\bar{x}$ ) and standard deviation ( $s$ ) were used in answering the research questions. Analysis of Covariance (ANCOVA) was used in testing the research hypotheses at 0.05 alpha levels. The study discovered among the four teaching methods (Guided, Unguided and Structural Inquiry Teaching methods, and Expository teaching method) that were used in this study, only the students that taught trigonometry using the Guided Inquiry teaching method had an improvement in their mean retention scores and had the highest mean retention score. Finally, the study discovered that the female students had higher posttest and retention mean scores than their male counterparts and the differences were significant. The study recommended that parents and mathematics should adopt Guided Inquiry Teaching method when teaching students Trigonometry in order to boost the students' retentive memory in trigonometry.*

### Introduction

In a modern society, mathematics education is an important part of life-long education. It builds up the foundation for the citizens to further themselves, and is needed for one's life-long development. Mathematics occupies a special position in school education. This is because according to Ukadike (1997), mathematics is applied to all other human activities including school science and technology based subjects. It enables students to grasp fundamental knowledge, basic skills, and basic ideas in mathematics, as well as develops students to express clearly and think systematically, so as to enable students to possess realistic and practical attitudes, and spirits of perseverance. Students learn how to deploy mathematics thinking methods to solve problems and know the world they live in. According to Anibueze (2018), mathematics is a vital gateway for students to triumph over the other subjects particularly for science subjects.

Yet, mathematics is a subject that is mostly failed in schools especially in secondary schools (Anibueze, 2017). Hence, Ndukwe (2018) revealed that one of the factors that affect students' achievement in mathematics is students' retention. This is because retention is the ability to remember things. Nneji (2011) affirmed that retention is the ability for someone to remember what one was taught after an interval of time. Retention is the act or process of holding what has been absorbed or assimilated. Ndukwe (2018) defined retention as the act of

“absorbing and holding” or to continue having or holding”. Stone, Zubby & Bill (2011) asserted that failure to provide enough applications to real life activities and social usage cum poor teaching techniques are strong limiting factors to students’ retention in mathematics. Eze and Egbo (2007) reported that a teaching method that promotes meaningful learning enhances the retention of the concept by the learners. It is common for a student to learn material, take a test and forget the materials soon after. This is a challenge that needs to be tackled by mathematics educators and researchers (Ndukwe, 2018). Based on this Ndukwe (2018)’s assertions, the researchers decided to embark on a study to determine the comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students’ retention in trigonometry.

Inquiry Teaching method is a term used in science teaching that refers to a way of questioning, seeking knowledge, information or finding out about phenomena, it involves investigating data and arriving at a conclusion (Sola and Ojo, 2007). Yagger and Akcay (2010) defined inquiry teaching method as an approach to teaching, the acts scientists use in doing science and it can be a highly effective teaching method that helps students to understand concepts and use of process skills. In inquiry situation, students learn not only concept but also self-direction, responsibility and social communication. It also permits students to assimilate and accommodate information. It is the way people learn when they are left alone. Cheval and Hart (2015) classified inquiry teaching method into three (3) classes, namely: structured inquiry, guided inquiry and unguided/open inquiry. All these types of inquiry can be useful to students to learn science when taught appropriately.

Cheval and Hart (2015) revealed that structured inquiry is the most teacher-centered of the three types of inquiry. This type of inquiry is commonly seen in science classrooms in the form of laboratory exercises. The teacher provides fairly structured procedures for the inquiry activity, and students carry out the investigations. Structured inquiry could be described as the most traditional approach to inquiry (Cheval and Hart, 2015). The Unguided/open inquiry on the other side is a type of inquiry which requires the least amount of teacher intervention and is student centered (Yagger and Akcay, 2010). Students, in this case, often work in groups and plan all phases of their investigations, while guided inquiry falls in the middle of the inquiry instructional spectrum. This type of inquiry is commonly used when students are asked to make tools or develop a process that results in a desired outcome (Omokaadejo, 2015). For example, a science teacher gives his seventh grade middle school students materials to create a rocket but no instructions for designing the rocket. The students must use their own knowledge and creativity to design the rocket so that it will launch properly, fly a certain distance, and land without becoming disassembled. The teacher provides the problem and materials and the students develop the rocket using their own scientific process or procedure (Cheval and Hart, 2015). Since that the educational authors are opining that the three classes of Inquiry Teaching Method improves students’ achievement, hence, there is need to determine if anyone type improves students’ retention more than the other. Thus, this study determined comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students’ retention in trigonometry.

Trigonometry is a branch of mathematics that is very important topic in the secondary school mathematics curriculum that is taught early and that links all the branches of mathematics that are taught in secondary schools such as algebraic, geometric, number and numeration, statistics and graphical reasoning (Vajiac & Snow, 2019). Trigonometry can serve as an important precursor to calculus as well as college/university level courses (Weber, Knott, & Evitts, 2008). Unfortunately, many students do not experience the richness,

connections or creativity that trigonometry allows, instead they often perceive it as another memory exercise where rules and formulae must be learnt by rote, along with methods for working out problems (Umar & Ibrahim, 2018). Hence, there is need to determine if Inquiry Teaching method can make students experience the richness of trigonometry. Therefore, this study determined comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students' retention in trigonometry. Also, this study shall determine the influence of gender on the retention of students that are taught trigonometry using guided, unguided and structural inquiry teaching methods.

### **Statement of the Problem**

Mathematics is a subject that is mostly failed in schools especially in secondary schools. Scholars have revealed that one of the factors that affect students' achievement in mathematics is students' retention which is affected by teachers' methodology. This is because retention is the ability to remember things and without retention, there will be no achievement but good teaching method promotes meaningful learning which enhances the retention of the concept by the learners. This has prompted so many researchers to introduce some innovations which are discovery, expository, laboratory, concept mapping, computer-aided instruction, analogy method, Inquiry, etc. All these innovations have been tried in Mathematics and have be found to be effective but no research work ever known by the researchers have investigated on the effect of Inquiry Teaching Methods in Mathematics. Hence, there is a need for the researchers to investigate the comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students' retention in trigonometry. The researchers choose to concentrate on trigonometry because trigonometry is a branch of mathematics that is very important topic in the secondary school mathematics curriculum that is taught early and that links all the branches of mathematics that are taught in secondary schools such as algebraic, geometric, number and numeration, statistics and graphical reasoning and it also serve as an important precursor to calculus as well as college/university level courses.

### **Purpose of the Study**

The main aim of the study was to determine the comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students' retention in trigonometry. Specifically, the study determined the;

1. The comparative between students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods.
2. Male and Female students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods.

### **Research Questions**

1. What is the comparative between the mean retention scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods?
2. What are the mean retention scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods?

### **Research Hypotheses**

The following research hypotheses which were tested at 0.05 levels of significance guided the study.

- H0 1: There is no significant difference between the mean retention and posttest achievement scores of students that are taught Trigonometry.
- H0 2: There is no significant comparison between the mean retention scores of students that are taught Trigonometry using inquiry teaching methods and the expository methods.
- H0 3: There is no significant comparison between the mean retention scores of male and female students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods.
- H0 4: There is no significant interaction between gender of students and the methods on students' retention scores in Trigonometry.

### **Research Methods**

The design of this study was non-equivalent quasi-experimental research. This study was conducted in secondary schools in Enugu Education zone of Enugu State. The population of the study was three thousand nine hundred and thirty-six (3936) Senior Secondary School students. Simple random sampling method was used to sample three (3) out of twenty-one (21) coeducational schools in Enugu education zone. The sample size of the study was Four hundred and fifty-six (456) Senior Secondary School Students One (SSS 1) in the three (3) sampled coeducational secondary schools in Enugu Education zone. In each of the sampled coeducational school, simple random sampling was used to sample one (1) intact class for Experimental group 1 (Guided Inquiry Teaching Method), one (1) intact class for Experimental group 2 (Unguided Inquiry Teaching Method), one (1) intact class for Experimental group 3 (Structural Inquiry Teaching Method) and one (1) intact class for Control group.

Hence, the researcher sampled one hundred and eleven (111) students in Experimental group 1 (Guided Inquiry Teaching Method), one hundred and eighteen (118) students in Experimental group 2 (Unguided Inquiry Teaching Method), one hundred and fourteen (114) students in Experimental group 3 (Structural Inquiry Teaching Method) and one hundred and thirteen (113) students in Control group (Expository method). The researcher made use of coeducational secondary schools because gender was a research variable in this study so that this study can have a base for comparison. This study sampled coeducational secondary schools that have more than four classes because this study had three research treatments which this study shall use. Trigonometry Achievement Test (TAT) was the instrument that was used for data collection, which underwent face validation only and was reliable with the K-R20 coefficient of 0.78.

The researcher trained twelve (12) research assistants (which comprised of 4 mathematics teachers from each school). The research assistants received training from the researcher based on the group they were placed in for a period of four (4) weeks (once in a week). After the training, the researcher gave each of them lesson notes based on his/her group. The experiment lasted for four weeks. At the end of the fourth week, post TAT was administered to the students by the research assistants. Two weeks after, retention-TAT was administered. The researcher marked both the post test and retention-test of TAT and recorded them accordingly. The Mean ( $\bar{x}$ ) and standard deviation ( $s$ ) were used in answering the research questions. Analysis of Covariance (ANCOVA) was used in testing the research

hypotheses at 0.05 alpha levels. The null hypothesis ( $H_0$ ) was rejected if the significance of F (value of the test statistics) was less than 0.05, otherwise do not reject at 0.05.

### Data Analyses

**Question 1:** What is the comparative between the mean retention scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods?

**Table 1: The Mean Retention Scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods (ITM)**

Groups	Number	Post-test		Retention-test	
		Mean ( $\bar{x}$ )	Standard Deviation ( $s$ )	Mean ( $\bar{x}$ )	Standard Deviation ( $s$ )
Guided ITM	111	61.59	16.70	63.40	15.85
Unguided ITM	118	61.07	15.41	52.47	11.78
Structural ITM	114	63.11	16.45	62.73	15.13
Expository	113	55.83	15.43	55.62	14.85
<b>Total</b>	<b>456</b>	<b>60.41</b>	<b>16.18</b>	<b>58.56</b>	<b>15.10</b>

Table 1 above displayed the Mean Retention Scores of students that were taught Trigonometry using guided, unguided and structural inquiry teaching methods (ITM). Table 1 revealed that the posttest mean score of students that were taught Trigonometry using Guided Inquiry Teaching method was 61.59 with a standard deviation of 16.7, the posttest mean score of students that were taught Trigonometry using Unguided Inquiry Teaching method was 61.07 with a standard deviation of 15.41, the posttest mean score of students that were taught Trigonometry using Structural Inquiry Teaching method was 63.59 with a standard deviation of 15.43, while the posttest mean score of students that were taught Trigonometry using Expository method was 55.83 with a standard deviation of 15.43 whereas the retention mean score of students that were taught Trigonometry using Guided Inquiry Teaching method was 63.40 and a standard deviation of 15.85, the retention mean score of students that were taught Trigonometry using Unguided Inquiry Teaching method was 52.47 and a standard deviation of 11.78, the mean retention scores of students that were taught Trigonometry using Structural Inquiry Teaching method was 62.73 and a standard deviation of 15.13 while the posttest mean score of students that were taught Trigonometry using Expository method was 55.62 with a standard deviation of 14.85.

Also, the table revealed that the students' retention scores were lower than the students' posttest achievement scores. The study discovered that at posttest, the mean score of students that were taught Trigonometry was 60.41 with a standard deviation of 16.18 and at retention test, the mean score of students that were taught Trigonometry was 58.72 with a standard deviation of 15.10. However, the higher mean posttest achievement scores of students that were taught Trigonometry may be neglected. This is because the mean difference between the retention-test score of students that were taught Trigonometry and the posttest mean score of students was 1.69 and the standard deviation difference between the retention-test score of students that were taught Trigonometry and the posttest mean score of students was 1.08.

**Question 2:** What are the mean retention scores of male and female students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods?

**Table 2: The Mean Retention Scores of Male and Female students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods (ITM)**

Gender	Number	Post-test		Retention-test	
		Mean ( $\bar{x}$ )	Standard Deviation ( $s$ )	Mean ( $\bar{x}$ )	Standard Deviation ( $s$ )
Guided ITM	60	57.88	16.20	60.18	15.39
Unguided ITM	64	61.98	15.05	52.78	11.43
Structural ITM	62	63.15	15.19	62.97	15.91
<b>Males</b>	<b>186</b>	<b>61.00</b>	<b>15.48</b>	<b>58.64</b>	<b>14.24</b>
Guided ITM	51	65.94	16.38	67.18	15.70
Unguided ITM	54	59.98	15.91	52.09	12.27
Structural ITM	52	58.58	15.40	62.44	14.28
<b>Females</b>	<b>157</b>	<b>61.50</b>	<b>15.90</b>	<b>60.57</b>	<b>14.08</b>

Table 2 above displayed the Mean Retention Scores of male and female students that were taught Trigonometry using guided, unguided and structural inquiry teaching methods (ITM). Table 2 revealed that the posttest mean score of male students that were taught Trigonometry using Inquiry Teaching method was 61.00 with a standard deviation of 15.48 while the posttest mean score of female students that were taught Trigonometry using Inquiry Teaching method was 61.50 with a standard deviation of 15.90 whereas the retention mean score of male students that were taught Trigonometry using Guided Inquiry Teaching method was 58.64 and a standard deviation of 14.24 while the retention mean score of male students that were taught Trigonometry using Inquiry Teaching method was 60.57 with a standard deviation of 14.08.

From the study, the study discovered that the female students had higher posttest and retention mean scores than their male counterparts but their male counterparts had smaller standard deviation both in the posttest and retention. Also, the table revealed that the male and female students' retention scores were lower than the male and female students' posttest achievement scores.

### Analyses of the Research Hypotheses

The four (4) null hypotheses were tested at 0.05 levels of significance using ANCOVA.

**Table 3: Analysis of Covariance (ANCOVA) on the Mean Scores of Students**

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	102743.312 <sup>a</sup>	8	12842.914	5424.445	.000	
Intercept	622.593	1	622.593	262.964	.000	
Postachievement	91021.802	1	91021.802	38444.763	.000	S
GROUPS	7605.184	3	2535.061	1070.731	.001	S
GENDER	21.993	1	21.993	9.289	.002	S
GROUPS * GENDER	70.803	3	23.601	9.968	.000	S
Error	1058.317	447	2.368			
Total	1676187.000	456				
Corrected Total	103801.629	455				

a. R Squared = .990 (Adjusted R Squared = .990)

Table 3 above showed the Analysis of Covariance (ANCOVA) on the Mean Scores of Students. The Table 3 shall be used to answer all the null hypotheses.

**H0 1:** There is no significant difference between the mean retention and posttest achievement scores of students that are taught Trigonometry.

From the result of ANCOVA in table 3, it was observed that Postachievement which was the main effect gave an f-value of 38444.76 and was significant at 0.000. Since 0.000 was less than 0.05, this meant that at 0.05 level, the f-value was significant. Therefore, hypothesis 1 was rejected. Hence, the study concluded that there was significant difference between the mean retention and posttest achievement scores of students that are taught Trigonometry.

**H0 2:** There is no significant comparison between the mean retention scores of students that are taught Trigonometry using inquiry teaching methods and the expository methods.

From the result of ANCOVA in table 3, it was observed that Groups which was the main effect gave an f-value of 1070.73 and was significant at 0.001. Since 0.001 was less than 0.05, this meant that at 0.05 level, the f-value was significant. Therefore, hypothesis 2 was rejected. Hence, the study concluded that there was significant comparison between the mean retention scores of students that are taught Trigonometry using inquiry teaching methods and the expository methods.

**H0 3:** There is no significant comparison between the mean retention scores of male and female students that are taught Trigonometry using guided, unguided and structural inquiry teaching methods.

From the result of ANCOVA in table 3, it was observed that Gender which was the main effect gave an f-value of 9.289 and was significant at 0.002. Since 0.002 was less than 0.05, this meant that at 0.05 level, the f-value was significant. Therefore, hypothesis 3 was rejected. Hence, the study concluded that there was significant comparative between the mean retention scores of students that were taught Trigonometry using inquiry teaching methods.

**H0 4:** There is no significant interaction between gender of students and the methods on students' retention scores in Trigonometry.

From the result of ANCOVA in table 3, it was observed that Groups\*Gender which was the main effect gave an f-value of 9.268 and was significant at 0.000. Since 0.000 was less than 0.05, this meant that at 0.05 level, the f-value was significant. Therefore, hypothesis 4 was rejected. Hence, the study concluded that there was significant interaction between gender of students and the methods on students' retention scores in Trigonometry.

### **Major Findings**

The study discovered the followings:

1. The students' mean retention scores were lower than the students' mean post-achievement scores except those students that were taught trigonometry using the Guided Inquiry Teaching method and, the difference was significant.
2. The mean retention score of students that were taught Trigonometry using Guided Inquiry Teaching method was highest followed by those taught using Structural Inquiry Teaching method, then followed by those taught using Expository method and finally followed by those taught using Unguided Teaching method and the differences were significant.

3. The female students had higher posttest and retention mean scores than their male counterparts and the differences were significant. Hence, there was significant difference between the mean retention scores of male and female students that were taught Trigonometry using inquiry teaching methods and there was also significant interaction between gender of students and the method on students' Trigonometry scores.

### **Discussion of the Findings**

The study determined the comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students' retention in trigonometry. The study was guided by two (2) research questions and four (4) research hypotheses. The study discovered among the four teaching methods (Guided, Unguided and Structural Inquiry Teaching methods, and Expository teaching method) that were used in this study, only the students that taught trigonometry using the Guided Inquiry teaching method had an improvement in their mean retention scores. In the other three teaching methods, the students' mean retention scores were lower than the students' mean post-achievement scores and, the difference was significant. The study also discovered that the students that were taught Trigonometry using Guided Inquiry Teaching method had the highest mean retention score followed by those students that were taught Trigonometry using Structural Inquiry Teaching method and these differences were significant. Vygotsky (1978) advocated that people retain best when guided. This is because according to Cheval and Hart (2015), in Guided Inquiry Teaching method, the teachers provide the problem and materials and the students develop them using their own scientific process or procedure.

Finally, the study discovered that the female students had higher posttest and retention mean scores than their male counterparts and the differences were significant. The study also discovered that there was also significant interaction between gender of students and the method on students' Trigonometry scores. This finding agreed with the findings of Ogunkunle (2007) whose report revealed there is significant difference between the mean retention scores of male and female students in mathematics but the difference is in favour of female students. This finding opposes the findings of Ozomadu (2006) who revealed no significant interaction between teaching method and gender on students' retention in mathematics.

### **Conclusion**

The study determined the comparative effect of guided, unguided and structural inquiry teaching methods on senior secondary school students' retention in trigonometry. The study was guided by two (2) research questions and four (4) research hypotheses. The design of this study was non-equivalent quasi-experimental research. The study discovered among the four teaching methods (Guided, Unguided and Structural Inquiry Teaching methods, and Expository teaching method) that were used in this study, only the students that taught trigonometry using the Guided Inquiry teaching method had an improvement in their mean retention scores. In the other three teaching methods, the students' mean retention scores were lower than the students' mean post-achievement scores and, the difference was significant. The study also discovered that the students that were taught Trigonometry using Guided Inquiry Teaching method had the highest mean retention score followed by those students that were taught Trigonometry using Structural Inquiry Teaching method and these differences were significant. Finally, the study discovered that the female students had higher posttest and retention mean scores than their male counterparts and the differences were



significant. The study also discovered that there was also significant interaction between gender of students and the method on students' Trigonometry scores.

### **Recommendations:**

Considering the findings in this study, the following recommendations are made:

1. Parents and mathematics should adopt Guided Inquiry Teaching method when teaching students Trigonometry in order to boost the students' retentive memory in trigonometry.
2. Seminars and workshops on Guided and Structural Inquiry Teaching methods should be organized by government and school authorities for parents and mathematics teachers through the Parent Teachers Association (PTA) forum.
3. Mathematics teachers and parents should ensure that there is no gender discrimination in Trigonometry lesson class or home.

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