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DIFFERENTIAL EFFECT OF GUIDED, UNGUIDED AND STRUCTURAL INQUIRY TEACHING STRATEGIES ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND INTEREST IN TRIGONOMETRY

by

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Abstract

The study determined the differential effect of guided, unguided and structural inquiry teaching strategies on senior secondary school students' retention in trigonometry. The study was guided by two (2) research questions and two (2) 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) and Trigonometry Interest Scale (TIS) were the instruments that were used for data collection, which underwent face validation only and were reliable with the K-R20 coefficient of 0.78 and Cronbach Alpha of 0.74 respectively. 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 that the students that taught trigonometry using the Structural Inquiry teaching Strategy had the highest posttest mean achievement and interest scores and secondly, the students that were taught trigonometry using the Unguided Inquiry teaching Strategy had the second highest posttest mean achievement and interest scores and the differences were significant. The study then recommended that parents and mathematics teachers should adopt Structural Inquiry Teaching strategy (ITS) and then can supplement it with Unguided Inquiry Teaching strategy (ITS) when teaching students Trigonometry in order to boost the students' achievement and interest in trigonometry.

Introduction

Trigonometry is important topic in the secondary school mathematics curriculum that is taught early and that links algebraic, geometric, 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). It provides an opportunity to link what is observed in real life with the world of the trigonometry classroom. It gives students good practice in employing the algebraic skills and most importantly, it benefits students' thinking processes (Gurat & Sagun, 2018). Trigonometry not only plays a very important role in secondary curriculum; it is also tragicomically rich, it links concepts about shape and space with other mathematical ideas such as ratio, deduction and mathematical proof (Anibueze, 2018).

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). Kotsopoulos (2017) discovered that in mathematics classroom where trigonometry is taught, 20% of students talked at a time and the rest of the 80% are not talking at all. Gurat & Sagun (2018) reported that students are having difficulties in solving trigonometry. When students do not succeed in problem solving they may feel bad and cause them to avoid math in the future (Tambychick & Meerah, 2010). Since students cannot get the topic, they do not

have any time as the teacher moves on the next topic (Gallup, 2005). One factor that could affect the students in learning trigonometry is the instructional strategy used by the mathematics teacher (Andaya, 2014; Gurat & Sagun, 2018). One of the strategies that the researchers want to determine its efficacy in the teaching of trigonometry is Inquiry Teaching Strategy.

The choice of inquiry teaching strategy was based on the fact that among all innovative teaching strategies, inquiry teaching strategy is the type of teaching strategy whose philosophy is heavily rooted in the works of some cognitive theorists like Jean Piaget, John Dewey, Vygotsky and Preire, Immanuel Kant, John Locke, among others (Kirshner, Sweller & Clark, 2006); Aniaku, 2012; Shittu, 2013; Omokaadejo, 2015). The inquiry teaching strategy is a learning process which seems to increase students' level of involvement in the teaching and learning of Trigonometry. It may also expose the students to the multiple ways of learning the concepts in Trigonometry and enable the students to pass through the sequential phases of cognition which seems to accommodate learning and cognition differences among students. Kuhlthau, Maniotes and Caspari (2007) defined this strategy as an approach to learning whereby students find and use a variety of sources of information and ideas to increase their understanding of a problem, topic or issue. Aniaku (2012) revealed that this strategy is a teaching method that encourages learners to apply scientific process to explore and construct meaningful knowledge and skills. One of the major objectives of inquiry teaching strategy is to encourage investigation in students. When students are encouraged to investigate into natural phenomena, a meaningful and relevant knowledge is constructed and sustained.

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. 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).

Seckers (2002), Guisti (2008), Bilgin (2009), Aniaku (2012) & Kiener (2015) in their separate studies adopted a type of Inquiry teaching strategy as the best Inquiry teaching strategy. Guisti (2008), Bilgin (2009) & Aniaku (2012) supported the use of Guided Inquiry teaching strategy as the best Inquiry teaching strategy; Seckers (2002) supported the use of Unguided Inquiry teaching strategy as the best Inquiry teaching strategy; while Kiener (2015) adopted the use of Structural Inquiry teaching strategy as the best Inquiry teaching strategy. Their adoptions are heavily backed up by educational/philosophical scholars.

Bruner (1961), Dewey (1971), Piaget (1977) and Guisti (2008) advocated that people learn best in an unguided or minimally guided environment which makes the learner instead of being presented with essential information, discovers or constructs for himself or herself information. In other words, Dewey (1971) stated that for a student to learn, he should be subjected to a problem, and the student should be provided with necessary materials and left alone (unguided) to find the solution to the problem. In support of these assertions, Piaget (1977) revealed that the child's achievement might be enhanced if he is allowed ample opportunity to act on the environment in unrestricted (that's unguided but safe) ways in order to start building concepts.

On the other hand, Vygotsky (1978), Mayer (2004) and Kirshner, Sweller & Clark (2006) advocated that people learn best when guided. In line with this assertion, Vygotsky (1978) stated that the child acquires knowledge through contacts (that is through guided learning) and interactions with people as the first step (interpsychological plane), then later assimilates and internalizes this knowledge, adding his personal value to it (intrapsychological plane) while Immanuel Kant (1938) stated that a child learns best when the learner's education is structured. According to this philosopher, a child learns best when he is guided to an extent and then allowed (unguided) to explore his inmate abilities. This is because it is nature and nurture that forms a child's education (Kiener, 2015).

In view of these arguments, the present study intends to contribute to this educational debate by trying to identify which of the inquiry teaching strategies, guided, unguided or structured inquiry, will have more effect in enhancing students' achievement and interest in Trigonometry. Hence, this study determined the differential effect of guided, unguided and structured inquiry teaching strategies on students' achievement and interest in Trigonometry since that the educational authors are opining that the three classes of Inquiry Teaching Method improves students' achievement and interest.

Purpose of the Study

The main aim of the study was to determine the differential effect of guided, unguided and structural inquiry teaching strategies on senior secondary school students' achievement and interest in trigonometry. Specifically, the study determined the mean;

1. Achievement scores of Students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies.
2. Interest scores of Students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies.

Research Questions

1. What are the mean achievement scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies and the expository methods?
2. What are the mean Interest scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies and the expository 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 achievement scores of students that are taught Trigonometry using inquiry teaching strategies and the expository methods.

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

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 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. 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). Trigonometry Achievement Test (TAT) and Trigonometry Interest Scale (TIS) were the instruments that were used for data collection, which underwent face validation only and were reliable with the K-R20 coefficient of 0.78 and Cronbach Alpha of 0.74 respectively. 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.

Data Analyses

Question 1: What are the mean achievement scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies (ITS) and the expository methods?

Table 1:The Mean Achievement Scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies (ITS) and Expository method

Groups	**Number**	**Pretest**		**Posttest**	
		Mean ($\bar{x}$)	**Standard Deviation (s)**	**Mean ($\bar{x}$)**	**Standard Deviation (s)**
Guided ITS	111	52.96	14.60	61.59	16.70
Unguided ITS	118	54.44	14.08	61.07	15.41
Structural ITS	114	53.05	14.65	63.11	16.45
Expository	113	51.57	14.34	55.83	15.43
Total	**456**				

Table 1 above displayed the Mean Achievement Scores of students that were taught Trigonometry using guided, unguided and structural inquiry teaching strategies (ITS) and the expository methods. Table 1 revealed that the pretest mean score of students that were taught Trigonometry using Guided Inquiry Teaching method was 52.96 with a standard deviation of 14.60, the pretest mean score of students that were taught Trigonometry using Unguided Inquiry Teaching method was 54.44 with a standard deviation of 14.08, the pretest mean score of students that were taught Trigonometry using Structural Inquiry Teaching method was 53.05 with a standard deviation of 14.65, while the pretest mean score of students that were taught Trigonometry using Expository method was 51.57 with a standard deviation of 14.34 whereas the posttest mean score of students that were taught Trigonometry using Guided Inquiry Teaching method was 61.59 and a standard deviation of 16.70, the posttest mean score of students that were taught Trigonometry using Unguided Inquiry Teaching method was 61.07 and a standard deviation of 15.41, the posttest mean scores of students that were taught Trigonometry using Structural Inquiry Teaching method was 63.11 and a standard deviation of 16.45 while the posttest mean score of students that were taught Trigonometry using Expository method was 55.83 with a standard deviation of 15.43.

The study revealed that the mean achievement scores of students that were taught Trigonometry using Guided and Structural Inquiry Teaching Strategies (ITS) were not homogenous particularly that of students that were taught Trigonometry using the Guided Inquiry Teaching method. This is because the posttest standard deviations of students that were taught Trigonometry using Guided and structural Inquiry Teaching Strategies were very high (16.45 – 16.70). Finally, the table 1 revealed that the students that were taught Trigonometry using Structural Inquiry Teaching Strategy (ITS) had the highest posttest mean achievement score followed by the students that were taught Trigonometry using Guided and Unguided Inquiry Teaching Strategies (ITS). However, the difference between the posttest mean achievement scores of students that were taught using Guided and Unguided may be neglected. This is because the mean difference is 0.52 and the students in Unguided Inquiry Teaching Strategy had smaller standard deviation.

Question 2: What are the mean interest scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies (ITS) and Expository method?

Table 2: The Mean Interest Scores of students that are taught Trigonometry using guided, unguided and structural inquiry teaching strategies (ITS) and Expository method

Groups	Number	Pretest		Posttest	
		Mean ($\bar{x}$)	Standard Deviation (s)	Mean ($\bar{x}$)	Standard Deviation (s)
Guided ITS	111	2.16	0.58	2.41	0.63
Unguided ITS	118	2.26	0.57	2.47	0.59
Structural ITS	114	2.21	0.59	2.49	0.66
Expository	113	2.25	0.58	2.38	0.60
Total	**456**				

Table 2 above displayed the Mean Retention Scores of students that were taught Trigonometry using guided, unguided and structural inquiry teaching strategies (ITS) and the expository methods. Table 2 revealed that the pretest mean interest score of students that were taught Trigonometry using Guided Inquiry Teaching method was 2.16 with a standard deviation of 0.58, the pretest mean interest score of students that were taught Trigonometry using Unguided Inquiry Teaching method was 2.26 with a standard deviation of 0.57, the pretest mean interest score of students that were taught Trigonometry using Structural Inquiry Teaching method was 2.21 with a standard deviation of 0.59, while the pretest mean interest score of students that were taught Trigonometry using Expository method was 2.25 with a standard deviation of 0.58 whereas the posttest mean interest score of students that were taught Trigonometry using Guided Inquiry Teaching method was 2.41 and a standard deviation of 0.63, the posttest interest mean score of students that were taught Trigonometry using Unguided Inquiry Teaching method was 2.47 and a standard deviation of 0.59, the posttest mean interest scores of students that were taught Trigonometry using Structural Inquiry Teaching method was 2.49 and a standard deviation of 0.66 while the posttest mean score of students that were taught Trigonometry using Expository method was 2.38 with a standard deviation of 0.60.

The study revealed that the mean interest score of students that was taught Trigonometry using Structural Inquiry Teaching Strategy (ITS) was not homogenous. This is because the posttest standard deviation of students that was taught Trigonometry using Structural Inquiry Teaching Strategy was the highest (0.66). Finally, the table 2 revealed that the students that were taught Trigonometry using Structural Inquiry Teaching Strategy (ITS) had the highest posttest mean interest score followed by the students that were taught Trigonometry using Unguided Inquiry Teaching Strategy (ITS) and finally followed by the students that were taught Trigonometry using Guided Inquiry Teaching Strategy (ITS).

Analyses of the Research Hypotheses:

The two (2) null hypotheses were tested at 0.05 levels of significance using ANCOVA. Tables 3 and 4 below showed the Analysis of Covariance (ANCOVA) on the Mean Scores of Students' Achievement and Interest respectively, which are used to answer all the null hypotheses.

H0 1: There is no significant difference between the mean achievement scores of students that are taught Trigonometry using inquiry teaching strategies and the expository method.

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

Source	Type III Sum of	Df	Mean	F	Sig.	Decision

	Squares		Square			
Corrected Model	117412.676[a]	4	29353.169	7646.574	.000	
Intercept	123.698	1	123.698	32.224	.000	
Preachievement	114011.667	1	114011.667	29700.323	.000	
GROUPS	2073.201	3	691.067	180.025	.000	S
Error	1731.269	451	3.839			
Total	1783019.000	456				
Corrected Total	119143.945	455				

a. R Squared = .985 (Adjusted R Squared = .985)

From the result of ANCOVA in table 3, it was observed that Group which was the main effect gave an f-value of 180.025 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 achievement scores of students that are taught Trigonometry using inquiry teaching strategies and the expository method.

H0 2: There is no significant difference between the mean interest scores of students that are taught Trigonometry using inquiry teaching strategies (ITS) and the expository method.

Table 4: Analysis of Covariance (ANCOVA) on the Mean Scores of Students' Interest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	166.768[a]	4	41.692	2589.340	.000	
Intercept	.484	1	.484	30.082	.000	
PreInterest	165.958	1	165.958	10307.037	.000	
GROUPS	1.568	3	.523	32.458	.000	S
Error	7.262	451	.016			
Total	2882.195	456				
Corrected Total	174.030	455				

a. R Squared = .958 (Adjusted R Squared = .958)

From the result of ANCOVA in table 4, it was observed that Groups which was the main effect gave an f-value of 32.458 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 2 was rejected. Hence, the study concluded that there was significant difference between the mean achievement scores of students that are taught Trigonometry using inquiry teaching strategies and the expository method.

Major Findings

The study discovered the followings:

1. The students that taught trigonometry using the Structural Inquiry teaching Strategy had the highest posttest mean achievement and interest scores and secondly, the students that were taught trigonometry using the Unguided Inquiry teaching Strategy had the second highest posttest mean achievement and interest scores and the differences were significant.

Discussion of the Findings

The study determined the comparative effect of guided, unguided and structural inquiry teaching strategies 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 strategies (Guided, Unguided and Structural Inquiry Teaching strategies, and

Expository teaching method) that were used in this study, only the students that were taught trigonometry using the Structural Inquiry Teaching Strategy (ITS) had the highest posttest mean achievement and interest scores. This is because according to Immanuel Kant (1938), a child learns best when the learner's education is structured. According to this philosopher, a child learns best when he is guided to an extent and then allowed (unguided) to explore his inmate abilities. Secondly, the study discovered that the students that were taught trigonometry using the Unguided Inquiry teaching Strategy (ITS) had the second highest posttest mean achievement and interest scores. This finding confirms Piaget's theory that a child's achievement will be enhanced if he is given an ample opportunity to act on the environment in unrestricted (that's unguided but safe) ways in order to start building concepts.

Conclusion

The study determined the comparative effect of guided, unguided and structural inquiry teaching strategies on senior secondary school students' retention in trigonometry. The study was guided by two (2) research questions and four (4) research hypotheses. The study was non-equivalent quasi-experimental research, which sampled 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 and used the Trigonometry Achievement Test (TAT) and Trigonometry Interest Scale (TIS) to gather data. The study used Mean ($\bar{x}$) and standard deviation (s) were to answer the research questions and Analysis of Covariance (ANCOVA) to test the research hypotheses at 0.05 alpha levels. The study discovered among the four teaching strategies (Guided, Unguided and Structural Inquiry Teaching strategies, and Expository teaching method) that were used in this study, only the students that were taught trigonometry using the Structural Inquiry Teaching Strategy (ITS) had the highest posttest mean achievement and interest scores and the students that were taught trigonometry using the Unguided Inquiry teaching Strategy (ITS) had the second highest posttest mean achievement and interest scores.

Recommendations

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

1. Parents and mathematics teachers should adopt Structural Inquiry Teaching strategy (ITS) and then can supplement it with Unguided Inquiry Teaching strategy (ITS) when teaching students Trigonometry in order to boost the students' achievement and interest in trigonometry.
2. Seminars and workshops on Structural Inquiry Teaching strategy should be organized by government and school authorities for parents and mathematics teachers through the Parent Teachers Association (PTA) forum.

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