



## Impact of Inquiry and Problem-Solving Strategies on Performance and Attitude in Trigonometry among Senior Secondary School Students in Zamfara State, Nigeria

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### ABSTRACT

The study investigated the effects of inquiry and problem-solving strategies on performance and attitude in trigonometry among senior secondary school students in Zamfara State, Nigeria. A Quasi-experimental research design with pretest-posttest control group design was adopted. The population was 21,901 SSS II students from 112 senior secondary schools in the state. A multi-stage sampling procedure was used to select 381 SS II students. Two research instruments were developed and used. The tests instruments were validated by experts and the reliability of the instrument were obtained using the test-retest methods of reliability. The reliability index was found to be 0.68 and 0.78. The research questions were answered using mean, standard deviation and median, while the null hypotheses were tested using the Kruskal-Wallis H test and Analysis of Variance (ANOVA). The results of the study indicated that no significant difference was found in the attitude of students taught trigonometry using inquiry, problem-solving and lecture methods. Also, students who taught trigonometry using inquiry, problem-solving strategies perform better than those taught with lecture methods. Based on the findings it was recommended among others that inquiry and problem-solving strategies should be used by mathematics teachers to teach senior secondary school students trigonometry to enhance positive performance.

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### INTRODUCTION

Trigonometry is the study of triangles with their sides and angles. It is widely applied in many disciplines: in particular, trigonometric functions have come to play great roles in science. For example in physics, it is used to analyze different kinds of waves, such as radio waves, sound waves, light waves, etc the study of trigonometry also has great importance to engineering, navigation and surveying. Therefore, secondary education is an important sub-sector of the entire education system. On one hand, it provides middle-level workers for the economy and on the other; it acts as a feeder for higher levels .of education. The quality of higher education, which is expected to produce high-quality professionals in different fields of the social, economic, and political life of the country depends upon secondary education. Emaikwu (2012) refers to academic performance 'as 'an individual's

academic attainment after a specified course of instruction. According to this definition, trigonometry performance can be defined as the quality of results produced by students in trigonometry as reflected in their examination scores. According to Olorundare (2007), the development of any nation is usually characterized by the degree or extent of the impact of science, technology and mathematics in such nation. To train the required highly skilled personnel needed for science, technology and the industry, Mathematical competence is essential. Despite the importance of and popularity of mathematics among Nigerian students, performance at the Senior Secondary School level had been poor (Osemwinye, 2009; Suleiman et al, (2020). This is of the important role which mathematics plays made it a compulsory subject at both primary and secondary school levels so that every



schoolchild will acquire appropriate scientific and mathematical knowledge. The Government of Nigeria recognized this, hence its inclusion in the National Policy on Education (FRN, 2013) as one of the core subjects being studied at both primary and secondary levels of education. Studies have shown that Nigerian students' achievement in Secondary School mathematics has been relatively low over the years. (WAEC, 2011)

Inquiry strategy of learning is a students' centred learning process where the teacher acts as a facilitator or coach rather than an instructor. In this methods the teacher allows the students to raise questions and seek solutions through guided instruction. The methods allows the students to use their initiative. According to (Abrams et al., 2008) inquiry is a "building" process that moves learners along a continuum when they are encultured in the practice of inquiry. Students come to the classroom expecting "one right answer" and need exposure to inquiry incrementally. By gradually structuring inquiry experiences, students can exhibit greater independence and feel less risk from the absence of the dreaded "just tell me what I need to know". This ability to find solutions to problems rather than memorize them is often cited as a better way to understand mathematics and is linked to better retention because if your memory fails you, your logic will not. In this study inquiry strategy which was a students-centred approach was used to teach the experimental group the concepts of trigonometry to see if the strategy would be the best in teaching trigonometry at the SSSII level.

Polya, (1973) established four stages of solving problems in mathematics as follows: Understanding the problem, Devising a plan, Carrying out a plan, and Looking back. According to Inekwe (2002), to teach problem-solving skills successfully, mathematics teachers must provide a more conducive learning atmosphere that will allow students to think.

The role attitude play in the teaching and learning of trigonometry cannot be overemphasized. Attitude is the degree of likeness associated with an object. Adedeji, (2007) stated that interest in activities tends to increase the like hood that individuals

formulate goals relating to that activity and invest more time and effort to achieve them.

It is based on this background that the researchers carried out the study to investigate the effects of inquiry and problem-solving, strategies on Performance and attitude in trigonometry among senior secondary schools students in Zamfara State, Nigeria.

The methods and strategies employed to teach difficult topics like trigonometry in secondary schools need to be given serious attention (Suleiman et al, 2021). Despite the importance of trigonometry in Science and technology, its teaching is being faced with a lot of problems and it is sad to note that the achievements of secondary school students in trigonometry are not encouraging. Students express difficulty in understanding and retaining concepts being taught by their teachers. According to WAEC Chief Examiners Report (2015) reported that questions on trigonometry were poorly attempted by candidates which lead to poor performance in mathematics in general. It is based on these problems that the researchers carried out the study on the effects of the inquiry and problem-solving strategies on performance and attitude in trigonometry among Senior Secondary Schools students in Zamfara State, Nigeria.

#### **Objectives of the Study**

The objective of the study was to investigate the effects of inquiry and problem-solving strategies on Performance and attitude in Trigonometry among Senior Secondary Schools Students in Zamfara State. The study specifically stated the following objectives:

1. Determine the effects of inquiry and Problem-solving strategies on students' academic performance in trigonometry among senior secondary schools. Zamfara State.
2. Investigate the effects of inquiry and Problem-solving strategies on student's attitudinal change level towards trigonometry among senior secondary schools in Zamfara State

#### **Research Questions**

This study was set to investigate the effects of Inquiry and Problem-solving Strategies on performance and attitude in trigonometry among Senior Secondary School



Students in Zamfara State based on the following research questions:

1. What is the difference between the mean performance scores of students taught trigonometry using inquiry, problem-solving strategies and lecture methods?
2. What is the difference between the mean attitudinal change levels of students taught trigonometry using inquiry, problem-solving strategies and lecture methods?

**Null Hypotheses**

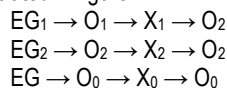
This study was set to investigate the effects of Inquiry and problem-Solving Strategies on performance and attitude in trigonometry among Senior Secondary School Students in Zamfara State based on the following null hypotheses that were formulated at P < 0.05 level of significance.

**H0<sub>1</sub>:** There is no significant difference between the mean academic performance scores of students taught trigonometry using inquiry, problem-solving strategies and those taught using lecture methods among senior secondary schools in Zamfara State.

**H0<sub>2</sub>:** There is no significant difference in the attitudinal change level of students in trigonometry when exposed to inquiry, problem-solving strategies and those taught using lecture methods among Senior Secondary Schools in Zamfara State.

**METHODOLOGY**

This study adopted a quasi-experimental design. The design was considered appropriate because it was not possible to have complete randomization of the subjects into experimental and control groups intact classes were therefore assigned to be experimental and control groups. It consists of three groups that are homogeneous in terms of the quality of teachers, the experimental group1 is a group of students who are exposed to inquiry strategy. The experimental group2 was exposed to problem-solving strategy .while the control group was exposed to lecture methods in teaching trigonometry. The design was illustrated in figure 1



**Figure .1:** Attitude and Performance research design illustration Key:

- EG<sub>1</sub> = Experimental group 1
- EG<sub>2</sub> = Experimental group 2
- CG = Control Group
- O<sub>1</sub> = Pre test
- O<sub>2</sub> = Post test
- X<sub>1</sub> = Treatment (With inquiry strategy)
- X<sub>2</sub> = Treatment (With problem-solving strategy)
- X<sub>0</sub> = No treatment (Control)

The population of the study comprised all 112 Senior Secondary Schools across the four education zones in Zamfara State. The population of the students was twenty-three thousand nine hundred and ten (23,910) SS II Students admitted in the 2019/2020 academic year. The student population is made up of 17,936 male and 5,974 female students from urban and rural areas with the same academic backgrounds. Zamfara State Public Schools were selected for convenience in terms of staffing, teaching materials, learning environment and infrastructure which were all averagely the same.

The multi-stage sampling procedure was used for the study. In the first stage, a simple random sampling methods involving balloting was used to select three zones out of four educational Zones in the state. To ensure relative similarities in the variables of interest such as gender, 6 sample schools were drawn from the 91 public senior secondary schools in the three zones. In the second stage, the Purposive sampling technique was used due to insecurity in the state to select two schools from each of the three educational zones to give the six schools that were used for the study. The 6 schools are of single-gender type and comprise of three boys' and 3 girls' schools. This was to ensure uniformity like the subject selected for the study. In selecting the schools for experimental and control groups of the six sampled schools, the researchers used a simple random sampling technique by categorizing the schools in each zone according to gender.

In the third stage, a sample random sampling technique was used to select one intact class from each of 6 schools. Since most of the schools have more than one arm, the researchers decided to use a simple random sample methods to select one class from each

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of the sample schools, such that all the students can benefit from the lesson. This gives a total sample of 381 students consisting of 200 males and 181 females used for the study. This is because secondary schools exist as intact classes and because of the design

proposed for this study. The sample size is in line with the Central Limit theory that recommends ( $N \geq 30$ ) sample size as pointed out by (Sambo, 2005). The sample selected is presented in Table.1

**Table 1:** Sample of SS2 Students in Zamfara State

Group	No. of Schools in each Zone	Gender		Total
		M	F	
Experimental 1	2	73	64	137
Experimental 2	2	64	57	121
Control	2	63	60	123
Total	6	200	181	381

Source: Field Survey, 2020

There were two instruments (measured variables) used in this study namely; Trigonometry Performance Test (TPT) and Trigonometry Attitude Scale Questionnaires (TASQ). The instruments (TPT & TASQ) were subjected to content validity by three experts: two from mathematics education in the science education department, and the other one from the psychology department of Ahmadu Bello University, Zaria.

The reliability coefficient of Trigonometry Performance Test (TPT), and Trigonometry Attitude Scale Questionnaires (TASQ) was determined by administering the test twice using test re-test methods within two weeks as Sambo (2005) recommended, on the same sample students used in the pilot study. The scores from the two administrations were then correlated as an estimate of the reliability of the test, with Pearson Product Moment Correlation Co-efficient (PPMCC) using Statistical Package for the Social Science (SPSS) Package Therefore co-efficient of 0.68 was obtained the value. Hence the reliability coefficient for Trigonometry Attitude Scale was found to be 0.78 using the Cronbach-alpha methods of estimating reliability. The methods

is a more generalized methods of estimating internal consistency.

The three treatments administered to the subjects involved in the teaching of trigonometry concepts are:

- a. Inquiry Strategy,
  - b. Problem-solving Strategy
  - c. Lecture methods
- Lesson plans were prepared to teach the selected trigonometric concepts. The treatment session for the two experimental groups and one control group took six (6) weeks. Before the commencement of the treatment, the researcher through the help of the research assistant (teachers) administered the Trigonometry performance Test (TPT) as a pre-test, ( $O_i$ ) to all the groups to determine their knowledge in trigonometry. While Trigonometry Attitude Scale Questionnaire (TASQ) was also administered to students in all three groups and their scores and responses were being collected.

## RESULTS

**Research Question One:** What is the difference between the mean performance scores of students taught trigonometry using inquiry, problem-solving strategies and lecture methods?

**Table 2:** Means and Standard Deviations on Students' Academic Performance Scores

Treatment	N	Mean	SD
Inquiry	137	26.39	5.421
Problem-solving	121	19.88	3.426
Lecture methods	123	17.48	3.166
<b>Total</b>	<b>381</b>	<b>21.45</b>	<b>5.667</b>

Table 2 presents the means and standard deviations on academic performance

in trigonometry of students taught using inquiry, problem-solving strategies and lecture

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methods. The mean academic performance of students taught trigonometry using inquiry strategy was (M=26.39, SD=5.321) and (M=19.88, SD=3.426), M=17.48, SD=3.166) for problem-solving and lecture methods, respectively. This shows that students that

were taught trigonometry using inquiry strategy performed better than those taught using problem-solving and lecture methods, and those taught using problem-solving performed better than those taught using lecture methods

**Table 3:** Mean and Median Ranks on Students' Attitude Level by Instructional Strategy

Treatment	Count	Mean Rank	Median Rank
Inquiry	135	102.67	102.00
Problem-solving	121	101.74	101.00
Lecture methods	125	102.56	103.00
<b>Total</b>	<b>381</b>		

Table 3 shows the mean and median ranks on students' attitude levels when taught using inquiry, problem-solving strategies and lecture methods. The mean and median rank on the attitude of students taught trigonometry using inquiry strategy (M=102.67, MD=102.00) was higher than (M=101.74, MD=101.00) and (M=102.56, MD=103.00) for students taught trigonometry using problem-solving strategy and lecture methods, respectively. That is, the attitude level of students towards learning

trigonometry was higher when taught trigonometry using inquiry instructional strategy than when taught using problem-solving and lecture methods.

**Null Hypothesis One:** There is no significant difference between the mean performance scores of students taught trigonometry using inquiry, problem-solving and lecture strategies among senior secondary schools in Zamfara State.

**Table 2a:** Inferential Statistics on Students' Academic Performance Scores

Source of Variance	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5574.571	2	2787.286		
Within Group	6627.576	378	17.533	158.971	.000
<b>Total</b>	<b>12202.147</b>	<b>380</b>			

Table 2a presents the mean academic performance scores of students taught trigonometry using inquiry, problem-solving strategies and lecture methods. The analysis revealed that  $F(2,378) = 158.971$ ,  $p = 0.001$ ; the null hypothesis that stated no significant difference was rejected. Therefore, there was a significant difference between the mean performance scores of students taught

trigonometry using inquiry, problem-solving strategies and lecture methods.

Since a significant difference exists between the three instructional materials, Scheffe's Post-hoc test was conducted to find where the difference is among the groups. The result of the post-hoc test is presented in Table 2b.

**Table 2b:** Scheffe's Post-Hoc Tests on Students' Academic Performance Scores

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Sig.
Inquiry	Problem-solving	6.503*	.000
	Lecture methods	8.907*	.000
Problem-solving	Inquiry	-6.503*	.000
	Lecture methods	2.405*	.000
Lecture methods	Inquiry	-8.907*	.000
	Problem-solving	-2.405*	.000

\* The mean difference is significant at the 0.05 level



Table 2b presented Scheffe's Post Hoc tests on students' academic performance scores based on the three groups' comparison. The result revealed that when all the groups were compared in pairs, there was a significant difference ( $p < 0.05$ ). Therefore, there was a significant difference between the mean performance scores of students taught trigonometry using inquiry, problem-solving strategies and lecture methods. Hence, the

null hypothesis which stated no significant difference was rejected.

**Research Question 2:** What is the difference between the mean attitudinal change levels of students taught trigonometry using inquiry, problem-solving strategies and lecture methods?

**Table 3:** Mean and Median Ranks on Students' Attitude Level by Instructional Strategy

Treatment	Count	Mean Rank	Median Rank
Inquiry	135	102.67	102.00
Problem-solving	121	101.74	101.00
Lecture methods	125	102.56	103.00
<b>Total</b>	<b>381</b>		

Table 3 shows the mean and median ranks on students' attitude levels when taught using inquiry, problem-solving strategies and lecture methods. The mean and median rank on the attitude of students taught trigonometry using inquiry strategy ( $M=102.67$ ,  $MD=102.00$ ) was higher than ( $M=101.74$ ,  $MD=101.00$ ) and ( $M=102.56$ ,  $MD=103.00$ ) for students taught

trigonometry using problem-solving strategy and lecture methods, respectively.

**Null Hypothesis Two:** There is no significant difference in the attitudinal change level of students in trigonometry when exposed to inquiry, problem-solving strategies and those taught using lecture methods among Senior Secondary Schools in Zamfara State.

**Table 4:** Kruskal-Wallis Test on Students' Attitude Level

Treatment	N	Mean Rank	Median Rank	X <sup>2</sup>	Df	P
Inquiry	135	102.67	102.00			
Problem-solving	121	101.74	101.00	1.445	2	0.486
Lecture methods	125	102.56	103.00			
<b>Total</b>	<b>370</b>					

- a. Kruskal Wallis Test
- b. Grouping Variable: Treatment

Table 4 presents the mean and median ranks on students' attitude levels when taught using inquiry, problem-solving strategies and lecture methods. The mean and median rank on the attitude of students taught trigonometry using inquiry strategy ( $M=102.67$ ,  $MD=102.00$ ) was higher than ( $M=101.74$ ,  $MD=101.00$ ) and ( $M=102.56$ ,  $SD=103.00$ ) for students taught trigonometry using problem-solving strategy and lecture methods, respectively. That is, the attitude level of students towards learning trigonometry was higher when taught trigonometry using inquiry instructional strategy than when taught using problem-solving and lecture methods. This is supported by  $X^2(2) = 1.445$ ,  $p=0.486$ ; the null hypothesis which stated no significant

difference was retained. Therefore, there was no significant difference between the mean attitude scores of students taught trigonometry using inquiry, problem-solving strategies and lecture methods among senior secondary schools in Zamfara State. This shows that the attitude level of students towards learning trigonometry when taught using inquiry, problem-solving and lecture methods was the same among the students.

**SUMMARY OF MAJOR FINDINGS**

1. Students performed better when taught trigonometry using inquiry and problem-solving strategies than lecture methods.
2. No relationship was found in the mean attitudinal level of students taught

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trigonometry using inquiry, problem-solving and lecture methods.

### DISCUSSION OF THE FINDINGS

This study investigated the impact of inquiry and problem-solving strategies on attitude and performance in trigonometry among senior secondary school students in Zamfara State. In this study inquiry and problem-solving strategies were found to be better than lecture methods of teaching. The finding from this study showed that there was a difference between the performance scores of inquiry, problem-solving strategies and the lecture methods from the results obtained. Senior Secondary School (SS-II) students who taught trigonometric concepts using inquiry and problem-solving strategies performed better than students taught using lecture methods. The findings agree with the findings of Usman and Musa (2015) and Ibrahim and Busari (2016) who observed that in their various reports the experimental group performed better than the control group. The reason has to do with that students learn more by getting actively involved in the lesson rather than being passive. It further revealed that methods were a significant factor in students' performance in trigonometry. This finding contradicts the finding of Samuelson (2010) which shows that there is no significant difference between problem-solving methods and conventional teaching methods in terms of students' performance.

The finding from this study showed that there was no difference between the attitudinal scores of Senior Secondary School (SS-II) students taught trigonometric concepts using inquiry, problem-solving strategies and those taught using lecture methods. The students taught using inquiry and problem-solving strategies do not differ in their attitudes towards trigonometric concepts with those taught using lecture methods of teaching. This finding disagrees with the finding of Meriam (2000; Adaramola and Adolphus (2013), who attested to the superiority of the constructivist instructional strategies over the conventional methods of teaching in improving students attitude towards the study of mathematics and trigonometry in particular.

### CONCLUSIONS

The study revealed that all the two teaching strategies (inquiry and problem-solving strategies) are better teaching strategies in trigonometry concepts than lecture methods. It was also observed that no relationships among the attitudinal levels of students with inquiry, problem-solving and lecture methods.

### RECOMMENDATIONS

Based the findings from the study, the following recommendations were made:

1. Mathematics teacher should adopt inquiry and problem-solving strategies in teaching trigonometry concepts to enhance better performance of the students.
2. Emphasis should be made to these strategies at training institutions across the country.
3. The use of lecture methods has been found in this study not to be suitable for teaching trigonometry, mathematics teacher should avoid a situation where poor teaching methods is promoted during teaching in the classroom.

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