

# EFFECTS OF INQUIRY AND PROBLEM SOLVING METHODS ON STUDENTS' ATTITUDE AND PERFORMANCE IN TRIGONOMETRY AMONG JUNIOR SECONDARY SCHOOLS IN BENUE STATE, NIGERIA

BY

Akaazua, Jacob. Tertsea PhD.

[akaazuatertsea@gmail.com](mailto:akaazuatertsea@gmail.com) phone number: +2348039203987

Department of Mathematics Education, Federal University of Agriculture, Makurdi, Benue State,  
Nigeria

## Abstract

This study investigated the effect of inquiry and problem solving methods on students' attitude and performance in trigonometry among Junior Secondary Schools in Benue State. The design of the study was a quasi-experimental pretest posttest research design using intact classes. The population of the study consisted of 6230 Junior Secondary School two (JSSII) students in Benue State with a sample of 211 students drawn using a purposive sampling technique. Two instruments were developed for the purpose of measuring student's attitude and performance in trigonometry: Students' Trigonometry Attitude Questionnaire (STAQ) and Trigonometry Performance Test (TPT). The reliability coefficient for STAQ and TPT was 0.82 and 0.76 using Cronbach coefficient alpha respectively. Two research questions were raised and two hypotheses were formulated to guide the study. The research questions were answered using mean, standard deviation and mean rank scores while the hypotheses were tested at 0.05 level of significance using Kruskal-Wallis U-test and analysis of variance statistical tools. The results indicated that students taught using inquiry and Polya's problem solving methods behaved well and performed better than those taught using lecture method. Based on the findings of this study, the paper recommends among others that the teacher should get the learners involved as much as possible in activities that will enable them develop the needed positive attitude in learning trigonometry.

Keywords: Trigonometry, Attitude, Performance, Junior Secondary School Students

## Introduction

Trigonometry is the study of triangles in relation to their sides and angles. The basic concept of trigonometry is to find out the unknown angles, length and areas in triangles using

tables or determining trigonometric values without the use of tables. The study of trigonometry provides skills that are basic for further education, verbal for communication, visual for observation and constructive for practical measurement, drawing and designs. Other skills include logical skill to help students in spatial perceptions and applied skill for development in the physical sciences. These are important not only as a student but throughout one's life. Moreover, trigonometry is more than just measuring triangles. It's also circle measuring, hyperbola measuring, and ellipse measuring; things that are decidedly very non-triangular. This can be achieved by the usage of the ratios between the sides and angles of a triangle and the manipulation of variables.

Trigonometric measuring powers has made policy makers to consider it as an important and essential branch of Mathematics curriculum at all grades levels in Nigeria (Federal Ministry of Education, 2006). The ability to apply trigonometric concepts is the life wire of many occupations. For example in physic it is used when we want to analyse different kinds of waves like the sound waves, radio waves, light waves among others. Trigonometric ideas are also of great importance to surveying, navigation, engineering and other branches of Mathematics. Furthermore, the study of trigonometry provides the learner with a vehicle for enhancing logical reasoning and deductive thinking for modeling abstract problems.

In view of this wide use, research in trigonometry is becoming an important and essential area in current research all over the world for better performance in trigonometry. With a desire to continue the teaching and learning of trigonometry as well as acquisition of practical skills that are expected to be of use to the learner and the society, the Federal and State Government of Nigeria and other bodies like the National Mathematics Centre, Abuja, Mathematics Association of Nigeria (MAN), National Teachers Institute (NTI) and Science Teachers Association of

Nigeria (STAN) among others have invested huge amounts of money and time in training and retraining of teachers who are expected to bring about the desired educational change. However, no significant changes seem to have been recorded Onah, (2012) and Benue State Examination Board (BSEB), (2015-2017). Students still continue to record poor performance in trigonometry. It could be observed that, the percentage pass of the students that participated in the Basic Education Certificate Examination (BECE) Mathematics paper over the period is not encouraging. This fall in standard of performance at Junior Secondary School level is attributed to the pedagogical approaches adopted by teachers in schools (Eze, 2011). The inadequacy of the heavily criticized Lecture Method (LM) to improve students' retention and performance in trigonometry has become a source of concern to many educators in Nigeria. Tom (2011) was of the view that students-centered approaches be used in teaching school subjects if students are to learn maximally.

Inquiry method of learning is a student-centered learning process where the teacher acts as a facilitator or coach rather than a Lecturer. In this method the teacher allows the students to raise questions and seek solutions through guided instruction. The method gives the opportunity to the students to access and use the memory trace representation earlier formed in their lives. It also gives them an opportunity to use their own initiative. According to Tom, (2011) inquiry is a "building" process that moves learners along a continuum when they are encouraged in the practice of inquiry. Students come to the classroom expecting "one right answer" and need exposure to inquiry steps. By gradually structuring inquiry experiences, students are able to exhibit greater independence and feel free from the dreaded "just tell me what I need to know" syndrome. Inquiry classrooms are open systems where students are encouraged to search and make use of resource beyond the classroom and the school.

Inquiry learning is a process rather than content driven learning. Longitudinal studies have also shown that gains made in inquiry based classrooms are more likely to last long periods of time, reduce performance gaps and help disadvantaged students to find success (Hmelo, Cindy, Duncan, Ravit and Chinn, 2007). Long term gain may be related to the fact that students involved in inquiry classrooms report that they find these classes more enjoyable than other studies in school, because of the discussion, practices and reasoning involved in place of memorization (Eze, 2011). This ability to find solutions to problems rather than memorizing them is often cited as a better way to understand trigonometry and is linked to better retention, because if your memory fails you, your logic will fail.

Problem solving techniques according to Obodo, (2004) comprises of identifying and choosing trigonometric problems which grows out of the experiences of individual students placing these problems before themselves and guiding their selves for the solution. Problem solving is an aspect of the Mathematics curriculum which begins with initial contact with the problem and ends when obtained solution is reviewed in the light of the given information. Problem solving has generally been accepted as a means for advancing thinking skills (Obodo, 2004).

Problem-solving performance seems to be enhanced through regular experiences and systematic instruction that aim to assist the development of problem scheme and increase students' awareness of problem solving strategies. According to Tom, (2011) to teach problem solving skill successfully, teachers must provide a more conducive and serene learning atmosphere that will allow students to recall, think, analyze, experiment and be willing to entertain and answer questions to improve students' performance in the concepts.

Lecture method on the other hand is a teaching method in which there is a one – way channel of communication where the teacher makes an oral presentation of the subject matter content and students react by silently listening and taking notes. Its main characteristics are verbal presentation of ideas about the topics. In this method also the teacher gives out all the facts he wants the students to know and master, caring very little if at all whether or not, the students are actively participating and contributing to the success of the lesson (Akem, 2007). The method reduces learners to mere note – takers and passive listeners. Learner's perception and assimilation of the subject matter is slow. Lecture Method often inhibits active participation of students in the classroom and teacher dependence on the part of students (Ransdem, 2009). Many students turn out to be very miserable and inattentive in a trigonometry class after being taught a topic and discover they could not memorize or recall such a concept with ease.

Attitude according to Galadima and Okogbenin (2012) is the degree of likeness associated with concepts. They add that student's success in achieving their goals encourage to develop positive attitudes towards mathematics and other problem solving activities. Positive attitude are assumed to have significant relationship with students' achievement. Adedeji, (2007) stated that interest in activities tends to increase the like hood that individual formulate goals relating to that activity and invest more time and effort to achieve them. Odeleye, Oluwatimilehin and Okereke, (2009) described attitude as the way an individual feels and is predisposes to act towards some aspect of his/her environment. The rationale for this study therefore is to discern whether inquiry and Polya's problem-solving produce a better understanding of the concepts of trigonometry in terms of attitude and performance among Junior Secondary Schools students in Benue State.

### **Statement of the Problem**

The methods and strategies employed to teach difficult topics like trigonometry in secondary schools need to be given serious attention. Despite the importance of trigonometry in science and technology, the teaching of trigonometry is being faced with a lot of problems. Students express difficulty in understanding concepts being taught by their teachers. Reporting the performance profile of candidates in Mathematics in the BECE 2015-2017, the BSEB reported that in 2015 alone, only 23.54% of the candidates passed with credit. In 2016, the figure went up to 31.96% and in 2017 it declined to 20.04%. Clearly, this performance profile on the basis of BECE 2015-2017 is poor, below standards and discouraging. According to BSEB examiners report (2017) students have problems with trigonometry areas of Mathematics. Students still have difficulty in handling concepts in bearing, application of sine and cosine formula and above all how to prove identities or use trigonometric formulae's. This may be due to the poor students' attitude and methods of teaching by some teachers. This study therefore, aims at investigating the effect of inquiry and Polya's problem solving methods on students' attitude and performance in trigonometry among Junior Secondary Schools in Benue State, Nigeria

### **Purpose of the Study**

The purpose of the study was to investigate the effect of inquiry, problem solving and lecture methods on students' attitude and performance in trigonometry among Junior Secondary Schools in Benue State. Specifically, the study seeks to:

1. determine whether Junior Secondary School students improved in their attitude towards trigonometry concepts taught using inquiry and Polya's problem solving methods than lecture method.

2. ascertain whether Junior Secondary School students improved in their academic performance in the learning of trigonometry concepts taught using inquiry and Polya's problem solving methods than lecture method.

### **Research Questions**

The following research questions were raised to guide the study:

1. What are the Mean Rank Rates of Students Attitude in the Inquiry and Problem Solving and Lecture Methods?
2. What are the mean academic performance scores of students taught trigonometry using inquiry, Polya's problem solving and lecture methods?

### **Hypotheses**

The following hypotheses were formulated for the study and tested at 0.05 level of significance

1. There is no significant difference between the mean attitude ratings of students taught trigonometry using inquiry, Polya's problem solving and lecture methods.
2. There is no significant difference between the mean academic performance scores of students taught trigonometry using inquiry, Polya's problem solving and lecture methods.

### **METHODOLOGY**

The research design was quasi-experimental in nature. Precisely, a pretest, posttest and post-posttest control group research design was employed for the study. To apply this design, the researcher gave the pretest to the students to determine their initial equivalence in all relevant aspects before their exposure to the treatment variables. To control for teacher quality variable,

all groups were taught by the regular trigonometry teachers in the selected schools. The population of this study was 6230 JSSII Students, distributed in 30 Government and Grant in aid private and missionary secondary schools in the three education zones of the state. The sample consisted of two hundred and eleven (211) JSSII students selected from 30 secondary schools in Benue State using purposive sampling technique. Intact classes in these schools were used having a total of 93 male and 118 female students. The researcher developed a Students' Trigonometry Attitude Questionnaire (STAQ) and 50-item Trigonometry Performance Test (TPT) for data collection. These were validated by five experts. To ensure that a proper content validity was done for TPT, an empirical item analysis and a table of specification showing an equal distribution of the test items over the concepts taught were handed over to the experts for their judgment. Junior Secondary School two (JSSII) students of Demonstration Secondary School, Mkar were used for the trial testing of the instruments. The results of the trial test were then used to calculate the reliability coefficient of the instruments. The reliability coefficients for the TPT was found to be 0.71 using the test re-test reliability estimate while that of the STAQ was also found to be 0.9 using the Cronbach-alpha method of estimating reliability. These reliability coefficients showed that the instruments were reliable to measure what it is purported to measure in this study (Pallant, 2011). The inquiry and Polya's problem solving methods as treatments for this study were administered to the experimental group while the lecture method was administered to the control group. Mean rank ratings, mean and standard deviations were used to answer the research questions while the hypotheses were tested at 0.05 level of significance, using Kruskal-Wallis U-test and Analysis of Variance statistical tool. For each question, separate mean ranks, mean scores and separate standard deviations were obtained to take decision on the items on the instrument while for the hypothesis, if the p-value obtained is

greater than 0.05 significant level, the null hypothesis is retained and in the alternative, if the p-value obtained is less than or equal to 0.05 significant level, the null hypothesis was rejected.

The researcher then collected the scores from the test for data analysis.

## RESULTS AND DISCUSSION

Research Question 1: What are the Mean Rank Rates of Students Attitude in the Inquiry, Problem Solving and Lecture Methods?

**Table 1: Mean Rank Rates of Students Attitude in the Inquiry, Problem Solving and Lecture Methods**

Method	N	Mean Ranks
Inquiry	69	132.05
Problem Solving	75	93.98
Lecture	67	92.63

Table 1 show that the Mean Rank Rates of students' attitude in the Inquiry, Problem Solving and Lecture Methods are 132.05, 93.98 and 92.63 respectively. This implies that the attitude of students taught trigonometry using inquiry, Polya's problem solving and the lecture methods differ from one another as can be observed from their means of 132.05, 93.98 and 92.63 respectively. Inquiry and problem solving methods are rated higher than the lecture method. To find out if the difference in mean ranks were statistically significant, the corresponding hypothesis one was therefore tested using Kruskal-Wallis U-test statistical tool.

### Hypothesis 1

There is no significant difference between the mean attitude ratings of Junior Secondary School Students' taught Trigonometry using Inquiry, Problem Solving and Lecture Methods.

**Table 2: Kruskal-Wallis U-test Analysis on the Mean Attitude Ratings of Junior Secondary School Students in the Inquiry, Problem Solving and Lecture Methods**

Method	N	Df	Kruskal-Wallis	P-value	Decision
Inquiry	69	2	19.514	0.001*	Significant
Problem Solving	75				
Lecture	67				

\* Significant at 0.05,  $P \leq 0.05$

From Table 2, the calculated Kruskal-Wallis U-test value is 19.514 and the calculated P-value of 0.001 is less than  $P \leq 0.05$  and is significant at  $P \leq 0.05$  alpha level hence Kruskal-Wallis U-test value calculated is statistically significant and therefore the null hypothesis was rejected. This implies that there was significant difference in the mean attitude ratings of Junior Secondary School students taught trigonometry using inquiry, Polya's problem solving and Lecture Methods. The result thus showed that the inquiry and Polya's problem solving methods are more effective in improving students' attitude in the trigonometry concepts taught than the Lecture Method.

**Research Questions 2** What are the mean academic performance scores of students taught trigonometry using inquiry, Polya's problem solving and lecture methods?

**Table 3: Mean and Standard Deviation of Students' Academic Performance in Inquiry, Polya's problem solving and Lecture Methods**

Method	N	Mean	Standard Deviation
Inquiry Method	69	83.76	3.903
Polya's problem solving Method	75	83.57	5.149
Lecture Method	67	50.62	9.297

From Table 3 the mean and standard deviation of students' academic performance taught trigonometry using inquiry, Polya's problem solving and lecture method were 83.76 and 3.903, 83.57 and 5.149, 50.62 and 9.297 respectively. This implies that the academic performance of students taught trigonometry using inquiry, Polya's problem solving and lecture method differ from one another as can be observed from their means of 83.76, 83.57 and 50.62 respectively. To find out if the difference in means was statistically significant, the hypothesis two was therefore tested.

**Hypotheses 2:** There is no significant difference between the mean academic performance of students taught trigonometry using inquiry, Polya's problem solving and lecture methods.

**Table 4: Analysis of Variance on the Academic Performance of Students taught trigonometry using inquiry, Polya's problem solving and lecture methods**

Source of Variation	Sum of Squares	Df	Mean Squares	F-cal	P-value
Between Methods	49916.204	2	24958.102	596.404	0.001*
Within Methods	8704.308	208	41.848		
Total	58620.512	210			

From the result in Table 4 the F-cal was 596.404 at 2 degree of freedom and the calculated P-value was found to be 0.001 which was less than 0.05 alpha level for the methods; hence F-cal is statistically significant and therefore the null hypothesis was rejected. This implies that there is significant difference in the mean academic performance of students taught trigonometry using inquiry, Polya's problem solving and lecture methods.

To calculate the effect size for this independent analysis of variance which provide an indication of the magnitude of the difference between the methods being statistically compared, the formula

eta squared =  $\frac{\text{Sum of squares between methods}}{\text{Total sum of squares}}$  is used to calculate the effect size.

$$\text{Eta squared} = \frac{\text{Sum of squares between methods}}{\text{Total sum of squares}} = \frac{49916.204}{58620.512} = 0.85151429588.$$

The guidelines for interpreting the value of eta squared are: 0.01 = small effect, 0.06 = moderate effect, 0.14 = large effect. In this hypothesis, we can see that the effect size of 0.85151429588 is a large size. Expressed as a percentage, (i.e. multiply the effect size by 100), 85.15 per cent of the variance in the dependent variable could be explained by the independent variable.

### Discussion of Findings

The study investigated the effect of inquiry and Polya's problem solving methods on students' attitude and performance among Junior Secondary Schools in Benue State. The results of data

analyzed in Table 1 showed the mean attitude ratings of 132.05 and 93.98 for the inquiry and Polya's problem solving methods which were ranked higher than the lecture method with a mean value of 92.63. The result of hypothesis one indicated that there was a significant difference in the mean attitude ratings of students taught trigonometry using inquiry, Polya's problem solving and Lecture Method. The setting of a problem solving goal in the experimental class alone increased the students' interest and curiosity. The interest in activities also tends to increase the likelihood that individuals formulate goals relating to that activity and invest more time and effort to achieve them. Moreover the putting together of models to solve problems raised the concentration of the students in the class. An increase in attitude rate was recorded when inquiry and Polya's problem solving was used in instructional delivery because using this approach in teaching; the teacher assumes the role of a facilitator, mediator and assessor of learning. This increase in attitude was attributed to the inquiry and Polya's problem solving methods used for teaching the experimental group. The free atmosphere and relaxed relationship between learners and objects and between a learner and the teacher who acted only as a guide and facilitator was also a benefit. This therefore supports earlier report by Zan & Martino, (2007) and Walker, et al. (2011) who found that the use of practical skills raised the level of concentration, developed positive attitude and enhanced learning. In addition to this, they further observed that students who learned with their initiatives were more interested, patient and curious in the classroom. It is therefore expedient that for effective teaching of trigonometry to occur, the teacher should get the learners' interest as much as possible through the use of teaching aids that will enable them to develop the needed attitude relevant to life.

From Table 3 also since the calculated P-value was found to be 0.001 which was less than 0.05 alpha level for the methods, F-cal was statistically significant and therefore the null

hypothesis was rejected. The implication of this is that students benefited greatly from inquiry and Polya's problem solving methods. This finding agrees with Herwit (2007) who asserted that children learn best by doing not just by sitting and listening. Tom, (2011) advised that, for effective teaching to occur, teachers should get the learners involved.

### **Conclusion**

Based on the results of the study, it can be concluded that there was statistical significant difference in the mean attitude rates of students taught trigonometry using inquiry, Polya's problem solving methods and those taught using lecture method. The result also indicated that large effect of inquiry and Polya's problems solving methods on students' performance was recorded in the trigonometry instructional delivery.

### **Recommendations**

In the light of these findings, the following recommendations are made:

1. Trigonometry teachers should deliver their lessons to students using inquiry and Polya's problem solving methods of teaching. This will invariably increase their attitude thus inducing their critical thinking and conceptual understanding.
2. For effective teaching of trigonometry, the teacher should get the learners involved as much as possible in activities that will enable them develop the needed positive attitude in learning trigonometry.
3. Trigonometry teachers should interact and share their experiences with one another through seminars and workshops to discover better strategies of teaching with a view to improving students' performance in the subject.
4. Trigonometric teachers should be encouraged to develop creative knowledge in improvising some models and teaching aids for use during lessons to concretely create pictures in the minds of students as knowledge retained.

## Reference

- Akem, I. A (2007). Practices and teaching methods. An unpublished lecture notes of the college of Education, Katsina-Ala Benue State.
- Benue State Examination Board, (2015-2017). Basic Education Certificate Examination Results, Makurdi. Benue Printing Press.
- Galadima, I. & Okogbenin, A. A. (2012). The effect of Mathematics Games on Academic Achievement and Attitude of Senior Secondary school Students' towards Mathematics in selected Schools in Sokoto State. *Abacus: The journal of the Mathematical Association of Nigeria*, 37(1), 30-37.
- Eze, J. E. (2011). A Practical Teaching and Learning of Mathematics in Normadic Schools. *Abacus: The Journal of the Mathematical Association of Nigeria*, 36(1), 129-138.
- Federal Ministry of Education, (2006). *National Policy on Education*, Abuja. NERDC press
- Herwit, J. S. (2007). *Teaching methods for today's school collaboration and inclusion* London: Allyn and Bacon.
- Hmelo-Silver, Cindy E., Duncan, Ravit Golan and Chinn, Clark A., 2007, *Scaffolding And Achievement In Problem-Based And Inquiry Learning: A Response To Kirschner, Sweller, and Clark (2006)*, *Educational Psychologist*, v. 4, no. 2, p. 99-107.
- Obodo G. C. (2004) Principles and Practice of Mathematics Education in Nigeria Enugu, Ave Maria Computer Services.
- Odeleye, D. A.; Oluwatimilehin, T. B. & Okereke, P. U. (2009). Secondary School Students' Attitude Towards the Teaching Profession. Retrieved from <http://www.thefreelibrary.com/secondary+students+attitude+towards+theteachingprofession>.
- Onah, A. E. (2012). Effect of motivation on students' achievement in mathematics. An undergraduate project submitted in the College of Agricultural and Science Education, University of Agriculture, Makurdi
- Pallant, J. (2011). *SPSS Survival Mannual: A Step by Step Guide to Data Analysis*. USA. New York.
- Ransdem, A. (2009). The relative effects of enquiry and lecture methods on the high and Low achievers in senior secondary school. *Journal of Science Research*. 3(6), 123-131
- Tom, B. C. (2011). Effect of process-oriented strategy and lecture method on students' achievement and problem-solving ability in biology. *Journal of the National*

*Association of Science, Humanities and Education Research (NASHER)*. 9(4), 11-15.

Walker, C. M., Winner, E., Hetland, L., Simmons, S. & Goldsmith, L. (2011). Visual Thinking: Art Students have an Advantage in Geometric Reasoning. *Creative Educ.*, 22-26. DOI:10.4236/ce.2011.21004

Zan, R. & Martino, P. D. (2007). Attitudes towards Mathematics: Overcoming Positive/Negative Dichotomy. *The Montana Mathematics Enthusiasts Monograph*, 3, 157-168. The Montana Council of Teachers of Mathematics.

IJSER