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Effect Of Problem-Based Learning Strategy On Senior Secondary Two Students' Attitude In Geometry In Bichi, Kano State, Nigeria

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Abstract: ***The aim of this study was to investigate the effect of Problem-Based Learning (PBL) strategy on Senior Secondary Two (SS2) students' attitude in geometry in Bichi, Kano State, Nigeria. The study adopted a quasi-experimental design with pretest-posttest control group. A population of 256 SS2 students and a sample of 60 SS2 students from two secondary schools participated in the study. The treatment group was exposed to PBL for a period of eight weeks totaling to 20 hours, while the control group received the traditional teaching method. The research instrument used was Geometry Attitude Scale (GAS). The data were analyzed with the Analysis of Covariance (ANCOVA) statistic at 0.05 level of significance. The findings revealed that PBL had a significant effect on the students' attitude towards geometry in the treatment group. The study concluded that PBL could be used as an effective instructional strategy in enhancing students' attitude towards geometry. The study recommends that PBL should be included in the geometry syllabus for senior secondary school students.***

Keywords: Problem-based learning, secondary school, mathematics students, attitude, geometry

I. INTRODUCTION

Mathematics is an integral part of everyone's life and it affects virtually every field of human endeavour. Mathematics is regarded as a science subject which involves logical reasoning, drawing conclusions from assumed premises, systematized knowledge, and strategic reasoning based on acceptable rules, laws or probability (Ziegler & Loos, 2014). Mathematical ideas are obtained through deductive or inductive reasoning and the level of mathematical skills in any society determines the level of science and technological component of that society. Mathematical sciences have helped to predict weather, to measure the effect of environmental hazards, project the outcome of electrons, and formulate models for treating malaria, among others. Orkar (2016) observes that improved scientific knowledge and the availability of modern technology will certainly increase economic productivity and viability with increased or increasing knowledge of mathematics.

Mathematics curriculum in Nigerian secondary schools is developed and structured around four major topics or themes namely: number and numeration, geometry and mensuration, algebraic processes and everyday statistics (FME, 2012). These topics are taught to students almost on daily basis preparatory to writing their final or certificate examinations in mathematics in the secondary school. However, geometry is one of the topics that feature in the Senior Secondary Certificate Examination (SSCE) in mathematics on a yearly basis. Geometry deals with the properties, measurement and relations of points, lines, angles, surfaces and shapes. The shapes could either be two-dimensional such as rectangles, squares, triangles, rhombuses, circles, kites, and trapezium or three-dimensional such as cubes, cuboids, cylinders, spheres, pyramid and cone. Some of these shapes are used by engineers in construction of bridges, houses, dams, tunnels and highway systems. Thus geometry plays an important role in construction. Besides, it is fundamental in learning school subjects such as Physics, Chemistry, Fine and Applied Arts

where for example it is applied in calculation of simple harmonic motion, chemical bonding and cloth design.

Questions in geometry have been a major problem to senior school students in Nigeria. This is evident with the WAEC Chief Examiners' reports for a time span of twelve years (2011-2022) which consistently point at geometry as the aspect of mathematics that students experience the greatest difficulty. The reports within the time span revealed that as a result of the difficulty involved in geometry, majority of students avoided geometry questions (WAEC Chief Examiners Reports, 2011, 2015 & 2019), obtained poor results after attempting the questions (WAEC Chief Examiners Reports, 2011-2022) and demonstrated poor knowledge of its application (WAEC Chief Examiners Reports, 2013-2019).

Several causes have been identified by mathematics educators and researchers for the negative attitude of students in mathematics and geometry in particular. Suleiman and Hammed (2019), posited that non implementation and utilization of research findings by mathematics teachers, ineffective mathematics curriculum, students negative attitudes towards mathematics, poor self-concept and methods employed by teachers are responsible for students' poor achievement in mathematics and geometry in particular. Furthermore, Hassidov (2019) and Isack (2015) revealed that teaching method employed by teachers is a factor affecting students' attitude in mathematics. Teachers are the most important single determinant of what takes place in the classroom. This is so because teachers are the originators of strategies used in teaching mathematics in the classroom. Teacher's failure to use appropriate and stimulating teaching strategies could be responsible for students' poor attitude in mathematics.

Ogunrinde and Akitande (2019) saw attitude as psychological construct that is composed of emotional, cognitive and behavioural components. Attitude is either a positive or negative view about a person, place, thing or event. Attitude towards mathematics according to Ndlovu (2017, p.6) is "an aggregate measure of liking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad in mathematics, as well as a belief that mathematics is useful or not useful". It is the disposition towards an aspect of mathematics that has been acquired by an individual through his or her beliefs and experiences, but which could be changed. This disposition will determine the measure of the learner's attractiveness or repulsiveness to mathematics. Attitude is one of the most important factors which determine students' success or failure. Studies have shown that students with low mathematics ability are likely to have a more negative attitude towards the subject (Oppong-Asante, 2012; Ukobong, 2015). Such students do not have the inclination to improve their skills in mathematics. However, students with high mathematics abilities have positive attitude towards the subject.

Studies in the Problem-based learning showed positive effect on students' learning. For instance, the finding of Melek and Miray (2016) showed that problem-based learning is effective in helping students gain a positive attitude toward courses. In addition, mediator variables do not affect students' attitudes toward courses in problem-based learning applications. The result of the study carried out by Daba, Asrat, Habte and Chandra (2015) on effects of Problem-Based Learning on students' academic achievement and their attitude towards Applied Mathematics in some selected Ethiopia Higher Institutions with specific reference of first year Civil Engineering Technology students showed that Students developed positive attitude towards PBL; their academic achievements and attitudes towards Applied Mathematics were positively correlated in each three Universities. On the contrary, Zamir, Yang, Wenwu, and Sarwar (2022) in their study revealed that the PLS-SEM students' model show a negative attitude towards mathematics. Furthermore, the study conducted by Kanyesigye, Uwamahoro and Kemeza (2022) shows that gender did not show any effect of changing attitude or supporting PBL to change students' attitude toward physics expert-like thinking.

Many factors tend to influence someone's attitude. Obumanu and Adaramola (2011) opined that, teaching method influences students' attitude to mathematics. The researchers stressed that the negative attitude exhibited by students towards mathematics is due to the fact that teachers do not apply student-centerd method during instruction, which are needed to engage learners appropriately. However, Ganal and Guiab (2014) observed that the attitude of students towards mathematics is a function of their perception of its difficulty. Positive attitude towards mathematics leads students towards success in the subject. Teaching strategies which do not support change in behaviour and are characterized by rote learning have been criticized for not enhancing positive attitude in students (Akinbobola & Folasade, 2012). This is due to the fact that learning occurs when there is a relatively permanent change in behaviour. Hence, there is the need to employ learner-friendly teaching approaches that could make learners develop positive attitude towards geometry.

Research evidences (Charles-Ogan & Amadi, 2017; Amadi & Onyeka, 2018;), suggested that mathematics instruction today, still follows the traditional or conventional method of acquisition of knowledge where the teacher controls the instructional process. This method involves lecturing about mathematical concepts. It is a situation where a teacher uses his knowledge to explain about the subject or concept being learned while the students pay attention. This method of instruction makes students passive instead of active learners. The process also involves simple regurgitation of facts. This method of teaching has been identified as being ineffective as it contributes to poor achievement of students in mathematics (Paris, 2014). Hence, there is need for teachers to use modern method of teaching such as Problem-Based Learning (PBL) strategy.

The PBL is a classroom strategy that organises mathematics instruction around problem solving activities and affords students more opportunities to discover important concepts (Zalmon & Nwagor, 2015). PBL is a method of teaching where the teacher helps students to focus on solving problems within a real-life context. This method is based on the ideals of constructivism and student-centred learning. Prem (2012) opined that the method is used to bridge the gap between student's procedural fluency and conceptual understanding. Concepts are clearly understood by the students instead of memorizing the procedure to a particular problem. Students derive some advantages from using PBL

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including the fact that it gives them opportunity to construct an intensive and flexible knowledge base, develop effective problem-solving skills, develop self-directed instruction and develop lifelong learning skills to become effective collaborators. Moreover, PBL affords students more opportunities to think critically as it enables them to develop creative ideas, and communicate with peers mathematically (Padmavathy & Mareesh, 2013). Despite the relevance of problem-based learning, there is paucity of empirical studies on its effects on senior school students' attitude in geometry in Bichi Educational Zone of Kano State, Nigeria. It is important to study the effects of problem-based learning on students' attitude in geometry. This study, therefore seeks to find out the effects of problem-based learning strategy on senior school students' attitude in geometry. The study also seeks to determine the extent to which the use of PBL strategy affects the students' attitude in geometry based on gender.

PURPOSE OF THE STUDY

The purpose of this study is to determine the effect of problem-based learning strategy on senior secondary two students' attitude in geometry in Bichi, Kano State, Nigeria. The specific objectives of the study are to:

- ✓ determine the difference in the attitude mean scores of SS2 students in experimental and control groups in geometry.
- ✓ determine the attitude mean scores of SS2 male and female students in experimental group in geometry.

RESEARCH QUESTIONS

- ✓ What is the difference in the attitude mean scores of SS2 students in experimental and control groups in geometry?
- ✓ What are the attitude mean scores of SS2 male and female students in experimental group in geometry?

HYPOTHESES

The following hypotheses were tested at 0.05 level of significant.

- ✓ There is no significant difference in the attitude mean scores of SS2 students in experimental and control groups in geometry.
- ✓ There is no significant difference in the attitude mean scores of SS2 male and female students in experimental group in geometry.

II. METHOD

DESIGN OF THE STUDY

The study employed the non-randomized pre-test, post-test quasi experimental research design. According to Awotunde and Ugodulunwa (2004) quasi experimental research design is an empirical interventional study used to estimate the causal impact of an intervention on target population without random assignment. The choice of the quasi experimental research design for the study was ideal because there was no randomization of participants for the experimental and control groups.

POPULATION OF THE STUDY

The population for the study consisted of 256 SS2 students in public secondary schools in Bichi Educational Zone, Kano. The choice of SS2 students was because geometry is treated in their curriculum.

SAMPLE AND SAMPLING TECHNIQUE

The sample for the study was drawn from two single sex schools (male and female). The sample consists of 60 SS2 mathematics students comprising 28 males and 32 females. The experimental group had 32 students (15 males and 17 females) while the control group had 28 students (13 males and 15 females).

The multistage sampling technique was used to select a representative sample based on the population of public schools in the study area. The male and female schools used were randomly selected using balloting method. Simple random sampling technique was used to categorise the classes into experimental and control groups.

INSTRUMENT FOR DATA COLLECTION

The instrument used for data collection was 20-item structured Geometry Attitude Scale (GAS) designed on 5-point Likert scale (10 positive and 10 negative worded items) having Strongly Agree (SA) = 5 points, Agree (A) = 4 points, Neutral = 3 points, Disagree (D) = 2 points, and Strongly Disagree (SD) = 1point for positive statements but for negative statements, the scale was presented in the reverse order of Strongly Disagree (SD) = 1 point, Disagree (D) = 2 points, Neutral = 3 points, Agree (A) = 4 points and Strongly Agree (SA) = 5 points.

VALIDATION OF THE INSTRUMENT

The instrument was face validated by three experts. Two of the experts were drawn from Mathematics Education unit and one from Research, Measurement and Evaluation (RME) units of the Faculty of Education of the University of Jos. Each of the experts was given the criteria for judgment which included but not limited to relevance of items of GAS, adequacy of difficulty level, content coverage, adequacy of language (wording) and the adequacy of item format. The construct validity of the GAS was determined using factor analysis. Factor analysis is a statistical technique that is used to reduce a large number of items to smaller number of items known as factors.

RELIABILITY OF THE INSTRUMENT

The internal consistency of GAS was determined using Cronbach alpha method. A trial test was carried out by the researcher using two senior secondary school students (SSII) from single-sex education school in Fagge Education Zone Kano State. Reliability co- efficient of 0.75 was obtained.

METHOD OF DATA ANALYSIS

Data collected were analysed using mean, standard deviation and Analysis of Covariance (ANCOVA) at 0.05 level of significance.

III. RESULTS

RESEARCH QUESTION ONE

What is the difference in the attitude mean scores of SS2 students in experimental and control groups in geometry?

Teaching Methods	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Mean Gain
Problem-Based Learning	32	52.85	7.40	56.88	9.01	4.03
Lecture Method	28	44.73	9.09	45.80	8.49	1.07
Mean difference		**8.12**		**11.08**		**2.96**

N= 60

Table 1: Attitude Mean Scores of SS2 Students in Experimental and Control Groups in Geometry

Result in Table 1 indicates that the problem-based learning strategy group had a mean attitude pre-test score of 52.85, and standard deviation of 7.40, a mean attitude post-test score of 56.88 and standard deviation of 9.01, and also a mean gain score of 4.03. The lecture method had a mean attitude pre-test score of 44.73 and a standard deviation of 9.09, a mean attitude post-test score of 45.80 and a standard deviation of 8.49, and also a mean gain score of 1.07. The higher mean gain in score of students taught with problem-based learning strategy (4.03) indicated that students taught with problem-based learning strategy had positive attitude more than students taught with lecture method. The pre-test, post-test and group mean score difference between the control and experimental groups are 8.12, 11.08 and 2.96 respectively in favour of the problem-based group. Thus, the attitude mean scores of SS2 students in problem-based learning strategy group is higher than their counterparts in the control group as indicated by the mean differences of 8.12, 11.08 and 2.96.

RESEARCH QUESTION TWO

What are the attitude mean scores of SS2 male and female students in experimental group in geometry?

Gender	N	Pretest Mean	Pretest SD	Post-test Mean	Post-test SD	Mean Gain
Male Students	15	48.80	6.35	55.05	9.21	6.25
Female Students	17	56.90	6.11	58.70	8.66	1.80
Mean difference		**8.1**		**3.65**		**4.45**

N=32

Table 2: Attitude Mean Scores of SS2 Male and Female Students in Experimental Group in Geometry

Result in Table 2 shows that in the experimental group, the males had a mean pre-test score of 48.80 with a standard deviation of 6.35, a mean post test score of 55.05with standard deviation of 9.21, and a mean gain in score of 6.25. The females on the other hand had a mean pre-test score of 56.90 with a standard deviation of 6.11, a post-test mean score of 58.70 with a standard deviation of 8.66, and a mean gain in score of 1.80. Also, the mean difference between the male and female pre-test scores is 8.1 in favour of the females, while the mean difference between the male and female post test scores is 3.65 in favour of the females. The mean difference between the male and female mean gain in score is 4.45 in favour of the male students.

HYPOTHESIS ONE

There is no significant difference in the attitude mean scores of SS2 students in experimental and control groups in geometry.

Source of Variation	Sum of Squares	Df	Mean Sum of Square	F	p-value	Decision
Corrected Model	2896.752[a]	2	1448.376	20.156	.000	
Intercept	3042.205	1	3042.205	42.336	.000	
Pretest	443.639	1	443.639	6.174	.015	
Group	1224.359	1	1224.359	17.038	.000	**S**
Error	5533.136	57	71.859			
Total	219273.000	60				
Corrected Total	8429.887	59				

R Squared = .344 (Adjusted R Squared = .327)
S = Significant

Table 3: Summary of Analysis of Covariance (ANCOVA) for the Difference in the Attitude Mean Scores of SS2 students in Experimental and Control Groups in Geometry

The analysis in Table 3 shows the F calculated value of 17.038 and P-value of .000. Since this p-value is less than the 0.05 alpha when tested at 0.05 level of significance, the null hypothesis which states that there is no significant difference in the attitude mean scores of SS2 students in experimental and control groups in Geometry is thereby rejected. It implies that there is significant difference in the attitude mean scores of SS2 students in experimental and control groups in Geometry.

HYPOTHESIS TWO

There is no significant difference in the attitude mean scores of SS2 male and female students in experimental group in geometry.

Variation Source	Sum of Squares	Df	Mean Square	F	p-value	Decision
Corrected Model	670.238[a]	2	335.119	4.963	.012	
Intercept	326.384	1	326.384	4.834	.034	
Pretest	537.013	1	537.013	7.954	.008	
Gender	10.546	1	10.546	.156	.695	**NS**
Error	2498.137	29	67.517			
Total	132559.000	32				
Corrected Total	3168.375	31				

R Squared = .212 (Adjusted R Squared = .169)
NS = Not Significant

Table 4: Summary of Analysis of Covariance (ANCOVA) for the Difference in the Attitude Mean Scores of SS2 Male and Female Students in Experimental Groups in Geometry

The analysis in Table 4 reveals the F calculated value of (0.156) and p-value of .695. Since this p-value is greater than the 0.05 alpha when tested at 0.05 level of significance, the null hypothesis which states that there is no significant differences in the attitude mean scores of SS2 male and female students in experimental group in Geometry is therefore upheld. It is therefore concluded that there is no significant difference in the attitude mean scores of SS2 male and female students in experimental group in Geometry.

DISCUSSION OF FINDINGS

The findings from this study indicated that students taught geometry with problem-based learning had a positive attitude when compared with students in the control group. The test of significance also shows a significance difference in the attitude of the two groups. Thus, the attitude mean scores of SS2 students in problem-based learning strategy group are higher than their counterparts in the control group. The findings of this study is in agreement with the findings by Melek (2016) which showed that problem-based learning is effective in helping students gain a positive attitude towards course. This is also in consonance with the findings of Daba, Asrat, Habte and Chandra (2015) which showed that students developed positive attitude towards PBL.

The result of the study also shows that that there is no significant difference in the attitude mean scores of SS2 male and female students in experimental group in Geometry. Problem-based learning has no effect on attitude mean score of students in the experimental group based on gender. This result showed that exposure to problem-based learning strategy has no effect on male and female students. The result of the study tend to agree with that of Kanyesigye, Uwamahoro and Kemeza (2022) which revealed that gender did not show any effect of changing attitude or supporting PBL to change students' attitude toward physics expert-like thinking.

IV. CONCLUSION

It can be argued from the results that students' attitude in solving geometry problems were largely due to the method adopted by the teacher. The intervention enabled students to do team work, collaborate, cooperate and communicate effectively together. Problem-based learning approach developed in students; critical thinking, good problem solvers and self-directed learners. This would lead to life-long memory of geometry concepts. It also motivated students and made them to develop positive attitude in learning geometry problems related to real life situations. Problem-based learning strategy has shown to have a positive effect on the attitude of students in geometry. It means that Problem-based learning is effective in helping students gain a positive attitude towards geometry.

V. RECOMMENDATIONS

- ✓ PBL should be included in the geometry syllabus for senior secondary school students.
- ✓ Collaborative and cooperative teaching of mathematics among the peers and teachers should be allowed and encouraged.
- ✓ Student - centered learning approach in mathematics should be emphasized.
- ✓ Teachers should contextualize lessons in real-life scenarios.
- ✓ Teachers should give students jobs/roles within groups (or have students choose their own roles within groups)

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