PROBLEM SOLVING INSTRUCTIONAL STRATEGY AND MATHEMATICS STUDENTS' PERFORMANCE IN INTEGRAL CALCULUS IN MKPAT ENIN LOCAL GOVERNMENT AREA, AKWA IBOM STATE

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Abstract

This study investigated problem-solving instructional strategy and mathematics students' performance in integral calculus in Mkpat Enin Local Government Area, Akwa Ibom State. Two research questions and two hypotheses guided the study. Quasi-experimental research design, specifically, pretest posttest non-equivalent group was adopted for the study. The population of the study consisted all government coeducational Senior Secondary School class three (SS3) students of 2022/2023 academic session. A sample of 80 SS 3 students drawn from intact classes in two randomly selected secondary schools was used for the study. Mathematics Achievement Test (MAT) was used as instrument for data collection. The instrument was subjected to face and content validity. The reliability of the instrument was established using Pearson Product Moment Correlation Coefficient with a reliability coefficient of 0.77. ANCOVA statistics was to test the hypotheses. Results revealed that there was a significant difference in the mean posttest scores of mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method in favor of those taught using problem-solving strategy. Gender had no statistical significant influence on students' performance in the concept of integral calculus. The researchers recommended that Mathematics teachers and educators should be encouraged to adopt problem-solving as instructional strategy in teaching mathematics.

Keywords: problem-solving, performance, gender, integral calculus

Introduction

Mathematics spreads across nature. It plays vital role in accelerating the social, economic and technological growth of any nation. Today's world thrives on science and technology which demands mathematical knowledge. Mathematical literacy is an indispensable attribute that individuals should possess in a bid to live more effectively as constructive, concerned and reflective citizens. According to Timayi, Ibrahim and Sirajo (2016), Mathematics is a logical language for expressing ideas, shapes, quantities, size, order, change and dynamism of single and complex system. Nkwocha (2016) defined mathematics as a science of numbers and

systematic reasoning for solving problem. The researcher further explains that, mathematics is a science of numbers and shapes which include Arithmetic, Algebra, Geometry, Trigonometry, Statistics and Calculus. To this end, it is necessary to prepare today's learners with a strong foundation in mathematics.

A number of subjects can be identified in the school curriculum at all levels of Nigerian education with the expectation that when properly taught, a more effective learning will occur and this will bring about realization of the goal of Nigerian education as stated in the National Policy on Education (Oche, 2012; Inyang, 2022). Mathematics is one of the subjects that is expected to bring about this national development. It is a core subject at all levels of education in Nigeria as such students are expected to excel in the subject. This is especially true because the concept of Mathematics plays an important role to an individual day-to-day life and also to the nation at large. Mathematics education in schools is more emphasized as it improves concept development, fosters higher cognitive abilities and skills (Abasi & Ado, 2021, Effiong et al, 2018).

Mathematics is a very useful subject for most vocations and higher specialized courses of learning. At the secondary and university levels, most of the physical and social sciences require the applications of Mathematics. No other subject can be a substitute for mathematics. It is in recognition of the importance of Mathematics that prompted the Federal Government of Nigeria to make Mathematics a compulsory subject from the primary school through to the end of the senior secondary school education. It is in light of this that, all over the globe, much effort and time are put in action by mathematics educators and practitioners for the teaching and learning of mathematics to be enhanced (Ado & Abasi, 2014, Anyadike et al, 2024).

. Despite the importance of mathematics to science and technology, literature abound constantly states the low achievement of students at various levels of education in the subject (Abasi, 2024; Oboqua et al 2018, Ado & Abasi, 2021; Edoho, Asuquo, Anditung & Abasi, 2020; Bello, 2014; Adamu, 2014). Other reports on the same subject matter have over the years indicated poor academic performance and general negative attitudes of students towards the subject (Abasi & Ado, 2021; Sherax, 2014). A survey of students' achievement in Mathematics depicts a very sad situation. Edoho and Abasi (2019); Ajai and Imoko (2015) reported a very poor achievement and negative attitude in Mathematics among secondary school students.

With the realization of the indispensability of Mathematics in the survival of human race, Mathematics educators; Abasi and Umoinyang (2020); Ado, Abasi and Nwankwo (2017) and other prominent stakeholders, like Mathematical Association of Nigeria (MAN) and Science Teachers Association of Nigeria (STAN) have been concerned with ways in which students learn Mathematics. This includes methods of innovative teaching pedagogies and instructional materials that can aid the learning processes, means of identifying and overcoming difficulties encountered in the learning of Mathematics, ways of providing for individual differences and the implementation of effective Mathematics instruction (Inyang, 2022; Ajai et al, 2019, Adie et al, 2018; Itighise, 2022).

Over the years, several studies have been shown by researchers that good instructional strategies are capable of improving the performance of students in mathematics and other subjects (Abasi, 2018; Abasi et al. 2022; Olofu et al, 2021). This is why problem-solving approach have been considered as one of the best approaches through which mathematics instruction can be made meaningful, understandable and comprehensible to learners (Igyu et al, 2022, Mbagwu et al, 2016; Itighise et al; 2021).

Problem solving is a method of teaching used to accomplish instructional goals of learning basic facts, concepts, and procedures, as well as goals within a problem context (Abasi & Ado, 2021). According to Perveen (2010), problem solving is a process of overcoming difficulties that appear to interfere with the attainment of a goal. This method encourages pupils or students to probe into a problem (Akpama, et al 2017; Kankpang et al, 2022). In teaching

Mathematics, problem solving strategy is characterized by interactions between students and teachers, mathematical dialogue and consensus between students, teachers providing just enough information to establish background of the problems, and students identifying, clarifying, interpreting and attempting to construct one or more solution process, teachers accepting right or wrong answers in a non-evaluative way, teachers guiding, coaching, asking insightful questions and sharing in the process of solving problems, teachers knowing when it is appropriate to intervene, and when to step back and let the pupil or student make their own way (Lester, Masingila, Man, Lambdin, Does-Santos & Raymond, 1994 in Abasi & Ado, 2021).

Problem solving has a special importance in the study of Mathematics. A primary goal of Mathematics teaching and learning is to develop the ability to solve a wide variety of complex Mathematics problems (Wilson, Fernandez & Hadaway, 1993 in Abasi & Ado, 2021). Mathematics is synonymous with solving problems which include doing word problems, creating patterns, interpreting figures, developing geometric constructions and proving theorems (Abasi & Ado, 2021). Problem solving is an integral part of all Mathematics learning, in everyday life and in the workplace, being able to solve problems can lead to great advantages. However, solving problems is not only a goal of learning Mathematics, but also a major means of doing so. Problem solving means engaging in a task for which the solution is not known in advance. Good problem solvers have a "Mathematical disposition", they analyze situations carefully in Mathematical terms and naturally come to pose problems based on situations they see.

Problem solving involves application of thinking and reasoning to various kinds of problems encountered in life (Abasi & Ado, 2021). It is an integral part of developmental activities and provides opportunities for children to practice what they have learned by applying their learning situations. The amount of practice needed by any learner is reduced if he understands the concepts and skills to be practiced. Problem solving is at the very heart of understanding Mathematics (Abasi & Ado, 2021). The whole purpose of teaching the various concepts which make up Mathematics as a tool is to give the learner the tools and the building blocks with which he/she can actually solve problems, resolve difficulties which he/she wants to resolve (Abasi & Ado, 2021). This is why it is pertinent to teach mathematics through problem solving approach, hence the purpose of this study.

Teaching as well as learning of mathematics require a good measure of cognitive strength. Students' cognitive strength varies with respect to their gender which results to disparity in academic performance between male and female students. Gender stereotypes contribute greatly to difference in academic performance at the secondary school level because of certain factors like methodologies and styles, parental encouragement and advocacy as well as women's empowerment advocacy campaigns for improved academic achievement of females at the tertiary levels. Conversely, extracurricular activities on the part of male folks, and socio economic influences like economic hardship, gendered ideologies and financial constraint goes a long way to influence the academic achievement of the male folks at that level. Continuous education and sensitization of gender stereotypes and policy measures to sustain both males and females in the academic environment is very necessary for overall national development. This study therefore consider students' gender as a moderator variable as it could influence students' academic performance in integral calculus when exposed to problem solving instructional strategy.

Hence, the researchers sought to use the four-step processes (understand the problem, devise a plan, carry out the plan, look back) developed by Polya in 1971 to investigate the effect of problem-solving instructional strategy on mathematics students' performance in integral calculus considering mathematical ability as a moderator variable in Mkpat Enin Local Government Area of Akwa Ibom State, Nigeria.

Statement of the Problem

Despite the importance of mathematics to nation building and as a prerequisite for admission into tertiary institutions, it has been observed that students achieve poorly in Mathematics in both internal and external examinations and even in other public examinations. A number of efforts and contributions have been made by Mathematicians, Mathematics educators, researchers, Associations, and government, to remedy the situations and improve Mathematics education in our country. In another contribution towards solution to poor achievement in Mathematics, WAEC Chief Examiner in his report (WAEC, 2016/2017), recommended the use of effective teaching methods as the only remedy to students' poor achievement. Of particular reference is the use of problem-solving instructional strategy to Mathematics instruction. It is in response to the inconsistencies in the Mathematics achievement of students that this study seeks answer to the question: Would the use of problem-solving instructional strategy improve mathematics students' performance in integral calculus in Mkpat Enin Local Government Area of Akwa Ibom State?

Purpose of the Study

The main purpose of the study was to examine the effect of problem-solving instructional strategy on mathematics students' performance in integral calculus in Mkpat Enin Local Government Area of Akwa Ibom State, Nigeria. Specifically, the study sought to:

1. examine the difference in the mean performance scores of mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method.
2. Determine the difference in the mean performance scores of male and female mathematics students in integral calculus when taught using problem solving instructional strategy and lecture teaching method.

Research Questions

The following research questions were formulated to guide the study

1. What is the difference in the mean performance scores of mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method?
2. What difference exists in the mean performance scores of male and female mathematics students in integral calculus when taught using problem solving instructional strategy and lecture teaching method?

Hypotheses

1. There is no significant difference in the mean performance scores of mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method.
2. There is no significant difference in the mean performance scores of male and female mathematics students in integral calculus when taught using problem solving instructional strategy and lecture teaching method.

Methods

Quasi-experimental research design, specifically, pre-test posttest non-equivalent group was adopted for the study. The population of the study comprised all Senior Secondary three (SS3) students in the 16 public secondary schools in Mkpat Enin Local Government Area with a total enrolment of 1935 SS3 students in 2022/2023 session (Akwa Ibom State Secondary Education Board, 2023). The sample size consisted 80 SS 3 students from two intact classes in two schools. This sample was arrived at by selecting 2 government owned secondary schools in the area of

study using simple random sampling. Simple random sampling involving hat and draw method was used to select the sample. In each of the two selected schools, one intact class with forty-two (42) students and another intact class with thirty-eight (38) students from another school were sampled. With simple random sampling technique each school was assigned to as experimental group (problem-solving) and control group (lecture method) respectively. The instrument used for data collection was "Mathematics Achievement Test (MAT) on integral calculus". The Mathematics Achievement Test instrument consisted of 50 multiple choice items. Each item had four options lettered A to D with only one correct answer. The test was used to gather the scores for pretest and posttest of students on the concept of integral calculus in mathematics using Polya's problem solving instructional strategy and lecture method. The instrument was content and face validated by two experts in measurement and evaluation. A test blue print was developed with content relevance and ambiguity of expression corrected and suggestions made by experts were used to restructure the instrument. Upon validation of the instrument a trial test was conducted with an intact class of 20 SS 3 students outside the area of the study to establish the reliability of the instrument. A reliability coefficient of 0.77 was obtained using Pearson Product Moment Correlation (PPMC) estimate which showed a high reliability for the instruments. Data collected were used in tested the null hypotheses at 0.05 level of significance using Analysis of Covariance (ANCOVA) statistics.

Results

Hypothesis one: There is no significant difference in the mean performance scores of mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method

Table 1: Analysis of Covariance (ANCOVA) of Students' Post-test Scores Classified by Treatment with Pre-test as Covariate.

Source of Variation		Sum of Squares	df	Mean Square	F	P
Covariates	Pre-test	63.006	1	63.006	15.170	.000
Main Effects	Treatment	24.643	1	24.643	5.933*	.017
	Gender	20.110	1	20.110	6.015	.016
	Treatment * gender	13.917	2	6.959	2.081^{NS}	.130
Error		303.200	74	4.153		
Total		13910.000	80			
Corrected Total		441.950	79			

*Significant at P>0.05 level of significance

Table 1, the analysis of the post-test scores of the two groups of students taught integral calculus using problem-solving instructional strategy and lecture teaching method is significant (F = 5.933; df = 1, 79 @ 0.05 level of significance), indicating a statistical significance difference between the mean posttest scores of the two groups. As shown in the result of table 1, the calculated F-ratio of 5.933 with corresponding P-value of .017 is less than the declared probability value of 0.05 level of significance, hence, the null hypothesis is rejected. This implies that there is a significant difference in the mean posttest scores of mathematics students

in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method in favor of those taught using problem-solving strategy.

Hypothesis Two: There is no significant difference in the mean performance scores of male and female mathematics students in integral calculus when taught using problem solving instructional strategy and lecture teaching method. As shown in Table 1, the analysis of the post-test scores of male and female students taught the concept of integral calculus using problem-solving instructional strategy and lecture teaching is not significant ($F = 2.081$; $df = 2, 79$ @ 0.05 level of significance), indicating a no statistical significance difference between the mean posttest scores of male and female students. As shown in the result of table 1, the calculated F-ratio of 2.081 with corresponding P-value of .130 is greater than the declared probability value of 0.05 level of significance, hence, the null hypothesis is upheld. This implies that there is no significant difference in the mean posttest scores of male and female mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method.

Discussion of Findings

Data in table 1 ascertained the difference in the mean performance scores of mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method. The findings revealed that there is a significant difference in the mean posttest scores of mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method in favor of those taught using problem-solving strategy. Students taught the concept of integral calculus using problem-solving instructional strategy achieved significantly better than those taught using lecture teaching method. The findings could be attributed to the fact that problem-solving method provokes students' thought, set them to logical thinking thereby enhancing achievement. The result of this finding is in line with the findings by Abasi and Ado (2021) who found out that students taught probability using problem-solving method achieved significantly better than those taught probability using expository method.

Data in table 2 ascertained the difference in the mean performance scores of male and female mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method. The findings revealed that there is no significant difference in the mean posttest scores of male and female mathematics students in integral calculus when taught using problem solving instructional strategy and those taught using lecture teaching method. Both instructional methods were found to be gender friendly. The result of this finding is in line with the findings by Ajai and Imoko (2015) who opined that male and female students are capable of competing and collaborating in mathematics with high achievement levels and that there are no longer distinguishing differences in the cognitive, affective and psychomotor skill achievements of students in respect of gender and that girls are being encouraged and sensitized into developing positive attitudes towards science, which subsequently result in high academic achievement. The finding of the study is contrary to that of Unodiaku (2023) who found that sex is one of the factors that influence mathematics readiness of students.

Conclusion

Based on the findings of the study, it is hereby concluded that problem-solving instructional strategy is the most effective in facilitating mathematics students' academic performance in integral calculus. Also, gender was found not to be a determinant factor that influence students' academic performance in integral calculus when exposed to problem-solving instructional strategy and lecture teaching method.

Recommendations

Based on the findings of this study, the researcher considered the following recommendations relevant for the improvement of Mathematics education.

1. Mathematics teachers and educators should be encouraged to adopt problem-solving as instructional strategy in teaching mathematics.
2. Education stakeholders should organize conferences, seminars and workshops for teachers to acquaint them with the knowledge on the use of problem-solving as instructional strategy to improve the process and product of teaching mathematics.

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