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EFFECT OF PROBLEM-BASED LEARNING STRATEGY ON STUDENTS' ACHIEVEMENT IN MATHEMATICS IN SENIOR SECONDARY SCHOOLS IN KWALI METRPOLIS, ABUJA

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Abstract

The study determined effect of problem-based learning strategy on students' interest and achievement in Mathematics in Senior Secondary Schools in Kwali Metropolis, Abuja. The study was guided by two research questions and two hypotheses. The study employed quasi-experimental research design. The population comprised5,638 (3,820 males and 1,818 females) SSII Mathematics students from 10 public secondary schools in Kwali Area Council for 2024/2025 academic session.195 (111 males and 84 females) SSII Mathematics students were selected as sample for the study. Mathematics Achievement Test (MAT) was used for data collection. Face and content validity was obtained for MAT by subjecting the instruments to critical appraisal of two experts in Faculty of Education and logical indices of 0.85 was obtained for MAT. Reliability coefficients of 0.83 for MAT was obtained. Data collected were classified into pre-test and post-test scores for both experimental and control groups. Descriptive statistics was used to get the group mean scores and standard deviation of students' achievement in MAT. Mean scores were used to compare the mean of the groups to

Keywords: *Problem-Based learning Strategy, Mathematics, Achievement, Gender, Students'*

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answer research questions while ANCOVA were used to test the hypotheses at 0.05 level of significance. The major findings of the study revealed that there was significant difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using the conventional teaching method as well significant difference in the mean achievement scores of male and female students taught Mathematics using problem based learning strategy in Kwali Metropolis, Abuja. Based on the findings of the study, it was recommended among others that Mathematics teachers should adopt the use of problem-based learning to improve students' achievement in Mathematics.

Introduction

Mathematics is an important subject and a day–to–day activity that every human being practice in one way or the other. Mathematics helps one to develop ability in creative thinking, seeing things with the inner eye and deep focusing. According to Effiom (2016), Mathematics is a creation of human mind concerned chiefly with ideas, processing and reasoning which is primarily a way of thinking and reasoning. As a way of reasoning, mathematics gives an insight into the power of human mind, which forms a very valuable discipline of teaching and learning. Odili as cited in Effiom (2016) stated that mathematics is man's most extensive and most profound effort to achieve precise and effective thinking and what it accomplishes measures the capacity of the human mind. Mathematics represents the superb and sublime product of human reasoning and this is the upper limit of what one hopes to attain in all rational domains.

The importance of Mathematics to the society at large cannot be overemphasized because it is one of the essential subjects of modern technology. According to Kolawole and Popoola (2019), Mathematics is an instrument that facilitates the learning of all subjects. No wonder Plato (a philosopher and mathematician) opined Mathematics is the bedrock of all other subjects and that is the reason why he said "let no man make destitute of mathematics". Due to the uniqueness of mathematics, it is classified as a compulsory subject right from the primary school to the secondary school and a subject that must be passed in the first school leaving certificate examination and Senior School Certificate Examination. Mathematics is one of the compulsory subjects both in the primary and secondary school level, not because the students are expected to become a mathematician but because of its application in day-to-day activities.

However, despite the many benefits students could derive from studying Mathematics, students' academic achievement and interest in the subject continue to deteriorate yearly. In the West African Examination Council (WAEC) Chief Examiners Reports in recent

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years (2022-2024). The achievement of students in school subjects including Mathematics particularly in Algebra was described as poor. According to West African Examinations Council Chief Examiner's reports (2024), in 2021, 467,011 candidates registered and sat for the examination, 43.2 % making a population of 201,748 obtained credit pass while 56.8% making a population of 262,927 failed. In 2022, 669,014 candidates registered and sat for the examination, 46.2 % making a population of 322,464 obtained credit pass while 53.8% making a population of 346,550 that failed. And in 2023, 397,017 candidates registered and sat for the examination, 42.1 % making a population of 194,935 obtained credit pass while 57.9% making a population of 206,051 failed Mathematics. The current state of affairs is displeasing and this trend could hamper meaningful development in Nigeria and Abuja in particular.

In a quest to unravel the reasons behind the students' poor academic achievements, Chiang and Wainwright (2015); Krugman (2019) observed that Mathematics topics are often structured around formal mathematical and statistical models and Mathematics students demonstrate weakness in Algebra. This affects their academic achievement and interest in the subject. Ongeri (2019) identified the factors responsible for poor academic achievement in Mathematics to include students' lack of interest, poor teaching methods and strategies, attitude of teachers who teach the subject, and inadequate time allotted to Mathematics in the timetable.

Due to the importance attached to the knowledge of Mathematics and how such knowledge can aid the scientific and technological development of any nation, educators and other stakeholders in education have been clamouring for modern approaches to the teaching and learning of the subject. This is because as important as the subject is, it is still plagued by setbacks that still negatively impact students' academic achievement. According to Abdullaha, Tarmizia and Abub (2016), students taught the concepts of Mathematics using conventional or traditional are preoccupied with exercises, rules, and equations that need to be learned, but are of limited use in unfamiliar situations such as solving real-life problems. Some of the factors responsible for students' poor achievement in Mathematics among secondary school students have been identified. Still, chief among these challenges are teachers' factors such as poor teaching methods or strategies and poor content knowledge.

Modern methods of teaching have shifted from conventional methods, and Mathematics should not be left out. Students-centred learning which also affords them active participation in their learning processes in which the teacher is merely a facilitator of learning remains the focal point of contemporary Mathematics education. Hence, active learning involves learners taking responsibility for their learning; are given the opportunity to make decisions about various dimensions of their learning process and also to perform self-regulation. The criticisms of the traditional or conventional method

may have led to the advent of students-interactive teaching strategies or one modern teaching strategy that has been shown to possess these qualities and which can be applied in teaching Mathematics is Problem-Based Learning (PBL).

Problem-based learning (PBL) is one of the constructivist teaching strategies and makes use of authentic tasks. Problem based learning has been recognised as a significant improvement to teaching (Boud & Feletti, 2019). This is because PBL provides learners with opportunities to develop conceptual and practical skills and practically apply this as they process knowledge and information from various sources. Barrows (2018) defined Problem-based learning as "the learning that results from the process of working toward the understanding or resolution of a problem". Problem-based learning (PBL) is an instructional method that challenges learners to "learn how to learn," working cooperatively in groups to seek solutions to real world problems. These problems are ill-structured and complex and they are used to engage learners' curiosity and initiate learning the subject matter. PBL prepares learners to think critically and analytically, and to find and use appropriate learning resources (Duch, 2015).

Problem-Based Learning (PBL) is a classroom instructional strategy that organizes mathematics instruction around problem solving activities and affords students more opportunities to discover important concepts. PBL which began over 25 years age has since been implemented in elementary and secondary schools as well as various undergraduate and graduate programs around the world (Padmavathy & Mareesh, 2016). PBL is described as a learning environment where problems drive the learning. That is, learning begins with a problem to be solved, and the problem posed in such a way that students need to gain new knowledge before they can solve the problem. Rather than seeking a single correct answer, students interpret the problem, gather need information, identify possible solutions and evaluate option; and present conclusions. Emmanuel (2019) outlined four major features of PBL as follows; focusing groups of students on specific problem(s), developing their critical thinking, analytical thinking or high order thinking, promoting team work through group discussion and presentation, and facilitating instruction. Hmelo-Silver (2016) stated that PBL was designed to help students construct an extensive and flexible knowledge base develop effective problem-solving skills, develop self-directed lifelong learning skills, becomes effective collaborators and intrinsically motivated to learn. Padmavathy and Mareesh (2016) revealed that PBL had effect in teaching mathematics and improved male and female students' understanding (cognitive achievement), creative mathematical reasoning and problem-solving skills equally PBL was also found to improve student mathematical comprehension level, problem solving and science process skills, Sule and Derya (2016) indicated a treatment effect on secondary school student critical reasoning (thinking) ability and content knowledge using PBL.

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Gender is a prominent variable in our schools especially in Nigeria. Gender refers to the socially, culturally constructed characteristics roles which are ascribed to male and female in any society. Okeke (2018) defined gender as a socially constructed concept based on the assumed position that a group of humans should possess. Gender studies are popular in Mathematics. This is because many have suggested that the stereotypically masculine content of Mathematicsword problems could account for some of the gender disparities in success on such objects, but Afonja (2018) opined that no evidence to support this theory. It is expected that the educational experience given to students in schools does not discriminate between men and women. It is important to ensure that male and female students have equal access to Mathematics education. Consequently, an average Nigerian girl goes to school with these fixed Stereotypes (Fabunmi, 2017).

Statement of the Problem

The problem of low academic achievement among the students in Mathematics especially in Algebra has been plaguing our educational system completely right from the primary to the tertiary levels. This problem is responsible for the tremendous wastage of human potential and facilities for education apart from the financial wastage, which a developing country like ours can ill afford. Mass failure of students in Mathematics has been a source of concern to parents, students, teachers and the society at large. The mass failure has been attributed to teachers' methodology, non-availability of teaching materials and parental factors. All of these appeared to have been investigated yet the problems seem to have remained persistent going by the recurring mass failure in Mathematics external examinations. If achievement in Mathematics continues to be poor as it is now, Nigeria may never attain her goal of developing modern technology using her own human resources and may have to continue to rely on manpower from other countries. Therefore, there is the need for students to perform well to achieve the required degree of accuracy and utilization of Mathematics for both personal and national development.

The belief that Mathematics is an uninteresting and hard subject to learn and pass persists. Because of this, students are always afraid, worried and anxious to learn mathematics and, therefore, mostly negatively affect the subject. Added to this wrong notion about Mathematics is the challenge of ineffective teaching methods used by teachers. While several factors affect the teaching and learning of Mathematics, chief amongst them is the approach or method used by teachers in delivering the contents of mathematics to their students. Because of this, modern approaches, of which PBL one and is fast gaining relevance due to its ability to instill problem-solving skills in students is one. Based on empirical reports, the Mathematician of the 21st Century cannot be raised using the conventional method. Hence, modern approaches have to be embraced. In most cases, they regard algebra mathematics as a difficult subject due to mathematical

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/statistical nature. In fact, many students, more especially girls have lost interest and retentive capacity in the enthusiasm to study mathematics in secondary schools due to the old and traditional ways of teaching the subject. Hence, this study attempted to fill this gap in addition to ensuring that Mathematics education is given to students using the right and modern approach while also instilling problem-solving skills required of the 21st Century workplace in students in FCT, Abuja, Nigeria. It is because of this that this research examines the effect of problem-based learning strategy on students' interest and achievement in Mathematics in senior secondary schools in Kwali Metropolis, Abuja.

Objectives of the study

The general objective of this study is to examine the effect of problem-based learning strategy on students' achievement in Mathematics in senior secondary schools in Kwali Metropolis, Abuja. Specifically, the study sought to:

1. examine the difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using conventional method in Kwali Metropolis, Abuja.
2. Determine the difference in the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy.

Research Questions

1. What are the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using conventional method in Kwali Metropolis Abuja?
2. What are the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy?

Statement of the Hypotheses

The following hypotheses formulated were tested at 0.05 alpha level:

Ho_1: There is no significant difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using conventional method.

Ho_1: There is no significant difference in the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy.

Problem-Based Learning (PBL)

Problem-Based Learning (PBL) is an educational concept or a teaching model based on problems, and organizing learning content with the research of authentic problems. This teaching model is superior to traditional education in the dimensions of teaching

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methods, discipline linkage, and teaching achievements. Although limited by educational policies, teaching conditions and teachers' level, the teaching model in many regions, such as China, is still dominated by traditional education, the development of PBL teaching mode is also very rapid.

Problem based learning is a student-centered educational method which aims to develop problem - solving skills through a self- directed learning as a life time habit and team work skills. Untidy, messy, ill structured situations are given to the students in which they take the role of owner of the situation. Students observe the problem and learn about the solution, compared to traditional lecture-based learning, we have many advantages from PBL. Some of the advantages are as- makes learning useful to the real world, encouraging and motivating how to learn, engage students learning similar to real world. PBL not only focus on problem solving but also responsible for the development of other skills and attribute. As stated by Larson (2017), students in PBL classroom improve their social skills as they have more opportunities to practice using the language for authentic communication. PBL is a process that is used to identify problems with a scenario to increase the knowledge and understanding. Some of the principles are listed below: (1) independent and self- directed learning, (2) learning happens in a group and teacher is a facilitator, (3) all groups have to participate equally, (4) students learn about motivation, teamwork, problem-solving and engagement with the task and (5) materials such as Data, photographs, articles, can be used to solve the problem. Problems have always mobilized and stimulated thinking and learning, when problems are experienced as relevant and important, they energize our activity and focus our attention, people are motivated to redirect their energies towards solving them.

Problem Based Learning (PBL) has its own characteristics when compared to other strategies. The characteristics of PBL include: (a) problem-solving activities are the focal point in learning, (b) the problems raised are abstract and unstructured problems in the real world, (c) existing problems are viewed from different perspectives, (d) problems are challenges and competencies from students who are then identified as learning needs, (e) learning to control oneself becomes an important point, (f) utilizing various sources of knowledge from all sources of users, because in PBL the source of the problem is the main essence, (g) students can learn to work together, communicate cooperatively. Based on the explanation above, it can be concluded that Problem Based Learning is learning that implements problems realistically, not structured but open as an element for students to improve skills in solving problems and reasoning while forming new knowledge.

Students' Academic Achievement in Mathematics

Academic achievements of a student in a particular subject or course are determined by short- or long-term goals acquired. According to Oxford Advance Learners Dictionary, to achieve means "to succeed in reaching particular goal, status or standard especially by an

effort for a long time" Achievement in mathematics goes to emphasize the effort or skill put in to acquire or achieve success in mathematics as a science subject.

Academic achievement deals with successful completion of academic task by a student in a school. In other words, it has to do with students' performance in school subjects determined by a score from an achievement test. Academic achievement is commonly measured by examination or continuous assessment. Academic achievement is the learning outcome of students which include the knowledge, skills and ideas acquired and retained through their course of studies within and outside the classroom situation. Was (2016) viewed that goal achievement might be focused on the task or end result. A student who performs well in school can be said to record high academic achievement and a student whose results are not good can be said to have recorded poor academic achievement. In other words, academic achievement can be either high or low, depending on the performance of students. Every learner is expected to record high academic achievement at the end of his or her course of study. Unfortunately, this is not always the case due to a lot of factors which include the use of inappropriate instructional technique or instructional tools by teachers. This is in line with the observation of Ekpo-Eloma, Arikpo and Effiom (2015) that teachers tend to rely more on traditional textbooks for the teaching of mathematics instead of making use of instructional tools that will involve students' active participation to achieve educational goals. Corraborating Damar, Hulda and Jonah (2016) stressed that experience over the years has shown that teachers have been depending on excessive use of words to express and convey ideas or facts in the teaching.

Achievement can be defined as the level of performance of individual response to a problem. It is described as the level of successful performance of a learner. When one strives to succeed at challenging tasks and meets high standard of accomplishment, it is referred to as achievement. People's view about achievement differs. Some people perceive achievement as a motivational concept while others see it as a behavioural concept. Motivational concept of achievement has it as learned motive to compete and to strive for success whenever one's behaviour can be evaluated against a standard of excellence (Shaffer, 2015). This implies that one is motivated to work hard, and to be successful for self-fulfilment; and to strive to beat others when faced with new challenges. Contrary to motivational view point, behavioural concept of achievement views it as any behaviour directed towards the attainment of approval or the avoidance of disapproval for competence in performance in situation where standard of excellence is operable. Academic achievement is the outcome of education, that is the extent to which a student, teacher or institution has attained their educational goals (Ezeudu, 2016).

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Gender and Students' Achievement in Mathematics

Gender issue is a contemporary one that attracts attention of psychologists, sociologist, educationist, scientists and biologists and even the home and parents. The concept "sex" could be discussed in term of masculinity and femininity observed in an individual (en.m. wikipedia.org/wiki/gendergg). The physical character of an individual may not be expressed psychologically or emotionally. For instance, careers or subject that are feminine in nature such as catering, is practiced by male while female is studying engineering and carpentry meant for male previously. A lot of researches have been carried out on gender and paper presentations to create awareness on gender equality and disparity.

Gender is defined as the behavioural, cultural, or psychological traits typically associated with one sex. Ifedili (2017) maintained that gender discriminations which are highly peculiar to girl-child could only be eliminated through education and empowerment; this is because some girls have proved that they could be the best if given a chance academically. Concerns about academic achievement with respect to males and females have generated a considerable interest in the field of education testing over the years. Willingham and Cole (2016), in a comprehensive Examination of gender differences, found that gender differences occur across different testing programmes and in different subject areas. According to their findings, females tend to achieve better grades in schools while males tend to receive better scores on standardized tests. Although some researchers have reported contradictory findings, the results regarding specific tests have generally shown that males tend do better in Mathematics and science-related subjects while females perform better on Verbal subjects (Meleku, 2016).

Differences in academic achievement of the two genders are likely to contribute disparities in the allocation of cognitive roles in the world or work. Much research on gender differences in testing relate to the type of examination used in educational testing. Essay and multiple-choice type of tests is the most popular item formats used in educational institutions around the world (Tozoglu, Gurses & Dogar, 2015).Ferber (2016) observed that not only did male students outperformed female students on multiple choice questions but also on essay examinations. For a course on Principles of Economics, male students outperformed female students on the essay section of the examination, while for a course in Mathematics, the female students performed significantly better than male students on the essay section of the examination. In general, most of the researchers found that female students significantly outperformed male students on the easy examination, while the better performance of male students on the multiple-choice examination was not significant.

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Research design

The study employed quasi–experimental research design involving the non-randomized pretest, posttest, control group design. Quasi–experimental research design is considered suitable for the study because randomization of subjects was not feasible as intact classes constituted the two groups that were used for the study. Uzoechi (2015) posited that the use of such designs that does not involve randomization is called quasi-experimental design. The choice of this design is to avoid disruption of normal school programme. The study comprised an experimental group (A) and a control group (B). The experimental group A was exposed to the use of problem-based learning strategy while the control group (B) was exposed to the use of conventional method. The researcher built in factor (gender) as independent moderator variable.

Population

The population of the study comprised 5,638 (3,820 male and 1,818 female SS II Mathematics students from 10 public secondary schools inKwali Area Council for the 2024/2025 academics session (SEB, 2025). The choice of public secondary schools was to avoid the effect of disruption that could emanate from disparity in school calendar between the public and private secondary schools as most of the private secondary schools in Kwali Area Council do not comply strictly with the school calendar produced by the FCT, Abuja. The choice of SS II students is informed by the fact that students at this level are assumed to have acquired some basic Mathematics concepts, knowledge and skills in SS I to enable them attempt the pretest items. Furthermore, the choice of SS II was to avert the disruption that may arise as a result of the conduct of WAEC and NECO, since they are not in their final examinations class. Thus, the common characteristic of the population is that they are SS II students in public secondary schools in Kwali Area Council.

Sample and Sampling Technique

The sample for this study consisted of 195 (111 male and 84 female) SS II Mathematics students from two senior secondary schools in Kwali Area Council. The number of students that participated in group A was 125 students (72 male and 53 female) and those of group B was 70 students (39 male and 31 female) SS II students from Kwali Metropolis were selected because data from Education Resource Centre in Federal Capital Territory, Abuja showed that students in Kwali was among the least in Mathematics performance relative to other Council Areas of the Federal Capital Territory. Also, stratified sampling technique was used to select two (2) SSII Mathematics teachers in each of the schools selected to serve as research assistant.

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Method of Data Collection

The researcher developed instrument: Mathematics Achievement Test (MAT) was used for data collection. The instrument was 50-items multiple choices of 4 options Mathematics Achievement Test. The test items covered three topics namely: Basic algebraic operations, Algebraic expressions, Linear equations and Algebraic Fractions. These topics are included in the SS2 syllabus.

Validity

Face and content validity was obtained for MAT by subjecting the instruments to critical appraisal of two research experts in the Faculty of Education, Nasarawa State University, Keffi. One from Department of Educational Foundations and the second one from Science, Technology and Mathematics Education. The experts validated the instruments by checking for appropriateness, comprehensiveness and relevance of the items for the stated purpose. They also checked for adequacy and agreement of MAT with the test blueprint to ensure its face and content validity. The logical indices of 0. for MAT

Reliability

To determine reliability of the instrument, MAT was pilot tested on a portion of the accessible population that was not part of the sample for the study. The instruments were pilot tested on 30 (20 male and 10 female) Mathematics students in Government Secondary School, Yangoji. Kuder-Richardson 21 Formula. The reliability coefficients of 0.83 was obtained for MAT.

Techniques for Data Analysis

Descriptive statistics was used to get the group mean scores and the standard deviation of students' achievement in MAT. The choice of mean and standard deviation was because the data related to students' achievement is continuous variable generated through interval scale of measurement. The mean score was used to compared the mean of the groups to answer research questions. The null hypotheses were tested using ANCOVA at alpha 0.05 level of significance. All analyses were done using Statistical Package for Social Sciences (SPSS).

Results and Discussions

Data were analysed and findings were presented and discussed as follows:

Research Question 1: What are the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using conventional method in Kwali Metropolis Abuja?

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The researcher used the MAT scores of pre-test and post-test of both experimental and control groups respectively and computed the mean and standard deviation to ascertain the achievement gain as shown in table 1.

Table 1: MAT Mean scores and Standard Deviation of Students for Experimental and Conventional Groups

Groups	No. of Students	Pretest		Posttest	
		Mean	SD	Mean	SD
Experimental Group (EG)	125	23.43	10.01	41.18	13.51
Conventional Group (CG)	70	22.64	11.07	35.26	15.45

Table 1, shows that students in experimental group had mean score of 23.43 and 41.18 in pretest and posttest respectively, and standard deviation of 10.01 and 13.51 in CAT. Also, students in control group had mean scores of 22.64 and 35.26 in pretest and posttest respectively, and standard deviation of 11.07 and 15.45 in MAT.

Research Question 4: What are the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy?
The researcher used the CAT scores of pre-test and post-test of male and female students in experimental group only and computed the mean and standard deviation to ascertain the achievement gain as shown in table 4.4.

Table 2: MAT Mean scores and Standard Deviation of Male and Female Students in Experimental Group

Group	Gender	No. of Students	Pre-test		Post-test	
			Mean	SD	Mean	SD
Experimental	Male	72	13.43	4.11	21.48	5.57
	Female	53	13.13	4.12	20.68	5.47

Table 2 shows MAT pre-test and post-test mean score and standard deviations of male and female students in experimental group. The result indicates that both male and female students in experimental group exhibited closely similar mean scores before the treatment as reflected by their relatively closed values of pre-test mean scores of 13.43, 13.13 and standard deviations of 4.11, 4.12 for the group. The result also reveals that students in the groups (EG) had relatively closed values of post-test means scores of 21.48, 20.68 and standard deviations of 5.57, 5.47 as segregated by gender.

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Testing of Hypotheses

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using conventional method.

To test null hypothesis 1, the mean achievement scores for experimental and control groups from pre-test and post-test with MAT were compared using ANCOVA and the results obtained are presented in Table 3.

Table 3: Summary of ANCOVA for Students' Achievement Scores in MAT in Experimental and Conventional Groups

Source of Variation	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected model	44304.51	2	22152.27	0.499	0.002
Intercept	620.98	1	253.17	0.486	0.002
Pretest	6462.21	1	2594.72	0.426	0.002
Groups	41308.83	1	168.23	21.243	0.002
Error	5953.28	193	46.26		
Total	344586.01	195			
Corrected Total	50257.81	194			

Table 3 shows ANCOVA test for significant difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and Conventional Group. At df=1, 193, F =21.243, P-value=0.002 ($p<0.05$).This suggested a statistically significant difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using the conventional method Thus, the null hypothesis two is therefore rejected. Hence, there was a difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using the conventional method. This implies that students taught Mathematics using problem-based learning strategy gained higher mean achievement scores than their counterpart students in conventional method.

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy.

Table 4: Summary of ANCOVA for Male and Female Students' Achievement Scores in MAT in Experimental Group

Source of Variation	Type III Sum of Squares	Df	Mean Square	F	Sig
Corrected model	30304.51	2	15152.27	156.010	0.002
Intercept	720.91	1	723.17	541 412	0.002
Pre-test	7462.21	1	94.72	12.425	0.002
Groups-Gender	41308.83	1	978.23	407.160	0.002

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Source of Variation	Type III Sum of Squares	Df	Mean Square	F	Sig
Error	5353.20	123	2.26		
Total	134586.01	125			
Corrected Total	360257.83	124			

Table 4 shows ANCOVA test for significant difference in the mean achievement scores of male and female students taught Mathematics in experimental (Problem-based learning Strategy) Group. At df=1, 123, F=407.160, P-value=0.002 ($p<0.05$). This suggested a statistically significant difference in the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy. Thus, the null hypothesis four is therefore rejected. Hence, there was a difference in the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy. This implies that treatment had a significant effect on the academic achievement of male and female students' taught Mathematics using problem-based learning strategy.

Discussion of Findings

Findings based on research question 1 shows mean and standard deviations for difference in the mean achievement scores of students taught Mathematics using the problem-based learning strategy and those taught using the conventional teaching method. The variation in the pre-test and post-test mean achievement scores for experimental group is 17.75 and 12.62 for conventional group as mean achievement gains. This is an indication that students taught Mathematics using the problem-based learning strategy gains higher achievement than their counterpart students in conventional group. This finding negates the null hypothesis 1 earlier formulated by the researcher. Specifically, the result indicated that there was significant difference in the mean achievement scores of students taught Mathematics using the problem-based learning strategy and scores of those taught using conventional method. This finding is in agreement with the findings of Abiodun (2024) which determined the effects of problem-based learning strategy on Secondary School Mathematics students' academic achievement and reported that that there was a significant difference in the mean achievement scores of the mathematics students in the conventional group and experimental groups before the intervention. In addition, the findings are similar to that of Bukari and Asiedu-Addo (2019) which examined the effect of problem-based learning on Colleges of Education students' achievement and attitude toward Probability and reported that there was a statistically significant difference between students of the experimental group exposed to problem-based learning approach and control group exposed to traditional method. It shows that the student's problem-solving skills and thinking abilities had improved when the PBL instructional

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strategy was used in teaching Mathematics. A good instructional strategy should motivate students to make them understand and reflect on what content they have been exposed and help to develop their critical thinking and problem-solving skills. With this, PBL can improve analytical skills through evaluation and inferences of data.

Findings based on research question 2 shows mean and standard deviations for difference in the mean achievement scores of male and female students taught Mathematics using the problem-based learning strategy. This finding negates the null hypothesis 4 earlier formulated by the researcher. Specifically, the result indicated the significant difference in the achievement means scores of male and female students taught Mathematics using the problem-based learning strategy. Hence, there was a significant difference in the mean achievement scores of male and female students taught Mathematics using the problem-based learning strategy. This finding is in agreement with the findings of Obaseye, Owolabi and Kayode (2021) which examined the effect of the problem-based learning (PBL) approach on students' academic performance in senior secondary Mathematics and reported that problem-based learning approach enhanced students' academic performance in Mathematics ($F_{1, 108}= 7.130$; $p = (0.009) < 0.05$). It also reported that gender has no main effect on the academic performance of students ($F_{1, 108}= 0.051$; $p = (0.821) > 0.05$). Also, there was no significant interaction effect of PBL and gender on students' academic performance in Mathematics ($F_{1, 108}= .000$; $p = (.985) > .05$). In addition, the findings are similar to that of Iji, Emiakwu and Utubaku (2015) which determined the effect of problem-based learning on Senior Secondary School students' achievement in trigonometry and reported that there was no significant interaction effect between teaching method and gender on students' achievement in trigonometry. The major findings of the study revealed that:

1. There was significant difference in the mean achievement scores of students taught Mathematics using problem-based learning strategy and those taught using the conventional teaching method.
2. There was no significant difference in the mean achievement scores of male and female students taught Mathematics using problem-based learning strategy in Kwali Metropolis, Abuja.

Conclusion

Based on the findings of this study, the study concluded that PBL as a student-centered approach is effective in the teaching and learning of Mathematics to improve students' achievement. More so, it was found that PBL was gender insensitive and therefore the method is applicable to both male and female students. The study therefore concluded that Problem Based Learning is a more effective approach, which mathematics teachers as well as other subjects' area teachers need to incorporate into their teaching. An

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advantage of problem-based learning strategy over the traditional method could be attributed to the fact that students are free to share ideas in a group. Students who are exposed to problem-based learning strategy are more likely to possess a meaningful in-depth knowledge of the content area.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. That Mathematics teachers should adopt the use of problem-based learning strategies to enhance students' academic achievement in Mathematics.
2. Mathematics teachers should design contextual task that allows students to connect abstract classroom concepts to real-world scenarios.
3. Mathematics teachers integrate PBL strategy into classroom instruction to foster improved achievement and retention and that training workshops be organized to equip teachers with the necessary skills for effective PBL implementation.
4. That workshop should be organized by the FCT Education Resource Centre to train teachers with the requisite knowledge and skills to teach mathematics, especially problems.

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