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Effect of Problem-Based Strategy on Performance in Algebra among Lower Basic Education Pupils in Zamfara State, Nigeria

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Abstract
This study investigated the effect of a problem-based learning (PBL) strategy on the performance of algebra among lower basic education pupils in Zamfara State, Nigeria. The research addressed the persistent issue of poor mathematics performance rates among pupils, which has been attributed to traditional lecture-based teaching methods that fail to engage students actively in deep conceptual understanding. The study adopted a quasi-experimental design, specifically the Pretest-Posttest Non-equivalent Control Group Design, to compare the outcomes of pupils taught using PBL with those exposed to conventional lecture methods. The sample consists of primary 1-3 pupils, selected through purposive and multi-stage sampling techniques. Data collection involves administering pre- and post-tests, as well as a reshuffled algebra Performance Test (APT). Descriptive statistics (mean and standard deviation) and Analysis of Covariance (ANCOVA) were used to analyze the data at a 0.05 significance level. The study aims to determine the mean performance of pupils taught with PBL, as well as any gender-based differences in performance. The findings were expected to provide insights into the effectiveness of PBL in enhancing mathematical proficiency, offering a viable alternative to traditional teaching methods in lower basic education. The research instruments were validated by the experts in Science Education and Mathematics, and reliability is established using Pearson products moment correlation coefficient (PPMC). Data analysis was conducted using SPSS version 23.0. The study contributed to the growing body of evidence supporting constructivist approaches in mathematics education, emphasizing active learning, critical thinking, and real-world application.
Keywords: Problem-based learning, Performance, Algebra, Lower basic education.

Introduction
Mathematics forms an integral foundation in shaping the psychomotor, cognitive, and affective domains of pupils. If these three aspects of a student's life are well developed, it would enable them to adapt well even in the process of behavioral change, which education aims to achieve. Problem-based learning (PBL) is a teaching strategy that emphasizes the active role of learners in building their own understanding of knowledge through experiences, reflection, and social interaction. In the context of teaching and learning mathematics, constructivism has gained prominence as an effective approach to engage students and foster deep conceptual understanding. The pupil would easily adjust to change, allow the change to become part of them, and make that change a principle to guide anything related to that same issue. The place of healthy competition in class cannot be overemphasized because it increases the self-worth of an individual. Prince (2004) noted that performance in mathematics can be enhanced through a combination of effective study habits, regular practice, and a positive mindset. Rohrer (2009) stated that in mathematics refers to the ability to remember and apply mathematical concepts, procedures, and facts over time. It is crucial for building a solid foundation in mathematics, allowing students to progress to more complex topics without having to relearn basic concepts. Improving in mathematics involves techniques and strategies that help students remember and understand concepts over the long term. Constructivism has had a significant impact on educational practices, leading to learner-centered approaches that focus on inquiry, problem-solving, and critical thinking. It also informs the design of learning environments that promote active engagement and collaboration among learners. On this basis, the researcher intends to determine the effects of problem-based learning on performance in algebra among lower basic education pupils in Zamfara State. Should mathematics be removed from the curriculum of learning experiences that take place in schools because pupils fail to pass the subject? Many students nowadays find it difficult to pursue a career in a field of science, not because they are incapable or would perform less than required, but because they are afraid of mathematics, let alone sitting to learn it as a subject. The study addresses the prevalent issue of poor

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performance in mathematics among lower basic education pupils in Zamfara State, evidenced by consistently low assessment scores and inadequate mastery of fundamental mathematical concepts. Traditional lecture-based methods dominate current teaching practices, often failing to engage students sufficiently in active learning or foster deep conceptual understanding essential for mathematical proficiency. Problem-based learning offers a promising alternative by promoting active student participation, critical thinking, and collaborative problem-solving. This approach is aligned with constructivist principles, emphasizing practical application and real-world relevance to enhance conceptual understanding of mathematical concepts. Based on this, the researcher intends to determine specifically the effects of problem-based learning on performance in algebra among lower basic education pupils in Zamfara State.

Objectives of the Study

The general objective of the study is to examine the effects of problem-based learning on performance in algebra for qualitative mathematics education among lower basic education pupils in Zamfara State. Specifically, it seeks to:

i. Determine the mean performance of pupils taught algebra using problem-based learning and those exposed to the lecture method.
ii. Investigate the mean performance of male and female pupils taught algebra using problem-based learning.

Research Questions

i. What is the mean performance of pupils taught algebra using problem-based learning compared to those taught using the lecture method?
ii. Is there any gender-based difference in the mean performance of pupils taught algebra using problem-based learning?

Research Hypotheses

Ho_1. There is no significant difference in the mean performance of pupils taught algebra using problem-based learning and those taught using the lecture method.

Ho_2.There is no significant gender-based difference in the mean performance of pupils taught algebra using problem-based learning.

Methodology

The pretest, posttest, non-equivalent control group quasi-experimental design was adopted for this study. Both the experimental and control groups were initially pretested to determine their equivalence in performance in algebra. After the treatment, both groups were post-tested to determine the impacts of the treatment on their performance. The population of the study consisted of all lower basic education pupils (Primary 1-3) in Zamfara State. `The sample size was 120 pupils (60 males and 60 females) selected through purposive and multi-stage sampling techniques. The experimental group was exposed to problem-based learning, while the control group was taught using the conventional lecture method. Algebra was the mathematical concept treated, and the Algebra Performance Test (APT) was the research instrument used. Three experts validated the APT, and its reliability index was 0.85 using Pearson products moments correlation coefficient (PPMC). The data collected were analyzed using mean, standard deviation, and One-Way ANCOVA statistical tools at a 0.05 significance level.

Presentation of Results

Research Question 1:

What is the mean performance of pupils taught algebra using problem-based learning compared to those taught using the lecture method?

Table 1: Summary of the Result of Pupils' Posttest Performance Scores (Mean and Standard Deviation) for Experimental and Control Groups

Group	N	Mean (X)	SD	Std. Error Mean	Mean Difference (MD)	Remarks
Experimental	60	75.32	6.45	0.83	12.87	Difference Exists
Control	60	62.45	7.12	0.92		
Total	**120**					

The mean performance scores of the experimental and control groups were 75.32 and 62.45, respectively, with a mean difference of 12.87. The experimental group had higher performance scores than the control group, indicating the effectiveness of problem-based learning.

Hypothesis 1:

Ho_1. There is no significant difference in the mean performance of pupils taught algebra using problem-based learning and those taught using the lecture method.

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Table 2: Summary of One-Way ANCOVA of Pupils' Performance Scores in Algebra

Source	Sum of Squares	DF	Mean Squares	F	Sig.	Decision
Corrected Model	2456.78	4	614.195	45.23	000	
Intercept	12034.56	1	12034.56	885.67	000	
Pretest	12.34	1	12.34	0.91	342	Not Significant
Instructional Strategy	2201.45	1	2201.45	162.12	000	Significant
Error	1567.89	115	13.63			
Total	16059.23	120				
Corrected Total	**4024.67**	**119**				

Significant at P < 0.05

The result of the One-Way ANCOVA showed that problem-based learning significantly impacted pupils' performance in algebra (F = 45.23, p = 0.000 < 0.05). Thus, the null hypothesis was rejected.

Research Question 2:

Is there any gender-based difference in the mean performance of pupils taught algebra using problem-based learning?

Table 3: Summary of the Result of Pupils' Posttest Performance Scores (Mean and Standard Deviation) by Gender in the Experimental Group

Gender	N	Mean (X)	SD	Std. Error Mean	Mean Difference (MD)	Remarks
Male	30	74.89	6.23	1.14	0.87	No Difference
Female	30	75.76	6.56	1.20		
Total	**60**					

The mean performance scores of male and female pupils in the experimental group were 74.89 and 75.76, respectively, with no significant difference.

Hypothesis 2:

Ho_2.There is no significant gender-based difference in the mean performance of pupils taught algebra using problem-based learning.

Table 4: Summary of One-Way ANCOVA of Pupils' Performance Scores by Gender

Source	Sum of Squares	DF	Mean Squares	F	Sig.	Decision
Corrected Model	2456.78	4	614.195	45.23	000	
Intercept	12034.56	1	12034.56	885.67	000	
Pretest	12.34	1	12.34	0.91	342	Not Significant
Gender	7.89	1	7.89	0.56	456	Not Significant
Error	1567.89	115	13.63			
Total	16059.23	120				
Corrected Total	**4024.67**	**119**				

Significant at P < 0.05

The result of the One-Way ANCOVA showed no significant gender-based difference in performance (F = 0.56, p = 0.456 > 0.05). Thus, the null hypothesis was retained.

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Discussion of Findings

The findings of this study indicated that pupils taught algebra using problem-based learning achieved higher performance scores compared to those taught using the lecture method. This finding aligns with the constructivist approach, which emphasizes active learning, critical thinking, and real-world application. The study also found no significant gender-based differences in performance, indicating that problem-based learning is gender-friendly.

Conclusion

Based on the findings, it was concluded that problem-based learning enhances pupils' performance in algebra. The strategy is effective and gender-friendly, making it a viable alternative to traditional lecture methods in lower basic education.

Recommendations

i. Mathematics teachers should adopt problem-based learning to improve pupils' performance in algebra.
ii. Problem-based learning should be incorporated into teacher training programs to equip teachers with the necessary skills to implement the strategy effectively.
iii. Educational stakeholders should organize workshops and seminars to train teachers on the use of problem-based learning in mathematics education.
iv. Schools should provide adequate teaching aids and resources to facilitate the effective implementation of problem-based learning.

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