# Effect of a Constructivist Approach on Students' Problem-Solving Skills in Mathematics Education

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## Abstract

The study investigated the impact of a constructivist approach on students' problem-solving skills in mathematics education on secondary school students' performance in Emohua Local Government area, Rivers State. The study employed a pre-test, post-test, and non-random control group quasi-experimental research design involving a sample of 84 mathematics students from a population of senior secondary school students. Two research questions and hypotheses were used for this study. The mean and standard deviation were used to analyse and answer the research questions, while the hypotheses were tested using ANCOVA statistics at a 0.05 level of significance. A 25-item instrument, Constructivist Problem-Solving Mathematics Test (CPMT) was used to gather data, and was validated for content and face validity. A reliability coefficient of 0.86 was obtained using Kuder-Richardson 21 (KR21). The results revealed that there is a significant difference between the mean scores of students taught mathematics with a constructivist approach and those taught mathematics with a lecture method. Also, there is no difference in the problem-solving skills of mathematics male and female students taught using a constructivist approach. Based on these findings, the study recommended, among others, that there is a need for mathematics teachers to approach the teaching of mathematics with more innovative approaches. This includes a constructivist-based teaching strategy to develop students' problem-solving skills in mathematics.

**Keywords: Constructivist Approach, Mathematics, Problem-Solving, Students' Performance**

## Introduction

Mathematics education is key to building students' problem-solving skills, which are essential for both school and daily life. Beyond academics, mathematics is practical and helps tackle real-world challenges (Rudzinska, 2024). Yet, traditional teaching methods often fail to equip students with these skills. Thus, educators explore alternatives like the constructivist approach, emphasizing active learning and conceptual understanding.

Constructivists focus more on learning than teaching, emphasizing the need for interactive and supportive environments where students actively engage with their teacher and peers to build knowledge (Olaoye et al., 2024). This approach centers on the learner, helping them understand and apply new information by connecting it to what they already know and developing new ideas as their understanding grows (Ruchiyat et al., 2024). This differs from the traditional teaching approach, which is primarily a repetitive activity where students eventually regurgitate information in tests. The lecture method is a type of lecture by which the teacher gives lessons by word of mouth the knowledge acquired by the students. It usually takes the form of a verbal presentation of the subject or content being taught (Onyemerekeya, 2004). The student-centered approach focuses on cognitive processes and social interaction, facilitating knowledge construction (Atteh, 2022). In constructivism, students collaborate in problem-solving tasks, fostering practical solutions and diverse outcomes. Students actively engage with maths concepts through this approach, developing critical thinking and reasoning (Jaspreet & Jaswinder, 2022). Anigbo and Ndukwe (2019) argued that the constructivist approach to teaching gives learners the opportunity for concrete, contextually meaningful experience through which they can search for patterns, raise questions, and model, interpret, and defend their strategies and ideas. They communicate, justify solutions, and participate in discussions which develop communication skills that help in connecting maths to real-world situations, hence promoting understanding and appreciation for the subject.

Problem-solving is integral to development (Jaspreet & Jaswinder, 2022). According to Xiao and Liu (2024), problem-solving is a way of thinking, making one focus, and finding how to reach a goal. It often involves coming up with a new method to tackle the problem. This definition has three parts:

1. Problem-solving involves the cognitive domain, which occurs internally in the mind and must be inferred indirectly from behavior.
2. Problem-solving is a process that involves the manipulation of representation (or carrying out computations) and
3. Problem-solving is directed, as it is guided by the goals of the knowledge problem solver. In sum, problem-solving is cognitive processing directed at transferring an issue from the given state to the goal state when the problem solver is not immediately aware of a solution method, which is very important in learning.

Problem-solving skills are an essential part of learning mathematics (Ruchiyat et al., 2024). They play a key role in the mathematics curriculum, making problem-solving ability one of

the fundamental skills students need to develop in mathematics (Solihah et al., 2024). Problem-solving involves finding solutions to challenges and achieving goals that are not easily attainable (Roorda et al., 2024). Nampung and Mone (2023) investigated improving students' problem-solving abilities through a constructivist approach. The results showed that students who learned using the constructivist approach achieved minimal completeness, and there was an increase in the mathematical problem-solving ability of students who learned through the constructivist approach. Learning with a constructivist approach can facilitate the problem-solving ability of high school students. Ruchiyat et al. (2024) studied the application of a constructivist approach to improving the mathematical problem-solving abilities and self-concept of junior high school students. They found that learning using the constructivist approach can have a good effect on students' mathematical problem-solving abilities and a good grasp of concepts by students towards learning mathematics. The male participants outperformed the female participants in the experimental group; however, the observed mean difference was not statistically significant. 0.05 alpha level. Olaoye et al. (2024) carried out a study on the effects of a constructivism-based blended learning approach on senior secondary school students' mathematics academic performance and retention. The findings of this study showed that there was a significant difference between the mean academic performance scores of students taught mathematics with a constructivism-based blended learning approach and those in the control group. There is no significant difference between the mean achievement scores of male and female students taught mathematics with a constructivism-based blended learning approach.

Yakubu and Jungudo (2023) also investigated the constructivist approach as a gateway to improving students' performance in indices and logarithms. It was found that with the intervention using this approach, students understand indices and logarithms better. The study also found that students develop an interest in learning indices and logarithms when given a chance to interact among themselves, with the instructor serving as a facilitator of learning.

Caraan et al. (2023) investigated the effectiveness of the realistic mathematics education approach on the problem-solving skills of students. The result showed that there is a highly significant difference in the mean pre-test and post-test performance of the respondent before and after using the RME approach in all four phases of problem-solving. This implies that RME is an effective teaching approach that successfully improves the mathematical proficiency of the students, especially in all aspects of problem-solving skills. Dentists et al (2024) investigated the impact of a realistic mathematics education (RME) intervention on

students' mathematical problem-solving skills. This study shows the positive impact of the RME intervention on students' problem-solving skills.

Adie et al. (2020) investigated the effects of the constructivist method of teaching basic science and mathematics on the academic performance of junior secondary school 3 students in Calabar Municipality, Cross River State, Nigeria. The result showed that students taught using the constructivist method had a higher mean than those who were taught using the traditional lecture method. Male students outperformed the female students, and gender was not significant.

**Statement of the problem**

The Nigerian mathematics curriculum emphasizes the importance of using mathematics in everyday life through the identification and use of relevant methods, such as teaching through constructivism. To help their students succeed in secondary school and beyond, primary school teachers must have strong mathematical backgrounds. Concept representation of all mathematical ideas needs to be taught with the help of practical activities and guidance from the teachers so that students can develop the concepts on their own. The constructivist approach in mathematics education significantly enhances students' problem-solving skills. This approach encourages active learning, critical thinking, and collaborative problem-solving, leading to students who are proficient in tackling mathematical challenges with confidence and creativity. Unfortunately, the limitations of traditional teaching methods in adequately nurturing these skills lead to a gap between educational aspirations and practical outcomes. To address this challenge, educators are increasingly turning to constructivist approaches, which emphasize active learning and conceptual understanding.

Despite growing interest in constructivist approaches, the effectiveness of constructivist approaches in enhancing students' problem-solving skills remains limited, particularly in the context of mathematics education. Thus, there exists a notable research gap necessitating a comprehensive investigation into the impact of a constructivist approach on students' problem-solving abilities in mathematics education.

**Aim and objectives of the study**

This study aims to explore the effect of the constructivist approach on students' problem-solving skills in mathematics education in Rivers State. Specifically, this study seeks to

1. Determine the difference between the mean scores of students taught mathematics with the constructivist approach and those taught mathematics with the lecture method.
2. Examine the difference between the mean scores of students' problem-solving skills taught mathematics with a constructivist approach to gender.

**Research Questions**

The following questions guided the researcher to undertake this study:

1. What is the difference between the mean scores of students' problem-solving skills taught mathematics with a constructivist approach and those taught mathematics with the lecture method?
2. What is the difference between the mean scores of male and female students' problem-solving skills taught mathematics with a constructivist approach?

**Hypotheses**

The following null hypotheses guided the study at a 0.05 level of significance.
H01: There is no significant difference between the mean scores of students' problem-solving skills taught mathematics with a constructivist approach and those taught mathematics with the lecture method.

H02: There is no significant difference between the mean scores of male and female students' problem-solving skills taught mathematics with a constructivist approach.

**Scope of the study/Area of the study**

The study is carried out in Emuoha Local Government Area in Rivers State among senior secondary school 2 (SSS2) Mathematics students. The students were taught linear and quadratic equations. The teaching methods used are the constructivist approach and the lecture method. Emuoha is a town and the headquarters of Emuoha Local Government Area of Rivers State. It has eight villages with an area of 831 km2(321 sq mi) and a population of 201,901 at the 2006 census. The people of the area are farmers, fishermen, and businessmen. There are higher institutions of learning and industries in the area.

**Methodology**

The design for this study was a non-randomized pre-test-post-test, quasi-experimental design. involving a sample of 84 students from a population of 1456 senior secondary school 2 (SSS2) students from two schools from Emuoha local government area. There were 43 students in the experimental group and 41 students in the control group. The experimental group was taught mathematics with a constructivist approach, while those in the control group were taught mathematics with a lecture method. The instrument for data collection was a 25-item constructivist problem-solving mathematics test (CPMT). It was used to measure students' problem-solving in mathematics. The constructivist problem-solving mathematics test (CPMT) had two sections. Section A had 20 multiple-choice questions, whereas Section

B had 6 essay-type questions, for which students had the option to select only 5 questions from the set. The instrument was scored 50 marks, 1 mark for the correct answer, while a zero mark was given to the wrong answer in section A, making a total of 25 marks. In section B, each was scored 5 marks, giving a total of 25 marks. The constructivist-solving mathematics test (CPMT) was validated using Pearson product moment correlation. The reliability of the Problem-solving Mathematics Test (CPMT) was determined using Kuder-Richardson, KR-21, and obtained a coefficient of r = 0.86. Data were analysed using mean and standard deviation to answer the research questions and analysis of covariance (ANCOVA) to test for the hypotheses at 0.05 level of significance.

**Results and Discussion**

**Research Question 1:** What is the difference between the mean scores of students taught mathematics with a constructivist approach and those taught mathematics with a lecture method?

**Table 1: Mean, Standard Deviation, and gain scores between the student's problem-solving skills when taught Mathematics with a constructivist approach and lecture method**

| | | Pre-test | | Post-test | | |
|---|---|---|---|---|---|---|
| Method | n | $\bar{x}\bar{x}$ | SD | $\bar{x}\bar{x}$ | SD | Mean Gain |
| Constructivist approach | 43 | 9.28 | 3.14 | 19.67 | 5.95 | 10.40 |
| Lecture method | 41 | 9.93 | 2.41 | 11.73 | 2.53 | 1.80 |

**Research Question 2:** What is the difference between the mean scores of male and female students' problem-solving skills taught mathematics with a constructivist approach?

**Table 2: Mean and Standard Deviation of Gender-Taught Mathematics using an approach to students' problem-solving skills**

| | | Pre- test | | Post – test | | |
|---|---|---|---|---|---|---|
| Method | n | Mean | SD | Mean | SD | Mean Gain |
| Male | 36 | 9.94 | 2.93 | 16.78 | 6.32 | 6.83 |
| Female | 48 | 9.33 | 2.72 | 15.06 | 5.85 | 5.72 |

Table 2 shows the pre-test and post-test scores of male and female mathematics students (9.94 and 16.78), and female ( 9.33 and 15.06) respectively. Male students had a mean gain of 6.83 while female students had a mean gain of 5.72. This implies that there is a difference

between the problem-solving skills of male and female students taught mathematics with constructivism. The male students gained more.

**$H0_1$:** There is no significant difference between the mean scores of students taught mathematics with a constructivist approach and those taught with the lecture method.

**Table 3: Summary of Analysis of Covariance (ANCOVA) of the difference between the mean on the problem-skills of the students in mathematics taught using the constructivist approach and lecture method.**

Depended on variable: Post-test

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 1359.707[a] | 2 | 679.853 | 32.282 | .000 |
| Intercept | 2088.945 | 1 | 2088.945 | 99.191 | .000 |
| Pretest | 35.638 | 1 | 35.638 | 1.692 | .197 |
| Methods | 1256.789 | 1 | 1256.789 | 59.677 | .000 |
| Error | 1705.853 | 81 | 21.060 | | |
| Total | 24029.000 | 84 | | | |
| Corrected Total | 3065.560 | 83 | | | |

a. R Squared = .444 (Adjusted R Squared = .430)

** P < 0.05 significant at the 0.05 level*

The result from Table 3 shows the summary of the analysis of covariance (ANCOVA) of the main effect of treatment on the problem-solving skills of the students in mathematics. It shows that there is a significant difference between the mean scores of students taught mathematics with a constructivist approach and those taught with the lecture method ($F(1, 81) = 59.677$, $p<.05$). The null hypothesis one was rejected at the 0.05 level of significance.

**Table 4: Least Significant Difference Post Hoc Analysis of students' academic problem-solving skills based on Teaching Method**

Pairwise Comparisons

Dependent Variable: Posttest

| (I) Methods | (J) Methods | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| Constructivist Approach | Lecture method | 7.791* | 1.008 | .000 | 5.784 | 9.797 |
| Lecture method | Constructivist Approach | -7.791* | 1.008 | .000 | -9.797 | -5.784 |

Based on estimated marginal means

*. The mean difference is significant at the 0.05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 4, which shows the least significant difference in post-HOC analysis of students' problem-solving skills classified by teaching methods, reveals a mean difference of 7.791 and a p-value of 0.001 ($p < 0.05$) between the effect of the constructivist approach and without the constructivist approach. This indicates that the students taught using the Constructivist Approach contributed more to the significant difference in the effects of the Teaching methods on students' problem-solving skill

**Hypothesis 2:** There is no significant difference between the problem-solving skills of male and female students taught Mathematics with a Constructivist approach

**Table 5: Summary of Analysis of Covariance (ANCOVA) of the main effect of treatment on the problem-skills of the male and female students taught mathematics using a Constructivist problem-solving approach.**

| constructivist | Type III Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 182.659[a] | 2 | 91.330 | 2.566 | .083 |
| Intercept | 2600.467 | 1 | 2600.467 | 73.065 | .000 |
| Pretest | 122.134 | 1 | 122.134 | 3.432 | .068 |
| Gender | 79.742 | 1 | 79.742 | 2.240 | .138 |
| Error | 2882.900 | 81 | 35.591 | | |
| Total | 24029.000 | 84 | | | |
| Corrected Total | 3065.560 | 83 | | | |

a. R Squared = .060 (Adjusted R Squared = .036)

The result from Table 5 shows the summary of Analysis of Covariance (ANCOVA) of the difference between the problem-solving skills of male and female students. It shows that there is no significant difference between the mean score of the problem-solving skills of male and female students taught mathematics with a constructivist approach and those taught with the lecture method. ($F(1,84) = 2.240$, $p>.05$). The null hypothesis two was retained at .05 level of significance.

**Discussion of Findings**

The findings revealed that the constructivist approach was able to improve the performance of the students in the problem-solving approach in mathematics than when the students were taught linear and quadratic equations with the traditional lecture method. This could be attributed to the teacher-friendly nature of the teaching method employed. The result from

Table 3 showed that there is a significant difference between the mean scores of students taught mathematics with constructivism and those taught Mathematics with the lecture method; therefore, the null hypotheses are rejected. The findings of the study therefore maintain that the application of the constructivist approach in teaching mathematics can help students in secondary schools to improve their problem-solving skills in mathematics. ivistMathematics. This supports the finding of Caraan et al. (2023); Nampung and Mone (2023); Ruchiyat et al. (2024); and Yakubu and Jungudo (2023) that the use of a constructivist approach in teaching improves the problem-solving skills of students when taught mathematics.

The result from Table 2 showed that improved students have higher problem-solving skills compared to their female counterparts. That is, the male participants outperformed the female participants in the constructivist approach; however, the observed mean difference was not statistically significant. 05 level of significance, and as such, the null hypothesis was retained. This could be that both male and female students participated in class. Which is in line with the work of Adie et al. (2020) and Olaoye et al. (2024), there is no significant difference between the mean achievement score of male and female students' taught Mathematics with constructivism-based blended learning approach.

**Conclusion**

The findings of this study indicated a significant positive effect of the constructivist approach on students' problem-solving skills in Mathematics education. Through the implementation of the constructivist approach, students demonstrated a substantial improvement in problem-solving abilities compared to those taught without using the constructivist approach. Moreover, the study explored the difference in problem-solving skills based on gender among students taught using the constructivist approach. While male students showed a slightly higher mean gain compared to female students, the constructivists were not statistically significant. This suggests that the constructivist approach equally benefits both male and female students in developing problem-solving skills in Mathematics education.

**Recommendations**

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

1. There is a need for educators to incorporate constructivist teaching methods into Mathematics education curricula to foster students' problem-solving skills development in mathematics.
2. The teachers should be trained to acquaint themselves with the knowledge of constructivist pedagogies.

3. Funds should be made available to purchase the necessary teaching materials for the constructivist approach in schools.

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