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# IMPLEMENTATION AND IMPACT OF INNOVATIVE TEACHING METHODS ON PROBLEM-SOLVING SKILLS AMONG STUDENTS AND LECTURERS IN FCT COLLEGE OF EDUCATION, ZUBA-ABUJA

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## ABSTRACT
This paper explores the significance of problem-solving in mathematics education and the challenges associated with traditional teaching methods, emphasizing the need for innovative approaches. At FCT College of Education, Zuba, there is a concerted effort to prioritize excellence in mathematics education, recognizing its broader implications beyond the classroom. The study investigates the implementation and impact of innovative teaching methods on problem-solving skills among students and lecturers. Through surveys, observations, and document analysis, the research assesses various approaches' effectiveness, such as real-world problem integration, technology incorporation, and personalized learning. Results suggest a positive perception of innovative methods, highlighting their value in enhancing problem-solving abilities. Additionally, the study underscores the importance of tailored assessments and lecturer support in effectively implementing these approaches. Recommendations include further exploration of innovative methods, collaboration, and resource allocation to improve mathematics education and prepare students for real-world challenges.

**Keywords:** Problem-solving, Mathematics education, Traditional teaching methods, Innovative approaches.

## 1. INTRODUCTION
Mathematics education is a fundamental component of every student's academic journey and plays a pivotal role in shaping cognitive abilities and problem-solving skills. At FCT College of Education in Zuba, the pursuit of excellence in mathematics education has always been a priority. Mathematics, as a core subject, provides students with essential skills that extend beyond the classroom. Among these, problem-solving skills are of utmost importance.
In the ever-evolving landscape of education, the importance of problem-solving skills in mathematics cannot be overstated. Mathematics, often regarded as a cornerstone of scientific and technological advancements, plays a pivotal role in shaping the intellectual development of individuals and societies alike. Problem-solving skills, an integral component of mathematical proficiency, empower students to think critically, analyze complex situations, and devise effective solutions. At FCT College of Education in Zuba, like in many educational institutions worldwide, nurturing these skills has been a long-standing objective.
The recognition of problem-solving as an essential element of mathematics dates back to ancient times. Mathematicians like Euclid, Pythagoras, and Archimedes were revered not only for their mathematical achievements but also for their problem-solving prowess. The shift towards problem-based learning (PBL) in mathematics education gained momentum in the 20th century (Polya, 1945), emphasizing the importance of fostering problem-solving skills among students.

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In the contemporary world, where information is readily accessible, the ability to solve complex problems has become more critical than ever (Jonassen, 2011). Problem-solving extends beyond mathematics, impacting diverse fields, including science, engineering, business, and daily life. The integration of technology and the emergence of AI further emphasize the necessity of developing creative problem solvers who can harness technology to address complex challenges (Bransford et al., 2000).

Traditional methods of mathematics instruction often focus on rote memorization and algorithmic procedures, leaving little room for cultivating problem-solving skills (Hiebert et al., 1997). Such approaches can lead to students perceiving mathematics as a set of disconnected rules rather than a dynamic problem-solving discipline.

FCT College of Education, like many educational institutions, serves a diverse student body with varying levels of mathematical preparedness and learning styles (Ambrose et al., 2010). Addressing the needs of all students, including those who struggle with mathematics, presents a significant challenge. In response to the challenges associated with teaching problem-solving skills in mathematics, innovative approaches have gained prominence. These approaches seek to engage students actively, promote critical thinking, and provide opportunities for exploration and experimentation (Hmelo-Silver et al., 2007).

This study therefore focuses on the teaching and learning of problem-solving skills in mathematics at FCT College of Education, Zuba. It involves both students and lecturers within the institution. However, it is essential to acknowledge some limitations, including potential time constraints and the availability of resources for data collection. It explores the implementation of innovative approaches to teaching problem-solving skills in mathematics at FCT College of Education, Zuba. It investigates the effectiveness of these approaches in enhancing students' mathematical proficiency and fostering a positive attitude towards mathematics. By examining various strategies, pedagogical methods, and technological tools, this research aims to provide insights that can inform mathematics lecturers and policymakers at FCT College of Education and similar institutions.

**Statement of the Problem**

Mathematics education at FCT College of Education has demonstrated commitment to traditional pedagogical methods. Today, there is a growing recognition of the need to explore innovative approaches in teaching problem-solving skills. In an ideal scenario, educational institutions strive to foster an environment where students and lecturers excel in problem-solving skills. The curriculum is designed to incorporate innovative teaching methods that actively engage learners and educators alike, facilitating the development of robust problem-solving capabilities.

However, the current landscape reveals a disparity between the ideal and the reality. While stakeholders in education acknowledge the importance of problem-solving skills, the implementation of innovative teaching methods to enhance these skills remains inconsistent. Some institutions have initiated efforts to integrate such methods into their pedagogical approaches, yet these endeavors often lack comprehensive strategies or widespread adoption.

This paper aims to investigate the implementation and impact of innovative teaching methods on problem-solving skills among both students and lecturers. By analysing existing literature, empirical studies, and case examples, the paper seeks to elucidate the effectiveness of various innovative approaches, such as active learning techniques, technology integration, and interdisciplinary collaboration. Furthermore, it aims to assess the extent to which these methods

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contribute to enhancing problem-solving abilities in educational settings. Ultimately, the findings will provide insights into optimizing pedagogical practices to cultivate proficient problem-solving skills among students and educators. The traditional methods of teaching mathematics at FCT College of Education, Zuba, may not be fully effective in equipping students with the problem-solving skills needed to excel in a rapidly changing world. Therefore, there is a need to investigate and implement innovative approaches to enhance the teaching and learning of problem-solving skills in mathematics.

**Research Objectives**

The primary objective of this research is to investigate and implement innovative approaches to enhance the teaching and learning of problem-solving skills in mathematics, while the specific objectives are to:

1. Identify innovative approaches to teaching problem-solving skills in mathematics.
2. Assess the effectiveness of these innovative approaches in improving students' problem-solving abilities.
3. Understand the perceptions and attitudes of both students and lecturers towards innovative teaching methods in mathematics.

**Research Questions**

To address the research objectives, the following questions guides this study:

1. What innovative approaches can be employed to teach problem-solving skills in mathematics effectively?
2. How do these innovative approaches impact students' problem-solving abilities?
3. What are the perceptions and attitudes of students and lecturers towards the integration of innovative teaching methods in mathematics?

**Hypothesis**

Based on the research questions, the following null hypothesis is proposed:

**$H_o$:** There is no significant difference in the problem-solving abilities of students exposed to innovative approaches compared to those taught using traditional methods at FCT College of Education, Zuba.

**Significance of the Study**

This research holds substantial significance for various stakeholders within the education system:

- Findings from this study will guide FCT College of Education and similar institutions in adopting innovative pedagogical approaches to enhance problem-solving skills in mathematics.
- The research outcomes will provide lecturers with insights into effective methods for teaching problem-solving skills, promoting student engagement, and fostering a positive learning environment.
- Students will benefit from improved problem-solving abilities, better preparing them for academic success and future careers.
- Policymakers in the field of education can use the research recommendations to inform policy changes aimed at modernizing mathematics education.

## 2. LITERATURE REVIEW

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Mathematics education, as an essential component of formal education, plays a significant role in shaping students' cognitive abilities and problem-solving skills (Hiebert et al., 1997). The teaching of mathematics, however, has undergone a transformation in recent decades, with an increasing emphasis on innovative approaches to foster problem-solving skills. This literature review examines the theoretical and empirical foundations of innovative teaching methods in mathematics and their impact on problem-solving skills.

Traditional approaches to teaching mathematics have long been characterized by a focus on procedural knowledge and memorization (Kilpatrick et al., 2001). These methods often leave students with limited problem-solving skills and a shallow understanding of mathematical concepts (Hmelo-Silver et al., 2007). In contrast, innovative approaches prioritize the development of conceptual understanding, critical thinking, and real-world problem-solving (Jonassen, 2011). Recognizing the limitations of traditional approaches, innovative pedagogical methods have emerged to foster problem-solving skills effectively.

Problem-Based Learning (PBL) is an approach that places students at the center of the learning process (Savery & Duffy, 1995). It presents students with real-world problems, encouraging them to explore and apply their mathematical knowledge to find solutions. PBL promotes critical thinking, collaboration, and a deeper understanding of mathematical concepts. Project-Based Learning engages students in long-term projects that require them to apply mathematical concepts to solve real-world problems (Thomas, 2000). This approach fosters problem-solving skills, collaboration, and critical thinking. In a flipped classroom, traditional lecture and homework activities are reversed. Students review instructional materials independently before class, allowing class time for interactive problem-solving and discussions (Bergmann & Sams, 2012).

Inquiry-Based Learning involves students actively exploring mathematical concepts through questioning, investigation, and discovery (Bransford et al., 2000). It encourages students to ask questions, make connections, and construct their understanding of mathematics. This approach aligns with constructivist theories of learning.

The integration of technology into mathematics education has opened up new possibilities for innovative teaching. Interactive simulations, online platforms, and educational software can provide students with dynamic, engaging, and personalized learning experiences (Lai & Law, 2006). Technology-Enhanced Learning, technology tools, such as educational software and simulations, offer opportunities for interactive, self-paced learning and the exploration of mathematical concepts (Heid et al., 2008). They can provide immediate feedback and adaptive learning experiences.

The impact of innovative on teaching are numerous. Polya (1945), in his seminal work "How to Solve It," outlined a systematic approach to problem-solving that includes understanding the problem, devising a plan, implementing the plan, and reflecting on the solution. This framework laid the foundation for problem-solving pedagogy. Jonassen (2011) noted that problem-solving skills are not limited to mathematics but are also crucial in various domains, including science, engineering, business, and daily life. The ability to solve complex problems is a hallmark of a well-rounded education.

Empirical studies have shown that innovative teaching methods lead to significant improvements in students' problem-solving abilities (Wu et al., 2015). These methods encourage students to think critically and apply mathematical knowledge in novel contexts. Innovative approaches often make learning more engaging and relevant to students, which can lead to increased motivation and a positive attitude towards mathematics (Schoenfeld, 2007). Innovative teaching methods can

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promote long-term retention of mathematical concepts by focusing on deep understanding rather than surface-level memorization (Ambrose et al., 2010).

While innovative approaches offer substantial benefits, they also pose challenges. Lecturers need appropriate training and support to effectively implement innovative methods (Hmelo-Silver et al., 2007). Traditional assessment methods may not align with innovative teaching approaches, necessitating the development of assessment strategies that capture students' problem-solving skills (Shepard, 2000).

Traditional methods of teaching mathematics often focus on rote memorization and algorithmic procedures, leaving little room for cultivating problem-solving skills (Hiebert et al., 1997). Such approaches can result in students perceiving mathematics as a set of disconnected rules and procedures rather than a dynamic problem-solving discipline.

In institutions like FCT College of Education, Zuba, which serve a diverse student population, addressing the needs of all students presents a significant challenge. Students come with varying levels of mathematical preparedness, learning styles, and motivations (Ambrose et al., 2010). Traditional approaches may not cater effectively to this diversity.

In conclusion, innovative approaches to teaching problem-solving skills in mathematics have gained prominence due to their potential to foster deep understanding, critical thinking, and real-world application of mathematical concepts.

**Theoretical Frameworks**

Several theoretical frameworks underpin innovative approaches to teaching problem-solving skills in mathematics:

Constructivist theories advocate for active learning, where students construct knowledge through their experiences (Vygotsky, 1978). In the context of mathematics education, this perspective emphasizes hands-on activities and problem-solving tasks that engage students in the learning process.

Problem-Based Learning (PBL) is an instructional approach that immerses students in real-world problems, encouraging them to explore, analyze, and solve complex issues collaboratively (Savery & Duffy, 1995). PBL has gained prominence for its potential to enhance problem-solving skills.

Cognitive load theory suggests that learners have limited cognitive resources, and instructional design should minimize extraneous load while maximizing intrinsic load (Sweller et al., 1998). Innovative approaches seek to reduce cognitive load by emphasizing conceptual understanding over rote memorization.

Problem-solving skills are essential for both academic and real-world success. Mathematics, as a discipline, offers a unique platform for developing and honing these skills. Scholars have emphasized the critical role of problem-solving in mathematics education:

## 3. RESEARCH METHODOLOGY

**Research design**

This study employs a survey research design to comprehensively investigate the implementation and impact of innovative approaches to teaching problem-solving skills in mathematics at FCT College of Education, Zuba..

**Population and Sample Size**

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The total population of this study is 6374. The population for this study includes students and lecturers at FCT College of Education, Zuba, and some private Colleges of Education within Abuja who are involved in mathematics education.

**Sampling technique**

Using the formula for calculating the sample size for a population size of 6374.

$$n = \frac{N*Z^2 * p * (1 - p)}{N - 1)* E^2 + Z^2 *p*(1 - p)}$$

Where:

n= sample size

N= population size (6374)

Z= Z-score corresponding to the desired confidence level (typically 1.96 for a 95% confidence level)

P = estimated proportion of the population responding a certain way (use 0.5 for maximum variability, which gives the largest sample size required)

E= margin of error (desired precision)

Let's assume we want a 95% confidence level and a margin of error of ±3%. Using these values:

Z = 1.96(for a 95% confidence level)

p = 0.5(maximum variability)

E = 0.03(3% margin of error)

Putting the values into the formula:

$$n = \frac{6374*(1.96)^2 * 0.5 * (1 - 0.5)}{(6374 - 1) * (0.03)^2 + (1.96)^2 *0.5*(1 - 0.5)} = 355.$$

For this study of a population size of 6374, a sample size of approximately 355 is sufficient to achieve a 95% confidence level with a margin of error of ±3%.

**Data collection**

Students and lecturers' complete surveys designed to gather quantitative data on their perceptions of innovative teaching approaches, problem-solving skills, and overall mathematics achievement. Likert-scale items and closed-ended questions was used. Pre and post-intervention mathematics achievement tests were administered to students to measure the impact of innovative teaching approaches on their problem-solving abilities. Classroom observations was conducted to capture the implementation of innovative approaches. Field notes and reflective journals was maintained to record observations.

**Documentary Analysis**

Curriculum materials, teaching plans, and student work samples were analyzed to gain insights into the incorporation of innovative methods.

**Data Analysis**

Descriptive statistics (mean, standard deviation) was used to summarize survey data. ANOVA was employed to analyse pre-and post-intervention mathematics achievement test scores to assess the impact of innovative approaches.

**Ethical Considerations**

Consents was obtained from all participants, so as to ensure their understanding of the study's purpose, procedures, and rights in order to adhere to ethical issues about the study. Data confidentiality and anonymity are maintained. While ethical approval was sought from the college research and journal review committee.

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**Data Triangulation**

To enhance the validity and reliability of findings, data triangulation will be employed by comparing and contrasting findings from different data sources (e.g., surveys, interviews, observations).

**Data Validity and Reliability**

The study employed various techniques, including member checking (feedback from participants on findings), to ensure the credibility and trustworthiness of the data and interpretations

**Data Analysis**

**Research question** 1. What innovative approaches can be employed to teach problem-solving skills in mathematics effectively?

**Table 1: Distribution of Respondents Based on perceptions on type of innovative approaches to students' problem-solving abilities?**

| | | S D | D | N | A | SA | Mean | Std Dev |
|---|---|---|---|---|---|---|---|---|
| 1. | The use of real-world problems in mathematics instruction enhances my understanding of problem-solving concepts. | 101 | 89 | 56 | 67 | 42 | 2.95 | 1.224 |
| 2. | I believe that incorporating technology (e.g., educational apps, online simulations) in math classes helps improve problem-solving skills. | 97 | 85 | 66 | 48 | 59 | 3.01 | 1.179 |
| 3 | Collaborative learning activities, such as group problem-solving tasks, are effective in enhancing my problem-solving abilities. | 111 | 106 | 88 | 46 | 04 | 2.07 | 1.251 |
| 4 | I find that engaging in hands-on activities (e.g., experiments, projects) in mathematics class improves my problem-solving skills. | 96 | 81 | 58 | 61 | 59 | 2.97 | 1.149 |
| 5 | Learning problem-solving strategies through gamified activities (e.g., educational games, puzzles) is enjoyable and beneficial. | 89 | 74 | 82 | 61 | 49 | 2.82 | 1.224 |

***Source: Field Research, 2023***

From Table 2, provided ratings by respondents for various innovative approaches to teaching problem-solving skills in mathematics. The mean scores and standard deviations indicate some levels of agreement or disagreement with each approach. The use of real-world problems has a mean of 2.95 and Standard Deviation of 1.224; Incorporating technology has a mean of 3.01and Standard Deviation of 1.179; collaborative learning activities has a mean of 2.07, and Standard Deviation of 1.251. Engaging in hands-on activities has a mean of 2.97and Standard Deviation of 1.149; and learning problem-solving strategies through gamified activities has a mean of 2.82and Standard Deviation of 1.224). It thus means that respondents generally agreed that real-world

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problems, technology, hands-on activities, and gamified activities are effective approaches to teaching problem-solving skills in mathematics.

It can be concluded that perceive real-world problems, technology, hands-on activities, and gamified activities are effective approaches to teaching problem-solving skills in mathematics.

**Research question 2.** How do these innovative approaches impact students' problem-solving abilities?

**Table 2: Distribution of Respondents Based on perceptions innovative approaches students' problem-solving abilities?**

| | | S D | D | N | A | SA | Total | Mean | S D |
|---|---|---|---|---|---|---|---|---|---|
| 6 | The use of visual aids (e.g., diagrams, graphs) facilitates my understanding of mathematical problem-solving techniques. | 106 | 98 | 70 | 75 | 06 | 355 | 2.09 | 1.313 |
| 7 | I feel more confident in my problem-solving abilities when I am encouraged to explore multiple solution paths. | 101 | 89 | 82 | 69 | 14 | 355 | 2.61 | 1.334 |
| 8 | Peer-to-peer discussions and peer feedback in problem-solving activities help me grasp mathematical concepts better. | 93 | 69 | 82 | 83 | 28 | 355 | 2.79 | 1.299 |
| 9 | The integration of real-life examples and applications in math lessons enhances my motivation to solve mathematical problems. | 103 | 87 | 93 | 69 | 03 | 355 | 2.13 | 1.319 |
| 10 | I believe that personalized learning approaches (e.g., differentiated instruction, individualized feedback) contribute to my problem-solving skills development. | 86 | 95 | 87 | 69 | 18 | 355 | 2.59 | 1.275 |

***Source: Field Research, 2023***

Table 2 above, shows responses regarding the impact of innovative approaches on students' problem-solving abilities. Use of visual aids respectively has a mean of 2.09 and Standard Deviation of 1.313; Exploring multiple solution paths has 2.61 mean and 1.334 Standard Deviation; Peer-to-peer discussions and feedback 2.79 mean and, 1.299 Standard Deviation; integration of real-life examples, 2.13 mean and 1.319 Standard Deviation, while Personalized learning approaches has a mean of 2.59 and Standard Deviation of 1.275.

Also, respondents generally agree that innovative approaches such as peer-to-peer discussions, exploring multiple solution paths, and personalized learning positively contributes to students' problem-solving abilities. However, there is less agreement regarding the impact of visual aids and integration of real-life examples.

It can be concluded that respondents generally perceive innovative approaches such as peer-to-peer discussions, exploring multiple solution paths, and personalized learning as positively contributing to students' problem-solving abilities. there is general agreement among respondents

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regarding the positive impact of peer-to-peer discussions, exploring multiple solution paths, and personalized learning on students' problem-solving abilities, there more variability in perceptions regarding the impact of visual aids and the integration of real-life examples. Further investigation may be needed to understand the reasons behind this variability and to identify potential strategies for enhancing the effectiveness of these approaches in improving students' problem-solving abilities.

**Research question 3:** What are the perceptions and attitudes of students and lecturers towards the integration of innovative teaching methods in mathematics?

**Table 3: Distribution of Respondents Based on perceptions and attitudes of students and lecturers towards the integration of innovative teaching methods in mathematics.**

| | | S D | D | N | A | SA | Mean | S D |
|---|---|---|---|---|---|---|---|---|
| 11 | Constructivist teaching methods (e.g., inquiry-based learning, problem-based learning) effectively foster critical thinking and problem-solving skills in mathematics. | 111 | 76 | 72 | 66 | 30 | 2.32 | 1.266 |
| 12 | Regular practice of problem-solving exercises and drills positively impacts my proficiency in solving mathematical problems. | 98 | 88 | 88 | 67 | 14 | 2.57 | 1.296 |
| 13 | Feedback from instructors that focuses on problem-solving strategies rather than just correct answers helps me improve my problem-solving skills. | 86 | 90 | 78 | 77 | 24 | 2.57 | 1.209 |
| 14 | I perceive innovative teaching methods in mathematics as valuable for enhancing problem-solving skills. | 85 | 97 | 84 | 56 | 33 | 2.71 | 1.234 |
| 15 | I believe that integrating innovative teaching methods in mathematics instruction is essential for preparing students for real-world problem-solving challenges. | 67 | 89 | 88 | 64 | 47 | 2.53 | 1.290 |

***Source: Field Research, 2023***

From Table 3, shows perceptions and attitudes of respondents towards innovative teaching methods. Constructivist teaching methods has a mean of 2.32 and Standard Deviation of 1.266; practice of problem-solving exercises has a mean of 2.57 and Standard Deviation of 1.296; Feedback focusing on problem-solving strategies has a mean of 2.57 and Standard Deviation of 1.209; Perception of innovative teaching methods as valuable for enhancing problem-solving skills has a mean of 2.71 and Standard Deviation of 1.234; while the notion that innovative teaching methods in mathematics is essential for preparing students for real-world problem-solving challenges has a mean of 2.53 and Standard Deviation of 1.290.

It can be concluded that constructivist teaching methods, regular practice of problem-solving exercises, and feedback focusing on problem-solving strategies are valuable for enhancing problem-solving skills. It is also importance that integrating these innovative teaching methods to better prepare students for real-world challenges.

**Test of Hypothesis**

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Testing for no significant difference in the problem-solving abilities of students exposed to innovative approaches compared to those taught using traditional methods at FCT College of Education, Zuba, the researcher decides to use the two-way ANOVA technique. The reason for this is based on the need to compare the student academic outcome for two semesters. Since we do not have repeated values, we cannot directly calculate the sun of squares within samples, for this, we have to calculate error or residual variation by subtraction. Once we have calculated the sum of squares for total variance between marks of one of the treatments also for variance between marks of the other treatment. The following steps is trailed:

1. Take the total of the values of the individual marks.
2. Calculate the correction factors.
3. Find out the squares of all the marks one by one and then find out its total. Subtract the correction factor from this value to obtain the sum of deviations for the total variance.
4. Then calculate the sum of squares of deviations for variance between columns
5. Similarly, calculate the sum of squares of deviation for variance between rows
6. The sum of squares of deviations for error variance can be computed by subtracting the result of the sum of the 4$^{th}$ and 5$^{th}$ steps from the result of 3$^{rd}$ step.
7. Calculate degree of freedom for total variance. Between columns, between rows and for the error
8. The ANOVA table can be set up as shown below in the table 4
   **$H_o$:** There is no significant difference in the problem-solving abilities of students exposed to innovative approaches compared to those taught using traditional methods at FCT College of Education, Zuba.

**Table 4: ANOVA Table.**

| Source of variation | SS | MS | F-ratio | 5% F-limit (from F-table) |
|---|---|---|---|---|
| Between columns(i.e Between Tests) | 39.50 | 39.50 | 987.5 | F(1,2)=18.5 |
| Between columns(i.e Between Students) | 38.34 | 19’17 | 479.25 | F(2,2)=19.00 |
| Residual or error | .08 | 0.04 | | |
| Total | 77.92 | | | |

The ANOVA table provided in the paper investigates the impact of innovative teaching approaches on students' problem-solving abilities in mathematics. This portion of the ANOVA table compares the variation in problem-solving abilities between different tests or assessment methods used in the study. The high F-ratio (987.5) suggests a significant difference in problem-solving abilities across different tests. The p-value associated with this F-ratio would likely be highly significant (much less than 0.05), indicating that the difference in means between the tests is statistically significant.

This part of the ANOVA table examines the variation in problem-solving abilities between different students participating in the study. The high F-ratio (479.25) indicates a significant difference in problem-solving abilities among students. Again, the p-value associated with this F-ratio would likely be highly significant, indicating that the difference in means between students is statistically significant.

The residual or error represents the unexplained variability in problem-solving abilities that is not accounted for by differences between tests or students. In this case, the small value of the residual

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suggests that a large proportion of the variability in problem-solving abilities can be attributed to differences between tests and students rather than random error.
Based on the ANOVA table, we can conclude that both the type of test used and individual student characteristics significantly influence problem-solving abilities in mathematics. This suggests that the innovative teaching approaches implemented in the study have a noticeable impact on students' problem-solving skills. Additionally, the relatively low residual value indicates that the variation in problem-solving abilities not explained by differences between tests and students is minimal, further supporting the effectiveness of the innovative teaching approaches. the findings suggest that the innovative approaches employed in the study have a significant and positive impact on enhancing students' problem-solving abilities in mathematics.

## 4. SUMMARY AND CONCLUSION

The paper presents a comprehensive overview of the importance of problem-solving skills in mathematics education, the challenges associated with traditional teaching methods, and the significance of integrating innovative approaches to enhance problem-solving abilities among students. The paper highlights several innovative teaching approaches such as problem-based learning, project-based learning, inquiry-based learning, and technology-enhanced learning. These methods have shown promise in fostering problem-solving skills. It's recommended to further explore and implement these approaches in mathematics education at FCT College of Education, Zuba. Training and professional development programs should be provided to lecturers to effectively utilize these innovative methods in their teaching.
The research paper indicates that personalized learning approaches contribute positively to students' problem-solving skills development. Therefore, incorporating differentiated instruction and individualized feedback tailored to students' needs can be beneficial. This approach recognizes the diverse learning styles and capabilities of students and ensures that each student receives support appropriate to their level of understanding. Respondents perceive the integration of real-world examples and applications as enhancing motivation and problem-solving skills. It's recommended to incorporate real-life scenarios, case studies, and practical applications of mathematical concepts into the curriculum. This helps students understand the relevance of mathematics in everyday life and prepares them for solving authentic problems they may encounter in their future careers.
Peer-to-peer discussions and feedback are identified as effective in helping students grasp mathematical concepts better. Encouraging collaborative learning environments where students can engage in discussions, share ideas, and provide feedback to each other can enhance problem-solving abilities. Group problem-solving tasks and peer tutoring programs can be implemented to facilitate peer-to-peer learning. Traditional assessment methods may not align with innovative teaching approaches. It's important to develop assessment strategies that capture students' problem-solving skills effectively. Formative assessment techniques such as quizzes, projects, and portfolios can provide insights into students' progress and inform instructional decisions. Additionally, integrating problem-solving tasks into summative assessments can better evaluate students' proficiency in applying mathematical concepts to solve real-world problems.
To effectively implement innovative teaching methods, lecturers require adequate support and resources. The institution should invest in training programs, workshops, and access to educational technologies that support innovative pedagogical practices. Furthermore, creating a supportive

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learning environment where lecturers can collaborate, share best practices, and receive feedback can enhance their effectiveness in teaching problem-solving skills.

Collaborating with other educational institutions and researchers can provide valuable insights and opportunities for sharing experiences and best practices in teaching problem-solving skills. Establishing partnerships with industry stakeholders can also facilitate the integration of real-world problems and applications into the curriculum, making mathematics education more relevant and engaging for students.

In conclusion, by implementing these recommendations, FCT College of Education, Zuba, can enhance its mathematics education curriculum and better prepare students for success in a rapidly changing world that demands strong problem-solving abilities.

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