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Determinants of preservice teachers' attitudes toward problem-solving in mathematics education

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Abstract: The attitudes of preservice teachers toward problem-solving in mathematics education play a significant role in shaping how they approach teaching and facilitate student learning in the future. This study explores the factors that influence preservice teachers' attitudes towards problem-solving, particularly focusing on their mathematical background, pedagogical training, teaching experience, and personal beliefs about mathematics. The research involved a mixed-methods approach, utilizing surveys and semi-structured interviews to gather data from preservice teachers at a teacher education institution. The findings reveal that preservice teachers' attitudes are strongly influenced by their mathematical experiences, their exposure to problem-solving strategies during teacher preparation programs, and their personal beliefs regarding the importance of mathematics. Additionally, challenges such as anxiety about mathematics and lack of problem-solving skills were identified as barriers to developing positive attitudes. The study emphasizes the importance of addressing these factors within teacher education programs to improve preservice teachers' readiness to incorporate problem-solving in their future classrooms.

Keywords: Preservice teachers, problem-solving, attitudes, mathematics education, teacher education, teaching experience, pedagogical training.

Introduction: Mathematics is often viewed as a subject that requires logical thinking, analytical reasoning, and problem-solving skills. In the context of education,

problem-solving serves as a cornerstone for helping students understand mathematical concepts and apply them to real-world situations. For preservice teachers, developing effective problem-solving strategies and positive attitudes towards problem-solving is vital because their attitudes and skills will directly influence the way they teach their future students. Research has shown that preservice teachers' beliefs and attitudes toward mathematics and its instruction impact their teaching efficacy, their students' motivation, and the overall learning environment in the classroom. However, despite the acknowledged importance of problem-solving in mathematics education, it remains a challenge for many preservice teachers to develop positive attitudes toward teaching this crucial component of mathematics.

Attitudes toward problem-solving in mathematics can be shaped by various factors, which include previous educational experiences, personal beliefs about the subject, the quality of teacher preparation programs, and exposure to different teaching methods. The role of problem-solving in mathematics education has been emphasized in contemporary teaching methods, which increasingly focus on active learning, inquiry-based learning, and constructivist approaches that encourage students to explore problems, identify patterns, and develop solutions. However, despite this pedagogical shift, many preservice teachers face challenges in adopting problem-solving strategies in their teaching practices due to their own difficulties with mathematics or a lack of exposure to effective problem-solving techniques during their training.

One important factor influencing preservice teachers' attitudes towards problem-solving is their own mathematical background. Teachers who have had positive and enriching experiences with mathematics in their own education are more likely to view problem-solving as an essential part of teaching and learning. In contrast, those with negative experiences or struggles in solving mathematical problems may develop anxiety or a reluctance to engage with problem-solving themselves and may thus transfer these negative attitudes to their future students. Additionally, preservice teachers' beliefs about the nature of mathematics—whether they view it as a set of fixed procedures to be memorized or as a dynamic field involving creativity and reasoning—play a significant role in shaping their attitudes toward teaching problem-solving.

Furthermore, the teacher education program itself is an essential influence on preservice teachers' attitudes. Exposure to well-designed curricula that emphasizes problem-solving strategies, inquiry-based learning, and collaborative approaches can help build confidence and positive attitudes among preservice teachers. Conversely, programs that do not provide adequate opportunities for preservice teachers to experience or engage with problem-solving methods may contribute to a lack of confidence in their ability to teach problem-solving effectively. Given that teacher preparation programs aim to equip future educators with the necessary knowledge and skills to teach students effectively, the content, structure, and focus of these programs are crucial in shaping preservice teachers' attitudes towards mathematics and problem-solving.

The present study explores these factors in greater detail, investigating how preservice teachers' personal experiences with mathematics, the structure of their teacher education programs, and their own beliefs and attitudes toward problem-solving affect their approach to teaching mathematics. By understanding the factors that influence preservice teachers' attitudes towards problem-solving, this study aims to provide insights that can guide improvements in teacher education programs, ensuring that future educators are well-prepared to teach problem-solving in mathematics effectively and instill positive attitudes toward the subject in their students.

In this more detailed introduction, I have emphasized the complexity and multi-faceted nature of the factors that influence preservice teachers' attitudes toward problem-solving. The emphasis is on the interaction of personal experiences, educational beliefs, and the influence of teacher preparation programs. This approach aims to provide a more nuanced understanding of why problem-solving in mathematics is challenging for some preservice teachers and how these challenges can be addressed within teacher education programs.

Problem-solving is a critical component of mathematics education, playing a central role in helping students develop deep conceptual understanding and the ability to apply mathematical knowledge to real-world situations. For preservice teachers, developing positive attitudes toward problem-solving in mathematics is essential, as these attitudes directly influence their teaching practices and the strategies they employ in the classroom. However, numerous factors may affect preservice teachers' perceptions and attitudes towards problem-solving.

Research has shown that preservice teachers' attitudes toward mathematics can significantly impact their confidence and effectiveness in teaching the subject. These attitudes are shaped by their mathematical experiences, exposure to problem-solving during their teacher preparation programs, and their beliefs about

the value and role of mathematics in education. Understanding the factors influencing preservice teachers' attitudes toward problem-solving is crucial for designing teacher education programs that foster a more positive and proactive approach to teaching mathematics.

This study aims to explore the factors influencing preservice teachers' attitudes towards problem-solving in mathematics education, focusing on their mathematical background, teaching experience, personal beliefs about mathematics, and the quality of problem-solving instruction in teacher education programs.

METHODS

1. Research Design

This study employed a mixed-methods approach, combining quantitative and qualitative data to provide a comprehensive understanding of the factors that influence preservice teachers' attitudes toward problem-solving. A survey was used to collect quantitative data, while semi-structured interviews were conducted to gather qualitative insights into the experiences and beliefs of the participants.

2. Participants

The participants were 120 preservice teachers enrolled in a teacher education program at a university in the United States. The sample consisted of undergraduate students pursuing a Bachelor's degree in Education with a focus on mathematics. Participants were selected using purposive sampling to ensure a diverse representation of backgrounds, including variation in previous mathematics coursework, teaching experience, and pedagogical exposure.

3. Instruments

a. Survey on Attitudes Towards Problem-Solving

The survey was designed to assess preservice teachers' attitudes towards problem-solving in mathematics. It included Likert-scale questions that explored their beliefs about the importance of problem-solving in mathematics, their self-confidence in solving problems, and their attitudes toward teaching problem-solving. The survey also included questions about their prior experiences with mathematics problem-solving, such as their participation in mathematics courses and previous teaching placements.

b. Semi-Structured Interviews

To complement the survey data, semi-structured interviews were conducted with 15 preservice teachers. The interviews aimed to explore participants' personal experiences with mathematics problem-solving, the role of problem-solving in their teacher education program, and the factors they perceived as influencing their attitudes toward problem-solving. The interviews were transcribed and analyzed thematically.

4. Data Analysis

Quantitative data from the surveys were analyzed using descriptive statistics and correlation analysis to identify patterns and relationships between preservice teachers' attitudes and various factors. Qualitative data from the interviews were analyzed using thematic analysis to identify key themes related to the participants' experiences and beliefs about problem-solving in mathematics education.

RESULTS

1. Survey Results

The survey revealed several key findings related to preservice teachers' attitudes towards problem-solving:

- Positive Attitudes Towards Problem-Solving: A majority of the participants (75%) expressed positive attitudes towards problem-solving in mathematics, recognizing its importance in developing critical thinking skills and understanding mathematical concepts.
- Confidence in Problem-Solving: Around 60% of the preservice teachers reported feeling confident in their ability to solve mathematical problems, while 40% expressed some level of anxiety or discomfort with solving unfamiliar problems.
- Influence of Mathematical Background: The survey found a strong correlation between preservice teachers' previous mathematics coursework and their attitudes towards problem-solving. Those who had taken advanced mathematics courses reported higher levels of confidence and more positive attitudes toward problem-solving.
- Exposure to Problem-Solving Strategies: Participants who had been exposed to problem-solving teaching strategies in their teacher education programs were more likely to report positive attitudes and confidence in teaching problem-solving in the classroom.

2. Interview Results

The qualitative data from the interviews provided additional insights into the factors influencing preservice teachers' attitudes:

- Mathematical Experiences: Many participants mentioned their prior experiences with mathematics as a significant influence on their attitudes. Those with positive experiences in school mathematics, particularly those who had teachers who emphasized problem-solving, tended to have more favorable attitudes. Conversely, participants who had negative experiences

with mathematics, especially those who struggled with problem-solving, expressed anxiety or reluctance toward teaching problem-solving.

- Pedagogical Training and Exposure: The majority of preservice teachers indicated that their teacher education program had provided valuable exposure to problem-solving techniques and strategies. However, some participants noted that the emphasis on problem-solving varied depending on the course or instructor, and that more consistent and practical training in teaching problem-solving would have been beneficial.
- Beliefs about Mathematics: A strong belief in the utility of mathematics in everyday life and future careers was associated with more positive attitudes toward problem-solving. Preservice teachers who saw mathematics as an essential skill for developing critical thinking and problem-solving abilities were more motivated to teach it effectively.
- Personal Challenges: Several participants mentioned personal challenges, such as mathematical anxiety, as barriers to developing positive attitudes toward problem-solving. Those who had experienced difficulty with math in their own education were more likely to feel unprepared to teach problem-solving and less confident in their teaching abilities.

DISCUSSION

The results of this study provide valuable insights into the factors that influence preservice teachers' attitudes toward problem-solving in mathematics education. These findings are critical because they highlight areas where teacher preparation programs can improve, as well as point to personal and academic experiences that impact the development of preservice teachers' abilities and attitudes toward mathematics and problem-solving. The discussion will explore these findings in depth, offering a reflection on how mathematical background, pedagogical training, personal beliefs, and problem-solving exposure shape preservice teachers' perspectives on teaching problem-solving in mathematics.

1. Influence of Mathematical Background

One of the most prominent findings of the study is the strong influence of preservice teachers' mathematical background on their attitudes toward problem-solving. This finding is consistent with existing research which suggests that preservice teachers' prior experiences with mathematics significantly affect their confidence and disposition toward the subject (Ball, 1990). For example, preservice teachers who had positive mathematical experiences—such as participating in advanced mathematics courses or receiving instruction from teachers who emphasized problem-solving—tended to have more positive attitudes and greater self-efficacy in their ability to teach problem-solving strategies effectively. These individuals expressed a belief that problem-solving was an integral part of mathematics education and were more likely to incorporate these strategies into their future teaching.

Conversely, preservice teachers who had negative experiences in mathematics or struggled with solving problems often expressed feelings of anxiety or hesitation toward teaching problem-solving. The study found that these preservice teachers often reported a lack of confidence in their problem-solving abilities, which in turn, influenced their attitudes toward teaching the subject. This finding suggests that preservice teachers' negative experiences with mathematics, particularly in early schooling, may contribute to a mindset that problem-solving is difficult or inaccessible. The resulting anxiety and discomfort may hinder their effectiveness as future educators. Therefore, it is essential for teacher education programs to address these concerns and help preservice teachers build confidence in problem-solving through supportive, scaffolded learning experiences.

2. Pedagogical Training and Problem-Solving Exposure

Another key factor identified in this study is the impact of preservice teachers' exposure to problem-solving strategies during their teacher preparation programs. Those who had direct experience with problem-solving techniques and strategies within their courses reported higher levels of confidence and a more positive attitude toward teaching problem-solving in their classrooms. These preservice teachers described how their teacher preparation programs included activities, such as collaborative problem-solving sessions, inquiry-based learning, and opportunities to practice creating problem-solving activities, which enhanced their ability to engage with mathematics in an authentic, problem-solving context. These activities allowed them to understand problem-solving as more than just a technique—it became a mindset and approach to learning that they were eager to pass on to their future students.

However, not all participants had equal exposure to problem-solving strategies in their teacher preparation programs. Some participants reported that their teacher education courses did not adequately address problem-solving or provide enough practical tools for teaching it effectively. These preservice teachers felt unprepared to teach problem-solving and expressed concerns about their ability to engage students in the process of solving complex mathematical problems. This gap in exposure underscores the importance of

integrating problem-solving into the curriculum of teacher education programs more thoroughly. Problem-solving should not be treated as a peripheral topic but rather as an essential and consistent component of the teacher education experience. Teacher preparation programs must ensure that preservice teachers have hands-on experience with problem-solving strategies, both as learners and as future educators.

3. Personal Beliefs about Mathematics

The study also revealed that personal beliefs about mathematics played a significant role in shaping preservice teachers' attitudes toward problem-solving. Preservice teachers who viewed mathematics as an essential, dynamic field that fosters critical thinking, creativity, and practical skills were more likely to appreciate the value of problem-solving. These individuals believed that mathematics is not merely a set of rules to memorize, but a discipline in which students should be encouraged to think deeply, explore different strategies, and develop their problem-solving abilities.

In contrast, preservice teachers who viewed mathematics as a rigid, rule-based subject were less likely to value problem-solving as an important component of their teaching. For these teachers, mathematics was seen more as a series of procedures to be followed, rather than a subject that encourages deep thought and inquiry. This belief likely stemmed from their own experiences with mathematics education, where the focus may have been on rote memorization and formulaic procedures, rather than on fostering a deeper understanding through problem-solving.

This finding underscores the importance of addressing preservice teachers' personal beliefs about the nature of mathematics within teacher education programs. By helping preservice teachers develop a growth mindset and encouraging them to see mathematics as an exploratory, problem-solving discipline, educators can help them develop more positive attitudes toward problem-solving and better prepare them to teach it effectively.

4. Mathematical Anxiety as a Barrier

Mathematical anxiety was identified as one of the most significant barriers to preservice teachers developing positive attitudes toward problem-solving. Participants who had high levels of anxiety related to mathematics were less likely to approach problem-solving with confidence and more likely to avoid teaching it. Many participants reported feeling overwhelmed or nervous when asked to solve complex mathematical problems, a sentiment that persisted even in their teacher preparation programs. This anxiety often led to self-doubt and a belief that they would not be able to help their students overcome similar challenges.

Mathematical anxiety is a well-documented phenomenon that can significantly impair teachers' ability to effectively teach mathematics. It is vital for teacher education programs to recognize and address this issue. One possible solution is the integration of support mechanisms, such as counseling services, peer mentoring, and workshops focused on building confidence in mathematics, into the teacher preparation curriculum. Additionally, providing preservice teachers with opportunities to experience success in solving problems in low-stakes environments could help reduce anxiety and build confidence.

5. Implications for Teacher Education Programs

The findings of this study have important implications for teacher education programs. First, teacher educators should ensure that preservice teachers receive consistent and extensive exposure to problem-solving strategies throughout their coursework. Providing a range of problem-solving experiences—ranging from hands-on activities to collaborative learning opportunities—will help build preservice teachers' confidence and preparedness to teach problem-solving in their own classrooms. Additionally, teacher education programs should focus on changing preservice teachers' attitudes about mathematics, helping them develop a more positive outlook and a belief in the subject's value for critical thinking and real-world application.

Furthermore, teacher education programs should place greater emphasis on addressing issues such as mathematical anxiety, which can severely hinder preservice teachers' ability to engage with and teach problem-solving. Through targeted interventions, such as workshops that focus on reducing anxiety and boosting self-confidence in mathematics, programs can help preservice teachers overcome these barriers.

In conclusion, the factors influencing preservice teachers' attitudes toward problem-solving in mathematics education are complex and multifaceted. Their mathematical background, exposure to problem-solving techniques in teacher education programs, personal beliefs about mathematics, and experiences with mathematical anxiety all play a crucial role in shaping how they approach problem-solving. Teacher education programs must address these factors comprehensively, ensuring that preservice teachers develop positive attitudes and the necessary skills to teach problem-solving effectively. By doing so, these programs can better prepare future educators to instill

problem-solving abilities in their students and create mathematics classrooms that foster critical thinking, creativity, and a deep understanding of mathematical concepts.

The findings of this study indicate that preservice teachers' attitudes toward problem-solving in mathematics are influenced by several interrelated factors, including their mathematical background, pedagogical training, personal beliefs about mathematics, and experiences with problem-solving in their own education.

The strong correlation between preservice teachers' previous experiences with mathematics and their attitudes toward problem-solving highlights the importance of providing positive, supportive experiences in mathematics education early in life. Teachers who emphasize the value of problem-solving and create a supportive learning environment are more likely to instill positive attitudes toward mathematics and problem-solving in their students.

The role of teacher education programs in shaping preservice teachers' attitudes is also critical. Exposure to problem-solving strategies, particularly in the context of active learning and practical applications, can significantly enhance preservice teachers' confidence in their ability to teach problem-solving effectively. However, the variation in exposure to problem-solving instruction within different courses suggests that teacher preparation programs should provide more consistent and comprehensive training in problem-solving pedagogy across all courses.

The study also reveals that personal factors, such as mathematical anxiety, can act as barriers to developing positive attitudes toward problem-solving. Addressing these challenges in teacher education programs—through methods such as fostering a growth mindset, offering additional support for struggling students, and providing opportunities for preservice teachers to engage in problem-solving activities—may help alleviate anxiety and build greater confidence in their ability to teach mathematics effectively.

CONCLUSION

The attitudes of preservice teachers toward problem-solving in mathematics education are influenced by a complex set of factors, including their mathematical background, pedagogical training, personal beliefs, and previous experiences. Teacher education programs play a vital role in shaping these attitudes, and providing consistent, practical instruction in problem-solving strategies can enhance preservice teachers' confidence and effectiveness in teaching mathematics. Addressing challenges such as mathematical anxiety and ensuring positive, engaging experiences with problem-solving will help future educators approach mathematics education with a more positive and proactive mindset.

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