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Problem-Solving Skills and Difficulties of Pre-Service Mathematics Teachers in Non-Routine Problems

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A B S T R A C T

This research explored pre-service mathematics teachers' problem-solving skills and challenges in solving non-routine problems using a mixed-method approach, specifically an explanatory research design. The study focused on third-year BSEd Mathematics students in a state university in the Philippines and was selected using stratified random sampling in the quantitative part. This data was then supplemented by qualitative insights from in-depth interviews with selected students based on their problem-solving test scores. The study's findings identified various difficulties encountered by pre-service teachers in non-routine problem-solving, such as difficulties in remembering equations, lack of resources, and motivational factors. The in-depth interviews further explored these challenges and the coping mechanisms employed by the participants through open-ended questions that aimed to elicit detailed responses about their experiences. The findings revealed a significant concern regarding the below-average problem-solving skills of the participants, emphasizing the urgent need for instructional interventions within teacher training programs. The study highlighted moderate challenges pre-service teachers face, particularly in recalling and applying equations due to insufficient practice. It underscored the importance of curriculum revision to incorporate more problem-solving exercises and strengthen the mathematical and pedagogical competencies of pre-service teachers. Based on the findings, the research recommends a comprehensive approach to enhancing problem-solving skills among pre-service mathematics teachers. This approach includes increasing practice opportunities, revising curricula to prioritize non-routine problem-solving strategies, improving teacher education programs, and establishing partnerships to facilitate problem-solving-focused training. Additionally, policy changes supporting increased mathematics education resources are crucial for fostering a problem-solving mindset among future educators.

Keywords: preservice mathematics teachers, problem-solving skills, problem-solving difficulties, non-routine problems, mixed method research, explanatory research design

1. Introduction

For mathematics educators, the capability to solve complex, non-routine problems is essential. This requires a deep understanding of mathematics and solving problems efficiently. In education today, as the emphasis has shifted from content to skills, innovation, and critical thinking are becoming increasingly critical. Over the last two decades, problem-solving has gained prominence in mathematics education (National Council of Teachers of Mathematics [NCTM], 2020). The teacher's capacity for solving non-routine problems is critical to mathematics teacher education (Stacey, 2017). Preservice mathematics teachers preparing to teach mathematics today must be capable of dealing with challenges that go beyond what they may have learned in their training (National Council of Teachers of Mathematics [NCTM], 2000). Therefore, teacher-training institutions and pre-service mathematics teachers must be able to cope with situations that are not routine, which implies a shift in approach.

A range of recent studies has focused on how mathematics teachers approach problem-solving. According to Berenger (2018), mathematics teachers utilize various strategies, such as calculation, trial and error with whole numbers, and algebraic equations. Nonetheless, less than half were successful in solving the problem. Avcu and Avcu (2015) found that these teachers limited their use of different problem-solving techniques. Concerning visual representations, mathematics teachers preferred mental visualization for simpler problems but used both symbolic and iconic visual mediators for more complex problems (Ubuz, 2017). The ability of these teachers to communicate their problem-solving through self-discourse has also been identified as an important factor in successful visualization (Ubuz, 2017). Teachers commonly employ Pólya's four-step method for solving mathematical problems; however, steps 1 (understand the problem) and 2 (devise a plan) are difficult for most preservice teachers, specifically when they come to appropriate strategy choice and making a plan (Schoenfeld, 2016). Lester (2015) provides useful strategies, including guessing and checking, drawing pictures, or using variable number patterns to find the sum.

In addition to mathematics teachers' problem-solving strategies, various research studies examine their overall problem-solving skills. One significant aspect is understanding a problem and identifying relevant information. Schoenfeld (2016) found this basic step was problematic for many preservice mathematics teachers as they often do not clearly understand a problem or when much information about it must be known to solve it. Moreover, preservice mathematics teachers struggle with planning and monitoring their problem-solving process. Lester (2015) observes that preservice mathematics

teachers usually rush to solve problems without creating a plan of action, resulting in inefficient and ineffective problem-solving. In addition, preservice mathematics teachers have limited metacognitive skills, such as monitoring their progress or modifying their strategies accordingly (Garcia, 2017). Another crucial aspect of problem-solving skills involves choosing and using suitable mathematical principles and processes. Researchers say this has been difficult because non-routine tasks often go beyond applying standard algorithms (Özgen & Alkan, 2015; Işık & Kar, 2015).

Furthermore, the mathematical content knowledge of preservice mathematics teachers can affect their problem-solving skills. Some studies have shown that preservice mathematics teachers with weaker mathematical knowledge often struggle to solve problems more because of conceptual understanding and procedural fluency (Mataka et al., 2015). Additionally, beliefs and attitudes about mathematics significantly develop preservice mathematics teachers' problem-solving competency. Preservice mathematics teachers better did problem-solving with more sophisticated beliefs about mathematics and its learning, as Schommer-Aikins et al. (2015) found. This deficiency in content knowledge often leads to PMTs relying on memorized algorithms and procedures rather than developing a deeper understanding of the underlying mathematical concepts (Berenger, 2018).

Problems in problem-solving pose a great challenge to preservice mathematics teachers, particularly non-routine ones. Özgen and Alkan (2015) discovered that most preservice mathematics teachers had poor problem-solving skills; Işık and Kar (2015) enumerated seven types of mistakes made by preservice mathematics teachers concerning their questioning abilities on fraction-splitting problems. Moreover, PMTs cannot opt for appropriate mathematical problems besides being unfamiliar with alternative problem situations (Temur, 2015). Their mathematical thoughts and processes are not well articulated, nor do they give them using suitable linguistic expressions (Özdemir & Çelik, 2021).

Another considerable problem is the lack of experience of preservice mathematics teachers in non-routine problem-solving. Most have been exposed to routine problems during their education and teacher training programs, leaving them unprepared to handle unknown problem situations (Lester, 2015). This deficiency in experience leads to difficulties concerning planning and applying appropriate problem-solving strategies (Mataka et al., 2015). Additionally, preservice mathematics teachers' beliefs about mathematics influence their problem-solving abilities. Several studies have indicated that those PMTs who hold negative beliefs about mathematics, including an understanding of its nature and learning process, have lower self-efficacy and higher levels of anxiety when they are faced with problem-solving tasks (Schommer-Aikins et al., 2015; Ramirez et al., 2016). Consequently, these views may result in avoidance behavior and reluctance to approach difficult problems. Moreover, there is an issue with the metacognitive aspects of problem-solving skills among PMTs, such as monitoring one's progress and adjusting strategies accordingly or making necessary changes (Garcia, 2017). A lack of metacognitive skills leads to ineffective ways of tackling problems and acknowledging failure.

Recent literature highlights several gaps in understanding preservice mathematics teachers' problem-solving skills and difficulties. There is a lack of in-depth investigation into the problem-solving skills of preservice mathematics teachers when faced with non-routine problems. The cited studies discuss strategies and challenges but do not comprehensively assess the skill level of preservice mathematics teachers in this specific context. This highlights the importance of the first objective of the research, which aims to measure and describe preservice mathematics teachers' problem-solving abilities, particularly with nonroutine problems. Previous research has identified common difficulties encountered by preservice mathematics teachers in problem-solving. However, there is a lack of comprehensive analysis to determine the overall extent of these difficulties, especially with non-routine problems. While the literature mentions obstacles to effective problem-solving, the specific problems, difficulties, and hindrances that preservice mathematics teachers experience in solving non-routine problems have not been thoroughly documented. Understanding these nuanced issues requires a more focused exploration. This exploration is crucial for identifying areas of weakness and providing insights that could inform the design of more effective mathematics teacher training programs, better equipping preservice mathematics teachers to tackle non-routine mathematical problems.

The current research explores the problem-solving skills and challenges Pre-service Mathematics Teachers encounter in solving non-routine problems. Specifically, this study sought to answer the following research questions:

1. What is the problem-solving skill of the Pre-service Mathematics Teachers in solving non-routine problems?
2. What is the overall level and the most prominent problem-solving difficulties encountered by preservice mathematics teachers in nonroutine problems?
3. What problems, difficulties, and hindrances emerged and were experienced by preservice mathematics teachers when solving non-routine problems?.

2. Methodology

The current research employed mixed-method research to attain the objectives of the study. According to Creswell (2014), mixed-method research is an inquiry approach that combines qualitative and quantitative forms of research. It involves philosophical assumptions, using qualitative and quantitative approaches, and mixing or integrating both approaches in the study. Specifically, the current research employed an explanatory research design. This is a two-phase mixed-methods design in which the overall purpose is that qualitative data help explain or build upon initial quantitative results (Creswell, 2016). The researchers gathered the data through a survey given to the participants. Then, qualitative data were collected to explain the quantitative results further.

The participants of the study were third-year pre-service teachers with a Bachelor of Secondary Education major in mathematics at a state university in the Philippines. In the quantitative part of the study, the researchers used 40 Preservice Mathematics Teachers who were selected using stratified random sampling. Stratified random sampling is a probability sampling procedure in which the target population is first separated into mutually exclusive,

homogeneous segments (strata). Then, a simple random sample is selected from each segment (stratum) (Daniel, 2012) using the fishbowl technique. The respondents were classified into five different campuses of the university. The participants for the qualitative part were determined based on the responses in the quantitative part, specifically in the general results of the problem-solving skills. The respondents' scores in the problem-solving test were ranked from the highest to lowest. Three students with the highest and three with the lowest scores were subjected to an in-depth interview on the qualitative part of the study.

To gather the problem-solving difficulties encountered by Preservice Mathematics Teachers in solving nonroutine problems, an adopted research instrument of Reddy and Panacharoensawad (2007) was utilized. The instrument consists of several factors on difficulties: (1)lack of ability to remember related equations; (2) lack of books or materials on problem-solving in non-routine problems; (3)lack of practice on problem-solving during classes; (4)lack of understanding the fundamental basics of the nonroutine problems; (5)poor mathematical scales on understanding of the non-routine problem; (6)poor comprehensive skills on definitions, laws, and basic principles of non-routine problems; (7) lack of motivation from the mathematics teacher and experience of the teacher; (8) inadequate exercises on specific unit wise non-routine problems; (9)confusion arises from the unit to unit and its reflections on non-routine problem.

In this research, an In-Depth Interview Guide was used to establish pre-service mathematics teachers' challenges and coping mechanisms in non-routine problems. The interview guide was composed of open-ended questions and prompts intended to elicit detailed and thoughtful answers from the participants. These questions were meticulously designed to investigate the participants' experience with non-routine problems and identify their particular hurdles. This included inquiries that made individuals reflect on specific difficulties they faced. Additionally, this guide sought to understand how preservice math teachers managed the identified challenges.

In order to evaluate the non-routine problem-solving skills of pre-service mathematics teachers, the researchers developed assessment tools. Mathematics teachers and language specialists validated the instrument and then piloted it for reliability estimation. Item analysis reviewed the performance of the individual test items, such as their difficulty index, discrimination index, and total item quality. Third-year BSEd Mathematics students were given revised instruments in sequence after discussing the validation process, pilot testing, reliability analysis, and item analysis.

The statistical software SPSS was used to analyze the test results using descriptive and inferential statistics. Regarding these results, the highest and lowest three were chosen for interviews. These interviews aimed to uncover participants' challenges, issues, and coping strategies on their way to gaining knowledge in solving non-routine problems.

The collected data was analyzed qualitatively to understand participants' experiences and perspectives better. The research team listened carefully and wrote down everything the participants said while being interviewed to avoid missing any points. If necessary, the transcriptions were translated by a language expert with vast experience in this field so that everybody could understand them. In-depth analysis, coding, categorizing, and analyzing themes were some of the processes used during the qualitative data analysis of the interview script.

3. Results and Discussions

Level of Problem-Solving Skills of Preservice Mathematics Teachers

Table 1 shows the distribution of scores among preservice mathematics teachers, categorized into five ranges indicating their problem-solving skills in nonroutine problems. The results reveal that 7.50% of the participants have poor problem-solving skills. Most participants (77.50%) are below-average level, while 15.00% have average problem-solving skills. However, no participants achieved scores in the above-average or superior ranges.

The mean score, M = 10.03, SD = 2.59, shows the average problem-solving performance of preservice mathematics teachers. The result suggests that, as a collective, the group demonstrated a level of problem-solving skills below the average. The relatively low standard deviation suggests that the participants' scores were not widely dispersed and were somewhat clustered around the mean.

The findings of this study highlight a concerning level of problem-solving skills among preservice mathematics teachers. Most participants demonstrated below-average skills, with only a small proportion exhibiting average skills. Notably, no participants achieved scores in the above-average or superior ranges. These results underscore the need for targeted interventions to enhance the problem-solving skills of these teachers. The current study suggests a potential gap in the problem-solving skills acquired during teacher education programs. The below-average performance of these teachers implies a need for focused attention on developing their problem-solving abilities during their training. It is crucial for teacher education programs to provide ample opportunities for teachers to engage in problem-solving activities, reflect on their problem-solving processes, and acquire strategies for guiding students in tackling nonroutine problems.

The present findings support the literature recognizing the issues preservice mathematics teachers face in non-routine problem-solving, a necessary skill in successful teaching in mathematics classrooms (National Council of Teachers of Mathematics [NCTM], 2020; Stacey, 2017). This deficiency of exposure during training can cause poor problem-solving scores, as was the case in the research (Özgen & Alkan, 2015; Temur, 2015; Lester, 2015; Mataka et al., 2015).

Table 1

Problem-Solving Skills in Solving Non-Routine Problems of Preservice Mathematics Teachers

Range of Score	f	%	Level of Problem-Solving Skills	M	SD
0-6	3	7.50	Poor	10.03	2.59
7-12	31	77.50	Below Average		
13-18	6	15.00	Average		
19-24	0	0.00	Above Average		
25-30	0	0.00	Superior		

Overall Level and the Most Prominent Problem-Solving Difficulties Encountered by Preservice Mathematics Teachers in Solving Nonroutine Problems

Table 2 shows the difficulty preservice mathematics teachers encountered in solving nonroutine problems. The table presents the mean scores, standard deviations for each problem-solving difficulty, and the corresponding difficulty level and rank. The students' overall level of problem-solving difficulty suggests that preservice mathematics teachers face a moderately difficult challenge (M = 3.00, SD = 0.52) when dealing with nonroutine problems. This finding highlights the complexity and demanding nature of nonroutine problem-solving tasks.

One prominent difficulty is the "Lack of ability to remember related equations" (M = 3.35, SD = 0.58), which suggests that participants struggle with recalling and applying relevant equations in problem-solving. Furthermore, the difficulties related to practice and exposure to nonroutine problems, such as "Lack of practice on problem-solving during classes" (M = 3.15, SD = 0.62) and "Inadequate exercises on specific unit-wise nonroutine problems" (M = 3.08, SD = 0.80), indicate the need for targeted instructional interventions and resources that focus on developing problem-solving skills and providing ample practice opportunities.

The next two difficulties with relatively high mean scores were "Lack of practice on problem-solving during classes" (M = 3.15, SD = 0.62) and "Inadequate exercises on specific unit-wise non-routine problems" (M = 3.08, SD = 0.80), both categorized as moderately difficult. The remaining problem-solving difficulties, such as "Confusion arises from the unit to unit and its reflections on non-routine problem," "Lack of understanding the fundamental basics of non-routine problems," "Lack of books or materials on problem-solving in non-routine problems," "Poor mathematical scales on understanding non-routine problems," "Lack of motivation from the mathematics teacher and experience," and "Poor comprehensive skills on definitions, laws, and basic principles of non-routine problems," were also perceived as moderately difficult.

These results suggest that preservice mathematics teachers encounter multiple challenges when solving nonroutine problems, ranging from conceptual understanding to pedagogical support. Teacher education programs must address these difficulties through targeted interventions and instructional strategies that enhance problem-solving skills, deepen conceptual understanding, and promote effective teaching practices.

It is a fact that the study findings confirm preservice math teachers' problems, especially in the recall and application of pertinent formulas, and reveal that preservice teachers of mathematics often find it difficult to understand the concepts underlying mathematical understanding or acquire appropriate problem-solving strategies (Özgen & Alkan, 2015; Işık & Kar, 2015). This matches with what is generally known about education, which indicates a need to move away from rote learning in favor of creative skills like critical thinking and problem-solving (NCTM, 2020). In addition, the intervention requirement called for by this research agrees with Lester (2015) and Schoenfeld (2017), who stress having strong problem-solving abilities, effective planning, monitoring, and metacognitive abilities required in addressing non-routine mathematical situations efficiently.

Table 2

Level and Most Prominent Problem-Solving Difficulty in Solving Non-Routine Problems of Preservice Mathematics Teachers

Difficulty	M	SD	Level of Difficulty	Rank
Overall	3.00	.52	Moderately Difficult	
Lack of ability to remember related equations	3.35	.58	Very Difficult	1
Lack of practice in problem-solving during classes	3.15	.62	Moderately Difficult	2
Inadequate exercises on specific unit-wise non-routine problems	3.08	.80	Moderately Difficult	3.5
Confusion arises from the unit to unit and its reflections on non-routine problem	3.08	.83	Moderately Difficult	3.5
Lack of understanding of the fundamental basics of the nonroutine problems.	3.05	.81	Moderately Difficult	5
Lack of books or materials on problem-solving in non-routine problems	3.03	.77	Moderately Difficult	6

Poor mathematical scales on an understanding of the nonroutine problem.	2.88	.79	Moderately Difficult	7
Lack of motivation from the mathematics teacher and experience of the teacher	2.70	.85	Moderately Difficult	8
Poor comprehensive skills in definitions, laws, and basic principles of non-routine problems.	2.65	.83	Moderately Difficult	9

Note: Very Difficult (1.00 - 1.75), Slightly Difficult (1.76 - 2.50), Moderately Difficult (2.51 - 3.25), Very Difficult (3.26 - 4.00)

Problems, Difficulties, and Hindrances that Emerged and Were Experienced by Preservice Mathematics Teachers in Solving Non-Routine Problems

The results of the qualitative research indicate several problems, difficulties, and hindrances experienced by preservice mathematics teachers when solving nonroutine problems. These findings were gathered through focus group discussions and analyzed using thematic analysis. The key themes that emerged from the data include difficulty understanding the concept in nonroutine problems, difficulty recalling or remembering formulas to use, difficulty familiarizing oneself with solving nonroutine problems, and difficulties in self-confidence.

Understanding the Concept of Non-Routine Problems. The study results revealed that preservice mathematics teachers encountered difficulties in understanding the concepts of non-routine problems. Participant 1 expressed frustration and impatience, stating, "I easily got irritated and became impatient because I could hardly understand the concept of non-routine problems."

Similarly, Participant 2 highlighted the challenge of remembering formulas, particularly for shapes such as cylinders, rectangles, and circles. He mentioned, "I could hardly remember the formulas, especially for cylinder, rectangle, and circle. If you are not familiar with the formulas..." A common sentiment among Participants 3, 4, 5, and 6 was their difficulty understanding mathematical concepts and formulas. They shared the same perspective, “Most of us have a hard time understanding the concepts in mathematics. We are also unfamiliar with the formulas because we are faced with so many formulas that we get confused, and therefore, we can hardly remember them." Participant 6 acknowledged that there were instances where understanding the problem required using formulas, further adding to the difficulty. She mentioned, "There are times that you could not understand the problem you encountered as you need formulas." The struggles with understanding nonroutine problems were also evident in Participant 4: "I could not understand the concept; therefore, it is a problem in solving a mathematics problem."

Additionally, Participant 2 and Participant 5 mentioned the challenge of analyzing given problems and determining the appropriate approach. Participant 2 expressed their uncertainty in knowing where to start and comprehending the problem, stating, *“*I do not know where to start, especially since I could not understand the problem."] Participant 5 emphasized the difficulty of analyzing given information, citing an example related to solving for the radius and height. Moreover, Participant 2 highlighted the challenge of remembering formulas and steps to solve non-routine problems. They expressed, “It was a problem for me answering non-routine problems because you need to remember the steps."

Lastly, Participant 4 shared their struggle with analyzing problems, particularly in real-world applications and understanding mathematical terms. She mentioned, “Solving non-routine problems, especially in real-world applications, was very difficult for me, particularly in analyzing the problem. I struggled with understanding the terms used."

In summary, the findings indicate that preservice mathematics teachers face difficulties in understanding the concepts of non-routine problems. Challenges include frustration, difficulty remembering formulas, unfamiliarity with concepts, confusion caused by numerous formulas, struggles in problem analysis, lack of knowledge in probability, and unfamiliarity with mathematical terms. These findings highlight the need for targeted support and interventions to enhance conceptual understanding, improve formula retention, and develop problem-solving skills among preservice mathematics teachers.

Difficulty in Recalling or Remembering Formulas. The participants highlighted their difficulty recalling or remembering formulas to solve non-routine problems. Participant 5 expressed, “I could hardly remember the formulas, especially for cylinder, rectangle, and circle. If you are unfamiliar with the formulas, you cannot solve non-routine problems.” She also mentioned that understanding how to apply mathematics formulas and properly analyzing problems before answering them can be challenging. Participant 1 further emphasized the difficulty caused by a lack of information and the inability to remember formulas. He stated, “When you lack information and cannot remember the formulas, it becomes hard to analyze the statement of the problem.” Participant 3 highlighted the significance of having information and familiarity with the problem. He mentioned, “If the problem is not familiar to you and you lack information about it, it becomes really difficult to solve it unless you have experience solving similar problems or possess stock knowledge about it.” Participant 2 shared their struggle with unfamiliar formulas and not knowing the steps to solve problems. He stated, “I found it hard because I feel unfamiliar with the formulas, and I do not know the steps to solve them.” Furthermore, Participant 5 expressed difficulty answering problems involving cylinders due to forgetting the formula. She stated, “I found it difficult to solve problems involving cylinders because I forgot the formula.”

These participants' responses highlight preservice mathematics teachers' challenges in recalling or remembering formulas, understanding their application, and analyzing problems accurately. The inability to remember formulas and the steps to solve problems significantly hinders their ability to tackle non-routine problems effectively. Addressing these challenges requires focusing on formula memorization, understanding the application of formulas in problem-solving, and providing adequate information and resources to support teachers in their preparation to handle non-routine problems.

***Difficulty in Familiarization with Solving Non-Routine* Problems.** The study's findings revealed that preservice mathematics teachers encountered difficulties familiarizing themselves with solving non-routine problems. Participant 3 expressed, “I feel discouraged when it is difficult, especially when unfamiliar with the concept. It becomes even more discouraging when you are unfamiliar with the formula and do not know how to answer the question."

Participant 2 emphasized the unfamiliarity with solving non-routine problems and finding a solution. She mentioned, "non-routine problems are about unfamiliarity in solving and being unfamiliar with the process of finding a solution."

Furthermore, Participants 3, 4, 5, and 6 shared the challenge of unfamiliarity with formulas, given the numerous formulas they encountered. They stated, ‘‘We are also unfamiliar with the formulas because we were faced with so many, making it difficult to remember them." Participant 2 highlighted their difficulty due to their unfamiliarity with formulas and the steps involved in solving non-routine problems. He said, "I found it hard because I feel unfamiliar with the formula and do not know the steps in solving it." These findings indicate that preservice mathematics teachers encountered challenges in familiarizing themselves with solving non-routine problems. Difficulties stemmed from unfamiliarity with the concepts, formulas, and steps involved in problem-solving. This lack of familiarity led to feelings of discouragement and hindered their ability to solve non-routine problems effectively. To address these challenges, providing support and opportunities for preservice teachers to develop familiarity with various problem-solving approaches, formulas, and strategies is crucial.

Difficulties in Having Self-Confidence in One's Person. The study's findings shed light on the difficulties faced by preservice mathematics teachers in terms of self-confidence. Two Participants, Participant 4 and Participant 6, expressed their struggles and the impact on their self-confidence. Participant 4 shared her experience, stating, "I also felt discouraged, and the moment I could not solve the problem, it increased my discouragement because I have not learned so well. Lastly, it gives you low self-confidence." Similarly, Participant 6 highlighted the effect on their confidence, "I can also feel the frustration because I did not focus on mathematics. Although they are challenges, sometimes I thought I had better not enroll in this course because it is really hard."

These responses indicate that difficulties in solving non-routine problems can significantly impact the self-confidence of preservice mathematics teachers. Struggling to solve problems and not achieving the desired outcomes can lead to discouragement and decreased self-confidence. This, in turn, may hinder their motivation and willingness to engage in further problem-solving activities.

Low self-confidence among preservice mathematics teachers has noteworthy implications. It can affect their instructional practices, as they may feel less capable of effectively guiding their students in solving non-routine problems. Moreover, it can hinder their professional growth and development as mathematics educators.

The findings of this study agree with existing literature that emphasizes deep mathematical understanding and efficient problem-solving skills for preservice mathematics teachers, highlighting the transition from knowledge to capabilities such as creativity and critical thinking in education (National Council of Teachers of Mathematics [NCTM], 2020; Stacey, 2017). On top of that, the literature underscores common obstacles encountered by preservice teachers, such as struggling to understand and solve non-routine problems, reliance on rote algorithms, and poor metacognitive ability, which coincide with difficulties in comprehending concepts, remembering formulas, and low self-esteem observed in the current study (Özgen & Alkan, 2015; Işık & Kar, 2015; Garcia, 2017). These similarities imply extra training that should focus on a better understanding of mathematical content areas, developing effective problem-solving techniques, and improving thinking about learning to prepare pre-service mathematics teachers better for their forthcoming assignments.

Table 3 summarizes the problems, difficulties, and hindrances that emerged and were experienced by preservice mathematics teachers when solving non-routine problems.

Table 3

Summary of the Problems, Difficulties, and Hindrances that Emerged and Were Experienced by Preservice Mathematics Teachers in Solving Non-Routine Problems

Problems/Difficulties/ Hindrances		**Participant**					
		1	**2**	**3**	**4**	**5**	**6**
1.	Understanding the Concept in Non-Routine Problems	/	/	/	/	/	/
2.	Difficulty in Recalling or Remembering Formulas	/	/	/		/	
3.	Difficulty in Familiarization with Solving Non-Routine Problems		/	/	/	/	/
4.	Difficulties with Having Self-Confidence of One's Person				/		/

4. Conclusions

The findings of this research point out that there is a serious matter regarding the problem-solving ability of pre-service mathematics teachers. Most participants had below-average skills, and no one showed above-average or superior problem-solving ability. This highlights the utmost need for instructional interventions within teacher training programs to improve the problem-solving skills necessary to teach mathematics effectively. It is thus essential to address this shortcoming to enable future teachers to impart a problem-solving mindset based on educational standards and objectives to their learners.

The study posits that preservice mathematics teachers experience moderate challenges while dealing with non-routine problems such as recalling and applying equations. This complexity arises from a lack of enough time spent practicing these problems. These findings reveal the significance of revising curricula in teacher training programs to incorporate more problem-solving skills by providing opportunities for repetition on non-routine problems, bolstering their mathematical knowledge and pedagogical competence.

A number of challenges faced by preservice mathematics teachers while solving non-routine problems were identified in the present study. These include difficulties with comprehending non-routine problems, recalling mathematical formulas in use and development of problem-solving skills. Deficiencies in these aspects arise from both cognitive and psychological impediments like unfamiliarity with types of problems and low self-esteem that prevent teachers from resolving non-routine mathematical questions effectively. The findings highlight the need for better educational strategies and supports centered on improving comprehension of mathematical concepts, retention of formulae as well as enhanced confidence levels among pre-service teachers to increase their skills in tackling non-standardized mathematics tasks.

5. Recommendations

A multifaceted approach is proposed to effectively enhance the problem-solving skills of preservice mathematics teachers and deal with the problems identified. First, preservice teachers may seek opportunities to practice using many non-routine mathematical problems. This can be facilitated through workshops and seminars dealing with problem-solving strategies to help students understand and remember formulae well. Also, group discussions work favorably as they provide relaxed environments for sharing experiences.

For teacher training institutions to ensure comprehensive exposure and familiarity of preservice teachers, curriculum revisions should include extensive focus on non-routine problem-solving strategies. The curricula must contain compulsory units that address different mathematical challenges, such as non-routine ones. Additionally, having resources like toolkits for solving mathematical problems and a collection of non-routine problems that have worked out solutions will be very useful for students. In addition, investing in the professional development of teacher educators will enable them to teach more effective problem-solving methods, which may include technology-enhanced learning.

Policymakers and curriculum designers set standards and benchmarks for problem-solving competencies within training programs. They should advocate for policy changes that support increased funding and resources to improve mathematics education. Fostering partnerships between educational institutions and organizations with expertise in mathematics can enhance problem-solving-focused teacher training.

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References

Avcu, R., & Avcu, S. (2015). Pre-service elementary mathematics teachers' use of strategies in divisibility problems. *Procedia-Social and Behavioral Sciences, 174*, 1380-1386.

Berenger, A. (2018). Pre-service teachers' difficulties with problem solving. In J. Hunter, P. Perger, & L. Darragh (Eds.), Making waves, opening spaces *(Proceedings of the 41st annual conference of the Mathematics Education Research Group of Australasia)* (pp. 162-169). MERGA.

Cai, J., & Nie, B. (2007). *Problem solving in Chinese mathematics education: Research and practice*. ZDM, 39(5-6), 459-473.

dos Santos Morais, A. (2020). Developing problem-solving skills in pre-service mathematics teachers. *Revista Brasileira de Educação*, 25, e250021.

Garcia, E. G. (2017). Enhancing the problem solving skills of preservice mathematics teachers through a bridging course. *International Journal of Mathematical Education in Science and Technology, 48(2),* 179-194.

Gómez, P. (2009). Learning to teach mathematics: An experience in distance education. *ZDM, 41*(1-2), 263-276.

Işık, C., & Kar, T. (2015). An error analysis in division problems in fractions posed by pre-service elementary mathematics teachers. *Kuram ve Uygulamada Eğitim Bilimleri, 15(2),* 457-464.

Izci, K., & Göktas, Ö. (2017). The opinions of in-service teachers on in-service training. *Pegem Eğitim ve Öğretim Dergisi, 7*(4), 537-578.

Kayan Fadlelmula, F., & Cakiroglu, E. (2008). Pre-service teachers' beliefs about problem solving. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 35(35), 144-158.

Lester, F. K. (2015). Thoughts about research on mathematical problem-solving instruction. *The Mathematics Enthusiast, 12*(1-3), 3-16.

Mallart, A., Deulofeu, J., & Martínez, M. (2018). Preservice teachers' ability to pose proportional and inverse proportional problems. *Mathematics Education Research Journal, 30*(2), 201-222.

Mataka, L. M., Cobern, W. W., Grunert, M. L., Mutambuki, J. M., & Akom, G. (2015). The relationship between level of adoption of the flipped classroom model and student performance in college general chemistry courses. *Chemistry Education Research and Practice, 16*(4), 820-830.

National Council of Teachers of Mathematics. (2020). Principles to actions: Ensuring mathematical success for all. NCTM.

Özdemir, E., & Çelik, D. (2021). Preservice mathematics teachers' difficulties in expressing mathematical operations. *International Journal of Science and Mathematics Education, 19*(1), 1-21.

Özgen, K., & Alkan, H. (2015). Determination of self-efficacy beliefs of high school students towards math literacy. *Educational Sciences: Theory and Practice, 15*(5), 1297-1304.

Ramatlapana, K. A. (2009). Provision of in-service training of mathematics and science teachers in Botswana*: Teachers' perspectives. Journal of Mathematics Teacher Education, 12(*2), 153-159.

Ramirez, G., Chang, H., Maloney, E. A., Levine, S. C., & Beilock, S. L. (2016). On the relationship between math anxiety and math achievement in early elementary school: The role of problem solving strategies. *Journal of Experimental Child Psychology, 141*, 83-100.

Schoenfeld, A. H. (1985). Mathematical problem solving. Academic Press.

Schoenfeld, A. H. (2016). Learning to think mathematically: Problem-solving, metacognition, and sense-making in mathematics. *Journal of Education, 196*(2), 1-38.

Schommer-Aikins, M., Duell, O. K., & Hutter, R. (2015). Epistemological beliefs, mathematical problem-solving beliefs, and academic performance of middle school students. *The Elementary School Journal, 115*(1), 1-24.

Selter, C., Prediger, S., Nührenbörger, M., & Hußmann, S. (2015). Taking away and determining the difference: A longitudinal perspective on two models of subtraction and the inverse relation to addition. *Educational Studies in Mathematics, 90*(3), 239-251.

Setoromo, M. M., & Hadebe-Ndlovu, T. (2020). Exploring in-service mathematics teachers' knowledge of teaching mathematics. *Pythagoras, 41*(1), 1-10.

Stacey, K. (2017). *The international assessment of mathematical literacy: PISA 2012 framework and items*. In G. A. Goldin & C. E. Laborde (Eds.), Handbook of international research in mathematics education (pp. 153-167). *Routledge.*

Temur, Ö. D. (2015). Examining pre-service elementary teachers' mathematical problem posing skills. *Procedia-Social and Behavioral Sciences, 174*, 609-614.

Ubuz, B. (2017). Interpreting a graph and constructing its derivative graph: Stability and change in students' conceptions. *International Journal of Science and Mathematics Education, 15*(4), 713-734.

Zsoldos-Marchis, I. (2015). The effect of collaborative problem solving on pre-service elementary teachers' attitudes towards mathematics. *Acta Didactica Napocensia, 8*(1), 21-26.