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Problem-solving difficulties, performance, and differences among preservice teachers in Western Philippines University

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ABSTRACT

The ability to solve problems is a prerequisite in preparing mathematics preservice teachers. This study assessed preservice teachers' problem-solving difficulties and performance, particularly in worded problems on number sense, measurement, geometry, algebra, and probability. Also, academic profile differences in the preservice teacher's problem-solving performance and common errors were determined. A descriptive-comparative research design was employed with 158 random respondents. Data were gathered face-to-face during the first semester of the school year 2022-2023, and data were analyzed with the aid of *jamovi* software, ensuring ethical measures. Overall findings revealed that the preservice teachers experienced average difficulty in solving problems. The low performance of the preservice teachers on the given problems was also demonstrated. Further analysis revealed a significant difference between the preservice teachers' problem-solving performance based on their subject preference and program. Moreover, the error analysis revealed that the preservice teachers incurred comprehension errors in misrepresentation, misinterpretation, and miscalculation. These results will serve as a measure for policymakers and curriculum developers of the teacher education institution concerned to make relevant enhancements to the math courses offered in the elementary and secondary education programs.

Keywords: educational research, mathematics education, teacher education, word problems

INTRODUCTION

Problem-solving is vital in building a solid foundation for quality mathematics education. It enhances students' thinking skills to discover and formulate new things, an activity that implicates mathematics into related real-life problems and situations. Problem-solving as a mathematical task provides academic challenges for enhancing students' mathematical understanding and development (Novita et al. 2012; Pentang 2019). A crucial process necessary in teaching and learning mathematics is interpreting the problem presented as text and applying different mathematical concepts. The goal of teaching mathematical problems is for the students to develop a generic ability to solve real-life problems and apply mathematics in real-life situations (Gurat 2018; Mariano-Dolesh et al. 2022).

Solving mathematical problems is a logical process that employs induction, deduction, and algorithm, specifying the requirements and steps to solving the problem or designing a strategy unique to the learners (Aljaberi and Gheith 2016), which is often linked to metacognition (Andres 2022). The current study focused on the preservice teachers' problem-solving abilities and deemed problem-solving models for their students. Since preservice teachers are students currently enrolled and practicing teaching preparation programs and are considered future educators, they are responsible for engaging in professional experience with dedication. Thus, exploring their problem-solving skills and performance is necessary, especially those engaging preservice teachers in problem-solving experiences that could deepen their understanding and creativity (Nielsen and Bostic 2020). Once the preservice teacher engages in more problem-solving opportunities, they become more expert in interpreting variables, symbols, and equations to illustrate mathematically the problems that eventually help them provide the appropriate solution. It is crucial for preservice teachers, who will be the knowledge facilitators in the future, to at least train them to appropriately respond to various complex problem-solving tasks and prepare them to apply the concept of mathematics correctly. Prepare them for actual teaching and enhance their critical thinking and problem-solving skills since there is a significant possibility that the students can also adopt these skills. Using real-world problems to improve students' mathematical thinking and literacy is essential (Gurat 2018; Pentang 2019; Mariano-Dolesh et al. 2022).

Preservice teachers can teach their future students cognitive problem-solving strategies such as rehearsal, elaboration, and organization, and metacognitive strategies such as critical thinking, self-regulation, planning, monitoring, and evaluating methods (Gurat 2018; Pentang 2019). Preservice preparation is the foundation for successful mathematics instruction; nevertheless, it covers only a trivial portion of what teachers will need to know and be able to do effectively during their careers. However, more focus is needed on future mathematics educators because they still lack the depth of conceptual understanding and problem-solving abilities required to effectively teach their future students (Berenger 2018; Mariano-Dolesh et al. 2022). Preservice teachers' way of facilitating mathematical learning impacts students' mathematics achievement, and solving problems may cause long-term student development issues. Mathematics' deficient performance can be traced to teachers' failure to impart students' necessary knowledge, skills, attitudes, and values. This part forms the rationale that focuses on preservice teachers who will be future math teachers. Evaluating the problem-solving performance of preservice teachers is essential to determine what, when, and how to generate action that can help them improve their skills while studying. Teachers with limited mathematics instruction indicate they will transfer the same to their students. It seems to sense that aspiring teachers who lack a solid foundation in mathematics will have students who are similarly underprepared for the classroom (Mariano-Dolesh et al. 2022).

Mathematics teachers are the key to accomplishing the goal of the K-12 mathematics curriculum to develop problem-solving skills among Filipino youths. They are expected to teach more complex concepts to diverse learners utilizing active learning methodologies geared to enhance understanding in response to the K-12 curriculum. Current changes in mathematics education also encourage teachers to create environments where students explore, discuss, and work together to solve complex problems and develop their mathematical reasoning. Thus, two primary education goals for mathematics were developed as part of the K-12 mathematics Curriculum to support the conceptual framework of mathematics education, including problem-solving and critical thinking skills. Problem-solving skills are essential for preservice teachers; however, several studies have shown that Filipino preservice teachers must develop this skill further. Pelingon (2019), Pentang (2019), Andrade and Pasia (2020), and Andres (2022) posited that preservice teachers in the Philippines exhibited low to fair performance in word problems due to poor math content knowledge and inadequate problem-solving skills. This was agreed by a comprehensive international study where Filipino preservice teachers' mathematics abilities are at par compared to other 16 countries (Tatto and Senk 2011). These alarming trends among preservice teachers hinder the country's future of credible and quality mathematics education.

Furthermore, the study was anchored on constructivist learning theory, which provides guidance and a theoretical foundation to address the study's objectives. Constructivism suggests that acquiring knowledge is a collaborative endeavor that involves interpreting and integrating new information with pre-existing cognitive structures (Tobin 1994). Transmitting knowledge from a teacher to a student is not a direct process. Instead, a teacher facilitates the construction of specific experiences by assigning activities to students. The objectives and aspirations of a constructivist approach entail fostering self-directed learning among students, promoting their autonomy, facilitating the acquisition of comprehensive comprehension of concepts, and encouraging the formulation and pursuit of significant inquiries. In the present study, the constructivist learning approach proposes that preservice students acquire and enhance their critical thinking abilities by solving real-world problems.

The literature cited mentioned theoretical and scientific underpinning to support the need for problem-solving enhancement among preservice teachers. However, more written accounts must explore the preservice teachers' problem-solving performance regarding number sense, measurement, geometry, algebra, and statistics (Pentang 2019), particularly in the Western Philippines. Thus, this study aimed to determine the specific academic profile of the preservice teachers that possibly influence their performance in solving problems, impacting their preparedness for teaching mathematics. It is a comprehensive endeavor to study preservice teachers' academic profile (such as campus, program, type of high school attended, and subject preference) and how it relates to their problem-solving abilities. These factors collectively contribute to educational equity and access, guiding curriculum and pedagogical relevance and informing policy decisions.

Besides, the study explored their problem-solving difficulties and common errors. The teacher education institution concerned may find the study helpful in conducting similar works exploring future math teachers' preparedness at the elementary and secondary levels. The findings of this study will offer insights that will benefit teacher educators in understanding students' challenges and experiences with problem-solving; as a result, they will serve as a basis for proposing strategies that will effectively improve the preservice teachers' [(Bachelor of Elementary Education (BEEd) and Bachelor of Secondary Education (BSEd) major in Mathematics students)] problem-solving skills. Further study ramifications are deemed to address the underperformances of young Filipinos in Mathematics revealed in the National Achievement Test results and by several international studies such as Trends in International Mathematics and Science Study and Program for International Student Assessment.

The study inquired about the problem-solving performance of preservice teachers. Specifically, this aimed to answer the following questions:

1. What problem-solving content areas are difficult?
2. What are preservice teachers' problem-solving performance levels on number sense, measurement, geometry, algebra, statistics, and probability problems?
3. When grouped according to their academic profile, do significant differences exist in the preservice teachers' problem-solving performance?
4. What are the common errors in the preservice teachers' solutions to word problems?

METHODS

Research Design

A descriptive-comparative research design was employed to address the study's objectives. The descriptive phase described the preservice teachers' difficulty level and problem-solving performance in mathematics, mainly in number sense, measurement, geometry, algebra, statistics, and probability, including the common errors they encountered. Meanwhile, the comparative part investigated the statistical differences between the problem-solving performance of preservice teachers in mathematics and when grouped according to their academic profile (campus, program, type of high school attended, and subject preference).

Respondents and Sampling Procedures

The respondents were preservice teachers, specifically the second-, third-, and fourth-year teacher education (BEEd and BSEd) students taking mathematics education courses at Western Philippines University. Simple random sampling was used based on the shared traits and profiles in determining the respondents since they belong to the same sampling frame. Before obtaining the sample from a population, it is imperative to possess a sampling frame, which serves as a means of identifying and locating the sampling units within the population (Gregoire and Valentine 2008). Also, it is essential to note that using a simple random sampling technique is feasible for selecting individuals from a population that solely possesses an area sampling frame (West 2016). Thus, a sample (n) of 158 (N = 267) preservice teachers participated in the study (Table 1). While the sample size exceeds that of several related studies (Gurat 2018; Pentang 2019; Andrade and Pasia 2020; Andres 2022; Mariano-Dolesh et al. 2022) that investigated the problem-solving performance of preservice teachers in various regions of the country, the importance of a large sample size must be acknowledged in ensuring the rigor and generalizability of the findings.

It was ensured that the respondents understood the study's intent and the data collection process. The respondents were informed of what to do and had their permission or consent to answer the survey voluntarily. The researchers also ensured that the data collected would not be subjected to any data exploitation and would remain confidential to ensure their information was safe and protected. Participation or not of the preservice teachers does not affect their class standing.

Table 1. Respondents of the study. Note: *n* = sample size.

Academic Profile	Frequency (*n* = 158)	Percentage (%)
Campus		
Puerto Princesa	68	43.04
Aborlan	90	56.96
Program		
BEED	88	55.70
BSED	70	44.30
Type of High School Attended		
Public	100	63.29
Private	58	36.71
Subject Preference		
Mathematics	72	45.57
Other Subjects	86	54.43

Instrumentation

The researchers adapted the problem-solving items by Pentang (2019). The researcher modified the problem-solving questionnaire to fit the study's purpose better and make it more comprehensible among the respondents of the present study. It comprises 25 multiple-choice items subjected to item analysis after the pilot testing. Still, the preservice teachers were expected to show their complete solutions before choosing an option from the distracters provided. The instrument determined skills in the preservice teachers' mathematical problems in number sense, measurement, geometry, algebra, and statistics. The Cronbach alpha obtained was excellent: number sense (α = 0.90), measurement (α = 0.92), geometry (α = 0.90), algebra (α = 0.91), and statistics and probability (α = 0.94), indicating the instrument is reliable (Cronbach 1951). The results suggested notable reliability and internal consistency, as demonstrated by Cronbach's alpha coefficient, ranging from 0.90 to 0.94. It is recommended to employ instruments with higher Cronbach alpha in research pursuits, as they tend to demonstrate decreased measurement error and augment statistical power in diverse research settings (Heo et al. 2015). The instrument underwent expert evaluation. Three mathematics faculty researchers, each holding a doctoral degree, were carefully selected from various academic institutions. These experts collectively possessed a decade of experience teaching mathematics at the tertiary level and a research background. They also actively participated in the evaluation of the outputs. This approach aligns with established research guidelines, emphasizing involving at least three experts in the respective field to ensure content validity (Shrotryia and Dhanda 2019). As a result of this thorough assessment, it was conclusively demonstrated that the instrument upholds its validity.

Data Collection and Analysis

Before administering the questionnaire, the respondents signed a consent form in compliance with the Data Privacy Act of 2012, emphasizing the confidentiality and anonymity of the collected data. Before administration, the respondents were given an orientation regarding the research objectives. They were then instructed to read the directions thoroughly and respond honestly to each item. Ethical factors included conflict of interest, privacy confidentiality and data protection, risk and benefit ratio, informed consent, and terms of reference. The questionnaire was administered face-to-face in the middle of the first semester (SY 2022-2023). The data were gathered over five days (from Monday to Friday) after classes so they would not experience fatigue from solving word problems.

Frequency distribution was used to organize and present the academic profile of the preservice teachers. Also, the level of difficulty in solving problems was determined. The difficulty level was reported as a proportion or percentage, ranging from 0 to 100 percent. The following verbal interpretation was used: very easy (90% to 100%), easy (70% to 89%), average (40% to 69%), difficult (20% to 39%), and very difficult (0% to 19%), which was based on Crocker and Algina (1986). In contrast, arithmetic means and standard deviation were used to determine the level of their problem-solving performance. At an alpha level of 0.05, differences in the problem-solving performance of the preservice teachers based on their academic profile were conducted using an independent samples t-test. Assumption tests for normality and homogeneity of variance were conducted using Shapiro-Wilk and Levene's, respectively, finding no violations (P > 0.05). The descriptive and inferential statistics and assumptions testing was conducted using *jamovi* (The jamovi project 2021).

On the other hand, error analysis was conducted to look for common mistakes in the preservice teachers' work. This was conducted to validate the problem-solving difficulties and performance of the preservice teachers. Three math instructors from several teacher education institutions locally and abroad served in determining the errors incurred.

RESULTS

Difficulties Incurred in Problem-solving by the Preservice Teachers

The preservice teachers faced difficulty with the problem-solving items provided, with only 45 percent responding correctly (Table 2). This is far below the 90 percent or better performance. The overall result manifests that they encountered problems involving number sense, measurement, geometry, algebra, and statistics. Specifically, most of them needed help to respond correctly to difficult (6, 8, 9, 10, 12, 15, 17, 18, 19, and 20) and very difficult questions (11, 13, and 14), which fall under measurement, geometry, and algebra.

Table 2. Difficulty level of the respondents and the percentage of their correct responses. Note: 90-100 = Very Easy; 70-89 = Easy; 40-69 = Average; 20-39 = Difficult; 0-19 = Very Difficult

Item Number	Correct Responses	Difficulty Index (%)	Item Domain	Difficulty Level
1	70	88.60	Number Sense	Easy
2	62	79.48		Easy
3	37	46.83		Average
4	64	81.01		Easy
5	68	86.09		Easy
6	30	37.97	Measurement	Difficult
7	55	69.62		Average
8	20	25.32		Difficult
9	23	29.11		Difficult
10	17	21.52		Difficult
11	10	12.66	Geometry	Very Difficult
12	23	29.11		Difficult
13	15	18.99		Very Difficult
14	15	18.99		Very Difficult
15	29	36.71		Difficult
16	35	44.30	Algebra	Average
17	31	39.24		Difficult
18	20	25.32		Difficult
19	25	31.65		Difficult
20	17	21.52		Difficult
21	41	51.90	Statistics and Probability	Average
22	43	54.43		Average
23	55	69.62		Easy
24	35	44.30		Average
25	50	63.29		Average
Overall Difficulty		**45.10**		**Average**

Problem-Solving Performance of the Preservice Teachers

Findings show that the preservice teachers have poor problem-solving performance, with an overall mean of 0.45 and a standard deviation of 0.16 (Table 3). Further analysis found that the preservice teachers performed satisfactorily in the number sense ($\bar{x}$ = 0.71, *SD* = 0.43). The preservice teachers performed very satisfactorily in addition, subtraction, and whole numbers ($\bar{x}$ = 0.84, SD = 0.30) and fraction, percentage, and multiple operations ($\bar{x}$ = 0.84, *SD* = 0.27). Meanwhile, they perform poorly in multiplication, division, ratio, and proportion ($\bar{x}$ = 0.47, *SD* = 0.50).

Regarding the measurement, the preservice teachers' performance results were below expectations ($\bar{x}$ = 0.42, *SD* = 0.48), indicating their poor ability to employ measurement concepts. Specifically, the future teachers performed poorly in the perimeter of a square, conversion from inches to feet ($\bar{x}$ = 0.34, *SD* = 0.40), and in the volume of a prism, conversion from meters to liters ($\bar{x}$ = 0.23, *SD* = 0.32), except for determining the area and conversion of a rectangle ($\bar{x}$ = 0.70, *SD* = 0.46) in the context of real-world mathematics problems whose recorded performance outcome was unsatisfactory.

Concerning geometry, the preservice teachers performed unsatisfactorily ($\bar{x}$ = 0.22, *SD* = 0.44). This result reveals how a preservice teacher's low score issue in one domain can affect their overall performance in mathematics. The difficulty of the items is relatively severe; thus, while a few people could provide the correct answer, the majority struggled. Specifically, the preservice teacher performed unsatisfactorily on the items about finding the area of a plane inscribed in solid ($\bar{x}$ = 0.28, *SD* = 0.33). Meanwhile, they performed poorly on the items relevant to the diagonal of a plane and solid figure ($\bar{x}$ = 0.13, *SD* = 0.33) and the hypotenuse of a right triangle ($\bar{x}$ = 0.24, *SD* = 0.35).

Similarly, they performed poorly in algebra ($\bar{x}$ = 0.32, *SD* = 0.32). This result indicates that their performance in algebra was below average to the desired level. Many gave incorrect answers. This implies that their understanding of mathematical ideas and the basis for approaching issues that can be employed in this context is weak. The preservice teacher performed below expectations, specifically in both presenting and solving equations in one unknown ($\bar{x}$ = 0.33, *SD* = 0.33), analyzing mathematical equations in one unknown ($\bar{x}$ = 0.32, *SD* = 0.47), and solving mathematical relationships in one unknown ($\bar{x}$ = 0.32, *SD* = 0.27) and labeled as poor performance.

Finally, in statistics and probability, the preservice teachers performed poorly ($\bar{x}$ = 0.59, *SD* = 0.50). The items divided into categories, reflected various learning situations that preservice teachers navigated. It indicates that preservice teachers need to be more competent to successfully teach statistics and probability as the topic of their instructional plan. Results revealed that the performance was poor in solving the problem intended for examining the ability of preservice teachers to use the language of chance in estimating the probabilities ($\bar{x}$ = 0.54, *SD* = 0.40), and determining probabilities by applying an empirical formula ($\bar{x}$ = 0.54, *SD* = 0.30) while making predictions and using theories of probabilities ($\bar{x}$ = 0.70, *SD* = 0.46) they performed unsatisfactory.

Table 3. Preservice teachers' problem-solving performance. Note: 0.91-1.00 = Excellent; 0.81-0.90 = Very Satisfactory; 0.71-0.80 = Satisfactory; 0.61-0.70 = Unsatisfactory; 0.00-0.60 = Poor

Content Area	Mean	SD	Description
Number Sense	0.71	0.43	Satisfactory
1. Addition, subtraction, and whole numbers.	0.84	0.30	Very Satisfactory
2. Multiplication, division, ratio, and proportion.	0.47	0.50	Poor
3. Fraction, percentage, and multiple operations.	0.84	0.27	Very Satisfactory
Measurement	0.42	0.48	Poor
4. Perimeter of a square, conversion from inches to feet.	0.34	0.40	Poor
5. Area of a rectangle,	0.70	0.46	Unsatisfactory
6. Volume of a prism, conversion from meters to liters.	0.23	0.32	Poor
Geometry	0.22	0.44	Poor
7. Area of a plane inscribed in solid.	0.28	0.33	Poor
8. Diagonal of a plane and solid figure.	0.13	0.33	Poor
9. Hypotenuse of the right triangle.	0.24	0.35	Poor
Algebra	0.32	0.32	Poor
10. Representing and solving equations in one unknown.	0.33	0.33	Poor
11. Analyzing mathematical situations in one unknown.	0.32	0.47	Poor
12. Solving mathematical relationships in one unknown.	0.32	0.27	Poor
Statistics and Probability	0.59	0.50	Poor
13. Using the language of chance in estimating probabilities.	0.54	0.40	Poor
14. Determining probabilities applying an empirical formula.	0.54	0.30	Poor
15. Making predictions and using theories of probability.	0.70	0.46	Unsatisfactory
Overall Performance	**0.45**	**0.16**	**Poor**

Academic Profile Differences in the Preservice Teachers' Problem-Solving Performance

An independent sample t-test was conducted to determine the significant differences in the problem-solving performance of the preservice teachers based on their academic profiles (Table 4). Regarding the campus attended, no significant difference was found between the problem-solving performance of the preservice teachers (t = -0.16, P > 0.05). This indicates that students from the Puerto Princesa Campus ($\bar{x}$ = 0.45, *SD* = 0.23) performed similarly to the Aborlan Campus ($\bar{x}$ = 0.44, *SD* = 0.15). It was also found that the preservice teachers that attended public ($\bar{x}$ = 0.50, *SD* = 0.56) and private ($\bar{x}$ = 0.41, *SD* = 0.20) high schools had no significant difference in problem-solving performance, t = 0.43, P > 0.05.

Besides, a significant difference was found between the problem-solving performance of the preservice teachers enrolled in the BSEd program. Preservice teachers enrolled in the BEEd program were found, t = 3.95, P < 0.05. This implies that BSEd preservice teachers ($\bar{x}$ = 0.51, *SD* = 0.17) perform significantly higher than the BEEd preservice teachers ($\bar{x}$ = 0.38, *SD* = 0.23). Regarding their subject preference, a significant difference was found between the problem-solving performance of the preservice teachers who prefer math and other subjects, t = 2.12, P < 0.05. Notably, the preservice teachers who like math ($\bar{x}$ = 0.63, *SD* = 0.77) perform significantly higher than those who do not like math ($\bar{x}$ = 0.37, *SD* = 0.11).

Common Errors found in the Preservice Teachers' Work

Table 5 summarizes the common errors found in the solutions made by the preservice teachers in the word problems provided. In general, they incurred mathematical comprehension errors. Particularly, they made misrepresentation (situation and mathematical model errors, conceptual errors, and syntax errors), misinterpretation (unintelligent guesses, conceptual errors, and procedural errors), and miscalculation (casual errors, PEMDAS errors, procedural errors, and being complacent). These errors were evident in the sample solution by one (Figure 1). Due to misrepresentation, misinterpretation, and miscalculation, the preservice teacher obtained an incorrect answer to the multiple-choice test requiring problem-solving.

DISCUSSION

Problem-solving Difficulties of the Preservice Teachers

The preservice teachers encountered problem-solving difficulties, which is parallel with Tanisli and Kose (2013), Pentang (2019), and Yayuk and Husamah (2020), yet contrary to Andres (2022). The preservice teachers do not master or understand fundamental techniques and concepts that can help them solve mathematical problems correctly; therefore, they have many calculation errors on some parts of the test. These points out that some preservice teachers needed to prepare for teaching training opportunities to enhance their teaching skills in mathematics as requisite for this teaching course. This can be attributed to a need for more problem comprehension (Barham 2020; Yayuk and Husamah 2020) and mastery of content knowledge (Tatto and Senk 2011). In support of Bahtiyar and Can (2016) and Zuya (2017), the preservice teachers need help responding with more appropriate conceptual and procedural knowledge in measurement, geometry, and algebra.

Table 4. Academic profile differences in the preservice teachers' problem-solving performance. Note: *significant at 0.05 level

Academic Profile	Characteristic	Mean	SD	*t*	*P*
Campus	Urban	0.45	0.23	-0.16	0.872
	Rural	0.44	0.15		
Type of High School Attended	Public	0.50	0.56	0.43	0.667
	Private	0.41	0.20		
Program	BSEd	0.51	0.17	3.95	0.040*
	BEEd	0.38	0.23		
Subject Preference	Math	0.63	0.77	2.12	0.037*
	Other subjects	0.37	0.11		

Table 5. Common errors in problem-solving incurred by the preservice teachers.

Errors	Emerging Themes	General Theme
Situation model errors (no/wrong visual representation of the problem, mistranslating word problems to graphs, tables, or charts)	Misrepresentation	Comprehension Errors
Mathematical model errors (no/wrong mathematical models to represent the problem, mistranslating word problems to mathematical expressions or equations)		
Conceptual errors (misapplied concepts, formula misuse, wrong derivation)		
Syntax errors (miswritten formula, symbols, and coefficients)		
Unintelligent guesses (wrong assumptions/hypotheses)	Misinterpretation	
Conceptual errors (cannot connect the problem to other scenarios, unable to apply concepts, incomplete understanding of the problem)		
Procedural errors (misinterpreting the problem and data provided)		
Casual errors (miscopied data, miswriting formulas, shortcut solutions)	Miscalculation	
PEMDAS errors (inadequate knowledge, misconceptions, and misapplications)		
Procedural errors (poor mental and manual computation ability, unable to perform mathematical tasks entirely and accurately, lack of strategies)		
Complacent (failure to check the completeness of the solution and the accuracy of the final answer)		

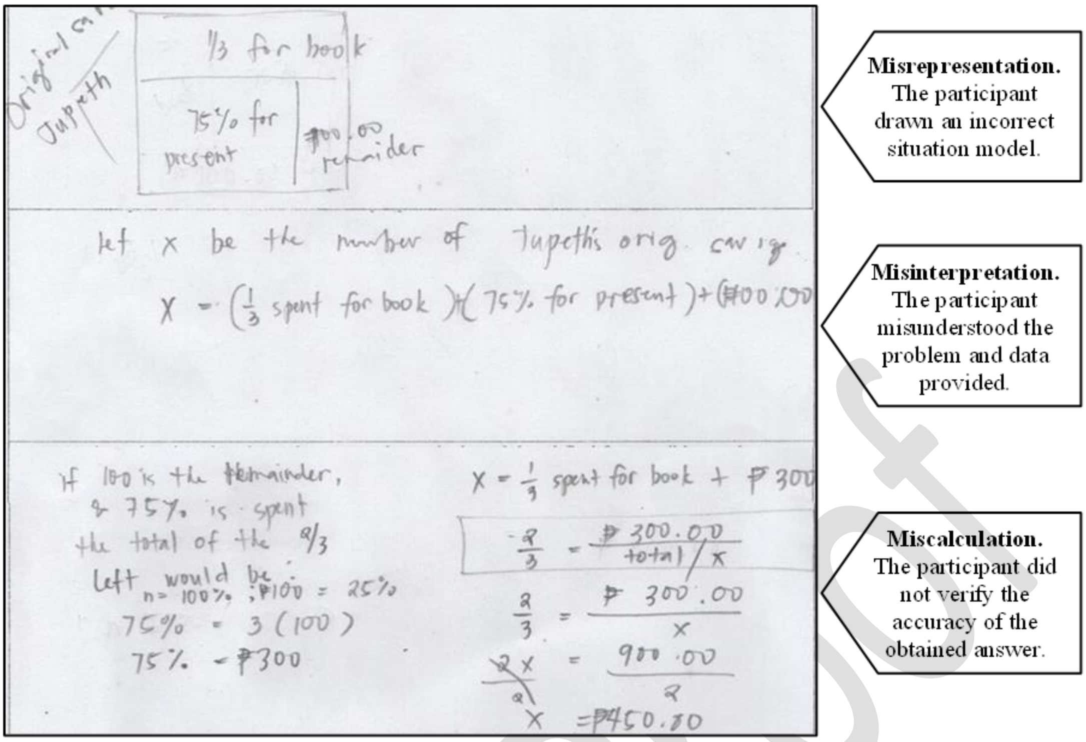

Figure 1. A sample solution of one participant showing multiple errors [Item #3 (Stem: *Jupeth used one-third of his savings to buy a book and spent 75% of the remainder to buy his mother a present. If he still has ₱100.00 left, how much was his original savings?*) Distracters: A. ₱300.00; B. ₱450.00; C. ₱600.00; D. ₱750.00). *The correct answer is C. ₱600.00.*].

One factor affecting their problem-solving performance is their willingness, interest, and attitude to answer any mathematical problem. Also, these findings indicate their deficient capacity to recall pertinent equations, apply problem-solving techniques, comprehend fundamental concepts, and exhibit mathematical proficiency (Reddy et al. 2017). Some of them may need help comprehending the context of mathematics problems and interpreting the issues; likewise, they need help to accurately identify the information given and the techniques that must be applied, which causes them to make more mistakes when attempting to solve the problems. The items mentioned earlier demonstrate that the preservice teachers cannot come up with perfect scores, which can also be attributed to their poor performance in mathematics and can describe the level of their problem-solving skills. Moreover, they need help with the questions on the five learning domains, as most of them fail to answer the items related to geometry and algebra correctly, and some of them to all subjects. Overall, the preservice teachers experienced average difficulty solving problems in number sense, measurement, geometry, algebra, statistics, and probability, foundational concepts in higher mathematics. These findings suggest that they should prioritize learning these competencies, which will be crucial in introducing them to their students.

Problem-Solving Performance of the Preservice Teachers

The preservice teachers' performance needs attention. While they consider mathematics challenging (Bacsal et al. 2022), many struggle with mathematical content knowledge and problem-solving (Aljaberi and Gheith 2016; Pelingon 2019). This may also be attributed to the methods of instruction used in the college do not encourage the preservice teachers to view mathematics as a medium for communication, reasoning, or problem-solving (Matić 2017), and problem-solving strategies have yet to be developed (Andrade and Pasia 2020). Moreover, it can be observed that students who possess high levels of self-efficacy may encounter challenges when it comes to evaluating and creating problem-solving questions, both in terms of conceptual and procedural aspects. In addition to cognitive factors and students' knowledge, inadequate attention to detail and a sense of urgency may contribute to challenges in problem-solving (Prismana et al. 2018). This result suggests that teachers should focus on deepening students' problem-solving understanding. Preservice teachers should be given constant opportunities to practice the proper procedures, concepts, and strategies to solve and comprehend mathematical problems.

The number sense performance of preservice teachers shows they need to understand this content area fully. Consistent to Santos et al. (2020), these future teachers needed help in the components and domains of number sense. Teachers could aid in developing number sense in their students by understanding it and knowing how to teach it. When students thoroughly comprehend number concepts, they can better apply math quickly, create efficient problem-solving techniques, and improve their number sense. Agreeing with Hasanah and Yulianti (2020), the preservice teachers incurred common mathematical mistakes in measurement, particularly in formula application errors, calculational inaccuracies, failure to fully understand the problem before attempting a solution, and a lack of familiarity with the fundamental concept. They need to grasp the measurement basics to reach the expected level of proficiency in that subject. Thus, teachers and educators must focus on problem-solving concepts and revisit their teaching approaches.

The result also indicates that preservice teachers need to be more effective in teaching their future students and more capable of managing the problems they could experience while teaching geometry. This aligns with Pentang (2019), which found that preservice teachers lacked the prerequisite geometry knowledge. However, these results contradict Niyukuri et al. (2020), which reveals that student-teachers have higher competencies in geometry. Besides, these preservice teachers have difficulties answering algebra, which may affect them once they take up the licensure examination for teachers and effectively fulfill their responsibilities to harness each of their future students' abilities towards mathematics. The result agrees with Brown and Bergman (2013) and Zuya (2017), where preservice teachers performed low on items demanding knowledge of algebra procedures. Their capacity in mathematics problem solving is insufficient and weak, similar to their knowledge foundation in solving equations, interpreting through variables and equations, and their ability to give assumptions to relate and provide solutions. Hence, one additional way to improve middle students' performance in algebra is to strengthen the preservice elementary and middle school teachers' understanding of variables. Finally, they performed low in statistics. Underperformance in statistics is a common issue for preservice teachers, similar to Pentang (2019) and Bacangallo et al. (2022). This can be attributed to their poor understanding of probability, as reflected by their scores. Thus, they need adequate training and support as future statistics teachers since they will play a vital role in developing a foundation in this field for their students.

The low performance of the preservice teachers on the given problem set indicates their lack of problem-solving skills, mathematical content knowledge, and comprehension of the application of mathematics to real-world problems. This may affect their off-campus deployment, class observation, actual practice teaching as required by their course, and their licensure examination when they are finally professional teachers who should exemplify excellence in education and problem-solving, incredibly complex mathematical problems that require a solid foundation of mathematical knowledge and comprehension. Results indicate the need for remedial classes, midyear clinics, comprehensive examinations, additional tasks, and extra time for detailed review for all preservice teachers and those who struggle to solve mathematical problems. Teacher education institutions need to initiate other pedagogical strategies (i.e., Bacsal et al. 2022) and activities to improve the problem-solving performance of preservice teachers.

Academic Profile Differences in the Preservice Teachers' Problem-Solving Performance

The external environments, such as facilities and learning settings, do not affect problem-solving performance. Both rural and urban campus facilities have the same functions (the design might be different) and are efficiently used by professors and preservice teachers. On the other hand, this result contradicts the study of Tomul et al. (2021), which found that the school's location (rural, suburban, urban) contributes to significant variance in math performance. Thus, much more study is needed to clarify this phenomenon. Meanwhile, the type of high school they graduated from poses no substantial contribution to their problem-solving skills that will distinguish them from the other group. One factor that may be guided to this result is that public and private high schools follow the curriculum provided by the Department of Education, and teachers in both schools have the same competencies. Correspondingly, Pentang (2019) showed similar results.

The BSED preservice teachers are exposed to complex mathematics tasks, making them able to solve correctly and understand problem-solving exercises more quickly. At the same time, it supported the statement that BSED preservice teachers are more competent in problem-solving tasks than those taking up BEED as their program, which is also distinguished as skilled preservice teachers in general or fundamental mathematics offered in primary education. In addition, this also demonstrates that most of those who choose mathematics as their specialization have excellent scores when solving mathematics problems compared to others. Besides, the interested preservice teacher prefers mathematics over other subjects, treats mathematics positively, is willing to be teachable, and is brave enough to conquer their weaknesses. They are more likely to achieve satisfying scores in mathematics problem-solving tasks.

The program and subject preferences are attributed to their problem-solving performance and that mathematics educators should consider when introducing problem-solving in their classes. These results also may be attributed to the curriculum differences of the program between BSEd and BEEd. The BSED programs specialize in mathematical subjects, and students in these programs are more frequently exposed to complex mathematical tasks, which reveals that these students are more likely to solve mathematical problems correctly. On the other hand, BEED programs are designed to hone preservice teachers in general or fundamental mathematics offered in primary education. This demonstrates that BSED preservice teachers perform better when solving mathematics problems than BEED preservice teachers. Moreover, if the preservice teacher is interested, prefers mathematics rather than other subjects, treats mathematics in a positive perspective, is willing to be teachable, and is brave enough to conquer their weakness in the subject, there is a higher possibility that they can achieve a satisfying score in a mathematics problem-solving task. This may be because students' interests are connected to their chosen courses. Students' preferred subjects are dependent on their cognitive abilities and interests. Also, students are more likely to enjoy engaging in activities they perceive as within their competence and interest sphere. Thus, this explains why students' subject preferences impact their problem-solving performance.

Common Errors found in the Preservice Teachers' Work

Common errors among the preservice teachers (Figure 1) validated their problem-solving difficulties and underperformance. They frequently make similar comprehension errors when solving math problems, such as misinterpretation, misrepresentation, and miscalculation. These concerns among preservice teachers were also raised in Pentang (2019). Findings even reflect the specific errors made by preservice teachers, including conceptual, procedural, and casual errors. These oppose Mariano-Dolesh et al. (2022), where preservice teachers have established their conceptual understanding for solving word problems. These errors may have been aggravated by the pandemic, which limited the interaction between teacher educators and preservice teachers. Moreso, these preservice teachers lack the fundamental mathematics content knowledge taught in the primary education curriculum. Agreeing with Nielsen and Bostic (2020), these findings emphasize the importance of providing targeted training and support to preservice teachers to help them develop problem-solving skills and prepare them for their future role as mathematics educators. These errors can be prevented by facilitating the preservice teachers to master fundamental concepts and practice problem-solving drills. They encouraged the preservice teachers to present their solutions and answers to a problem. This may help identify their comprehension errors, such as misrepresentation, misinterpretation, and miscalculation.

The study's limited scope constrains the generalizability of its results. It is important to note that the sample of students involved in this study may not fully represent the broader population of all preservice teachers. Furthermore, the study focused explicitly on mathematics classes, particularly preservice teachers. The researchers intentionally selected students from a specialized program, which may have resulted in the overrepresentation in this study. Also, the potential for confounding variables that were not accounted for in the study may have influenced the results, particularly the difficulties and performance in problem-solving. It is recommended that a broader range of samples be utilized and conducted over a more extended period to yield more precise outcomes.

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ETHICAL CONSIDERATIONS

The respondents provided their consent, and the data collected was kept confidential. The researchers ensured proper credit was given for any similarities to other studies.

DECLARATION OF COMPETING INTEREST

The authors declare no competing interests.

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