Well-Stated Problem: What is the Level of Problem-Posing Performance of Pre-Service Mathematics Teachers?

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Abstract: The Philippine mathematics education system aims to develop learners with strong critical thinking and problem-solving skills. However, students often struggle with problem-solving due to its complexity and ambiguity of tasks designed by educators. The use of problem-posing activities was seen as a new pedagogical approach in mathematics education. This study examined the problem-posing performance of preservice mathematics teachers. Quantitatively, it described their scores using the "Free Problem-Posing Performance Assessment", moreover, this study explored the strategies and difficulties in problem-posing performances. Results showed a satisfactory performance in Statistics and Probability, Number Sense, and Algebra, but a fair performance in Geometry and Measurement—mainly due to poor alignment between visual representations and mathematical goals. Common issues included ambiguous wording, grammatical errors, misleading contexts, and lack of authenticity. Socio-demographically, sex did not significantly affect performance, but academic year level indicates that higher-year students performs better than lower years. The recurring deficiencies in mathematics performance highlight the urgent need for curriculum enhancement; effective mathematics education must go beyond content delivery by fostering awareness of how learners think and approach problems. Promoting self-awareness among educators help them better understand diverse student approaches to both problem-solving and problem-posing, ultimately leading to more meaningful and effective instruction.

Keywords: Mathematics Education, Performance task, Pedagogical approach, Pre-service Education, Problem-posing

INTRODUCTION

Mathematics education emphasizes the importance of the problem-solving ability of the learners. Critical thinking and problem-solving skills were highlighted in the twin goals of the Philippine K-12 Mathematics Framework (Department of Education, 2016). The development of these competencies is the top priority of the education system gearing towards the advancement of mathematics education. However, despite the efforts to enhance the mathematical abilities of the learners through these concepts, learners still have a relatively low performance in the international mathematics assessment like Programme for International Student Assessment (PISA) where the performance of the Philippines in mathematics did not improve from 2018 to 2022 (Acido & Cabales, 2024). One possible reason is the complexity of the nature of problem-solving, combined with the ambiguity of the problem-solving activities developed by the educators.

To address this, new core competencies must be developed for mathematics teachers, which include learning to devise problem-solving activities that involve a heuristic approach and target the mathematical thinking, critical thinking, and creativity of the learners. One way to uphold this competency is through designing a well-structured problem through problem-posing. The line "A well-stated problem is half-solved" emphasizes the importance of clearly stated problem structure. In general, problem-posing in mathematics is defined as the ability of an individual to construct an effective mathematical problem.

Mathematical competency was recognized as an essential aspect of mathematics and mathematics education as it not only enriched the mathematical investigation, but also opened a promising approach to exciting and enriching activities for the development of mathematical thinking (Peng et al., 2022) In mathematics learning, teachers should present mathematics problems that can encourage the students to learn and demonstrate their critical and creative thinking (Masriyah et al., 2018). Problem-posing activities are characterized by the active learning approach where learners have control over their thinking processes, ultimately leading to the application of their prior learning experience that develops their mathematical knowledge (Wakhata et al., 2023).

Since it is a common practice to expose learners to an active learning environment, teachers can emphasize the role of problem-posing in classroom activities. In a common mathematics classroom, learners answer a mathematics problem from the book or where student and material engagement is rarely seen. While problem-posing activities deal with process-oriented and outcome-oriented skills, learners incorporate their interests and curiosity which leads to posing a problem that suits their critical thinking and their creative mind to come up with a solvable problem that is contextualized through their learning experiences (Baumanns & Rott, 2024; Divrik, 2023). This learning approach could target the mathematical interest of the learners, which can enhance the content knowledge in an engaging way.

The importance of problem-posing is that is a skill that emphasizes the competency of a learner to creatively construct a mathematical problem. Interestingly, previous studies emphasized that problem-posing activities are a method that can be used to incorporate into a teaching and learning process (Divrik, 2023; Li et al, 2020; Polat & Özkaya, 2023). Problem-posing can be an essential aspect of mathematics teachings and learning; it can be used as an assessment strategy to monitor the learner's capability in mathematical content and mathematical thinking (Cai et al., 2020). Moreover, teachers can encourage innovative thinking through creative thinking process.

Problem-Posing as Pedagogical Approach

By emphasizing the pedagogical approach of problem-posing, educators can bring a new contextualized environment to the mathematics classroom, not just by solely determining students' ability to solve problems but by employing the strategy of making mathematical problems. This could unlock a goal in teaching learning through gaining insights into every learner's approach coupled with their understanding and their competency not just about their knowledge of mathematical content, but also their perspective on a certain task through employing their learning experiences (Leung, 2012).

Given that the key persons in developing the teaching and learning process are the teachers, they must possess adequate knowledge and understanding not just of the content, but also an immersive idea of the pedagogical approach (Masriyah et al., 2018). In a teacher education program, preservice mathematics teachers were exposed to different mathematical contents: abstract, symbolic, and even interactive approaches in mathematics. They were taught the essential competencies of a mathematics teacher. Additionally, this ability is needed to be able to explore and evaluate the extent to which learners understand the material being taught. In addition, the teacher's ability to pose problems can assist students in reducing their dependence on textbooks and help students become more involved in learning activities.

However, principles and strategies in teaching mathematics remain intact on the traditional approaches due to the limitation of equitable materials on how to teach mathematics and the understanding of how a young learner thinks during a complex task like mathematical problem-solving. This may be linked to the absence of exposure to a real classroom setting scenario, which can be addressed through gaining insights on what a learner can do by posing their mathematical task. It can serve as a measure of their understanding and their level of competency.

Previous studies indicate that teachers themselves had difficulty engaging in problem-posing activities because of the unfamiliarity of these concepts (Kozakli Ulger et al., 2022; Ozgen, 2019; Vale & Barbosa, 2024). Moreover, the output quality produced by the educators in their content and pedagogical approach to problem-posing is not always valid, which leads to a deficiency in the quality of teaching and learning (Koichu & Kontorovich, 2013). Ironically, mathematics educators are the ones who must demonstrate a strong understanding of the given concept. Hence, if we could produce mathematics teachers that possess an equitable knowledge in varied approaches of problem-posing performance, it could significantly improve the mathematics education in the Philippines.

Mathematics teachers play a critical role in the development of strong new approaches in mathematical pedagogy. Hence, the main goal of this study is to assess if these future mathematics teachers could properly construct effective mathematical problem solving through their problem-posing strategies. Introducing problem-posing activities in mathematics classrooms could revolutionize the conventional approaches of problem-solving, thus it is a crucial to produce highly competent teachers in this concept to properly guide and evaluate the learners.

This study determines the current performance of the preservice mathematics teachers in problem-posing activities through evaluating their approaches and their content knowledge in mathematics. Moreover, determining the socio-affective domains in terms of gender roles, sex, and the developmental factor in terms of academic year level could significantly improve the targeted intervention in problem-posing performance. Taking these concerns into account could improve the relevance of the study.

Specifically, this paper answers three main questions:

(1) What is the competency level of the preservice mathematics teachers in problem-posing?
(2) What are the strategies and approaches used by the preservice mathematics teachers in posing a mathematical problem?
(3) Do problem-posing performance of the pre-service mathematics teachers differ across sex, and academic year level?

Addressing these concepts could inform curriculum experts and educators through understanding the underlying principles and concepts that might affect the learners in these competencies. Determining their competency in this matter will inform the educators and the teacher education programs to devise and design a strategy where the use of varied approaches in improving critical thinking, creativity, and problem-solving skills could be maximized. This could then eventually lead to the advancement of teaching and learning in mathematics education that might attain the twin goal in the mathematics framework.

METHOD

Research Design

This study utilizes a quantitative approach to determine the problem-posing competency level of the respondents; a descriptive design was used by quantifying the responses and interpreting it into descriptive categories. To properly evaluate and interpret the output made by the respondents, each performance was assessed to generate more in-depth analysis by examining and evaluating the common mistakes, strengths, and differentiated approaches performed by the respondents in the problem-posing activity. For the inferential part, mean comparisons on determining the differentiated performances of the respondents were utilized.

Sample and Data Collection

The research sample consisted of 75 pre-service mathematics teachers, who are currently enrolled in the Teacher Education Program–Bachelor of Secondary Education major in Mathematics. These participants were selected using a stratified sampling procedure with proportional allocation. This method allows the researchers to obtain a diverse research sample that represent every group in the population of interest, accounting for sex and academic year level.

The study was conducted during the first semester of the Academic Year 2024–2025, aligning with the period when the participants were taking the course "Principles and Strategies in Teaching Mathematics." This course explores various instructional strategies and methodologies essential for effective mathematics teaching. Its focus on pedagogical approaches made it an ideal context for investigating the participants' abilities in problem-posing.

To ensure meaningful data collection, the researchers introduced the participants to a series of structured problem-solving activities, incorporating both routine and non-routine mathematical problems. These activities were designed to expose pre-service teachers to different problem types, fostering an understanding of how mathematical concepts can be constructed and represented from various perspectives. The exposure aimed to cultivate their ability to generate cognitively demanding mathematical problems which are crucial skill for educators in teaching and assessment. Data collection took place after this instructional intervention, where students were tasked with crafting their own mathematics problems. These outputs were evaluated to determine the depth of conceptual understanding, creativity, and clarity of presentation.

The underlying assumption was that exposure to high-level cognitive tasks and diverse problem types would enhance their capacity to pose meaningful and engaging problem. By situating the activity within the framework of coursework and instructional development, this study emphasizes the potential of problem-posing as both a pedagogical strategy and an assessment tool. It highlights how intentional instructional design can foster a deeper understanding of mathematical thinking, preparing future educators to deliver richer learning experiences in their future classrooms.

Ethical Considerations

The study obtained an ethical clearance approval from the institution. The research complies with all relevant legal standards and regulations governing the rights and welfare of research participants. Participation in the study was entirely voluntary, and participants could withdraw at any stage without facing any negative consequences. The voluntary nature of participation was emphasized both in the informed consent process and during the study. Participants were informed about the study's purpose and procedures to maintain transparency throughout their involvement, ensuring strict confidentiality of the generated data; any published results do not include personally identifiable information to protect the privacy of participants.

Instrumentation

This research utilized a "Free Problem-Posing Performance Assessment." This is a researcher-made performance test that aligns with several research studies about the assessment of problem-posing performances and is validated by a group of experts in mathematics education, including a person holding a doctorate degree in Mathematics education and an in-service mathematics teacher from high school level.

This instrument comprises several tasks in which participants will generate or pose two problems based on the indicated task or given concept on each specific item. Free problem-posing activities can be the most effective tool in problem-generation as problem-posers can develop learners' mathematical thinking. Situations in free problem-posing activities encourage authentic assessments that target daily life scenarios that learners can relate to. Use of their prior knowledge will give them an advantage in solving and approaching the problem. This instrument consists of three main concepts, aligned to the content areas of K-12 Curriculum in the Philippines: Measurement and Geometry, Number Sense and Algebra, and Statistics and Probability. Sample tasks were provided as follows:

Sample item: Pose a problem that involves the length of measurements (mm, cm, and m) in it.

Sample item: Pose a problem involving a division of fractions.

Sample item: Pose a problem that deals about the probability of an event.

To objectively measure the performance of the participants in the problem-posing activity, a modified analytical rubric developed by Polat and Özkaya (2023) was utilized (Table 1). Given the qualitative nature of problem-posing tasks, a standardized and objective evaluation tool is necessary to ensure the reliability, validity, and fairness of the assessment process.

Criterion	Indicators	Score
Problem text criterion	The problem text is not clear and understandable.	0
	Problem text is partially understandable.	1
	The problem text is understandable, it is not clear what is asked.	2
	The problem text is clear, concise and understandable.	3
Compatibility with mathematical principles	The problem does not conform to the principles of mathematics	0
	The problem partially complies with the principles of mathematics (such as the use of misconceptions).	1
	The problem does not comply either mathematical or conceptual error, but the data used is not compatible with daily life	2
	The problem complies with mathematical principles and real life.	3
Type and structure of the problem	It is a simple exercise type.	0
	It is of the exercise type.	1
	It is of the simple word problem type.	2
	It is of word problem type.	3
Solvability of the problem	The data and information in the problem are not sufficient to solve the problem.	0
	Although the given in the problem is sufficient, it cannot be solved because it is too complex.	1
	The problem can be solved, but the data is either incorrect or missing.	2
	The problem is solvable because the data and information in the problem are complete and appropriate.	3

Table 1: Adapted Scoring Rubric developed by Polat and Özkaya (2023)

Each criterion captures a different but interdependent aspect of problem quality, ranging from language and context clarity to mathematical correctness and real-world relevance. This multidimensional assessment is necessary because problem-posing is a higher-order cognitive task that demands both pedagogical insight and mathematical competence.

This rubric quantifies qualitative responses, turning open-ended outputs into measurable data that can be analyzed statistically. This rubric will yield a total of 12 points in each problem, 24 points in each competency, and will generate a total of 72 points. To determine the performance of the participants in each competency, and the over-all problem-posing performance, a qualitative classification was used (Table 2).

Analysis of Data

This study used various methods on interpreting the obtained data. All are aligned to the stated objectives. To determine the level of the problem-posing performance, mean and standard deviation were utilized. The mean was transmuted into qualitative description given below (Table 2). To answer if there are significant differences based on sex and academic year level, an independent sample's t-test was utilized, along with a One-way Analysis of Variance, followed by a univariate analysis (Post-hoc) using Bonferroni analysis for a proper evaluation of the existing mean differences.

The use of descriptive and inferential statistical methods in this study is justified by the nature of the research objectives and the type of data collected. This study aims to determine the level of problem-posing performance among pre-service mathematics teachers; using the mean and standard deviation provides a clear summary of overall trends in their performance. The inclusion of a transmuted qualitative scale further enhances the interpretability of the scores in an educational setting.

Description	**For each Competency**	**For each task**	**For Overall Performance**
	Scoring	**Scoring**	**Scoring**
Poor	1.00 – 6.75	1.00 – 3.75	1.00 – 18.75
Fair	6.76 – 12.50	3.76 – 6.50	18.76 – 36.50
Satisfactory	12.51 – 18.25	6.51 – 9.25	36.51 – 54.25
Very Satisfactory	18.26 – 24.00	9.26 – 12.00	54.26 – 72.00

Table 2: Standard criteria for the level of Problem-posing Performance

To evaluate the respondents' demonstrated performances in problem-posing activity, the researchers investigated participants' responses and thoroughly analyzed the patterns, common mistakes, strengths, and weaknesses of their provided outcomes. Aside from quantitatively describing the differences in the performances of problem-posing activities, the researchers explored the answers of each response and compared it across the demographic profile of the respondents. The qualitative analysis of the participants' responses was integrated to gain deeper insight into their problem-posing abilities. This approach allowed for access beyond numerical scores by identifying common patterns, strengths, and weaknesses in how the participants construct mathematical problems. Exploring individual responses across demographic profiles supports a more comprehensive understanding of how different factors may influence performance.

RESULTS

Table 3 presents the breakdown of the scores on problem-posing performance of the respondents on different tasks, and the overall score on each competency in mathematics curriculum.

Area of Competency		Mean	SD	Level
Geometry and Measurement	Task 1	6.19	3.348	Fair
	Task 2	6.73	4.323	Satisfactory
	Total	12.20	6.877	Fair
Statistics and Probability	Task 1	7.07	3.306	Satisfactory
	Task 2	6.84	2.927	Satisfactory
	Total	13.91	5.199	Satisfactory
Number Sense and Algebra	Task 1	5.53	3.310	Fair
	Task 2	7.65	3.100	Satisfactory
	Total	13.19	5.399	Satisfactory
Overall Problem-Posing Performance		39.29	14.050	Satisfactory

For each task: Poor (1.00–3.75), Fair (3.76–6.50), Satisfactory (6.51– 9.25), Very satisfactory (9.26–12.00)
For total of Competency Area: Poor (1.00 – 6.75), Fair (6.76–12.50), Satisfactory (12.51-18.25), Very satisfactory (18.26–24.00)
For Overall Problem-posing performance: Poor (1.00–18.75), Fair (18.76–36.50), Satisfactory (36.51-54.25), Very satisfactory (54.26 –72.00)

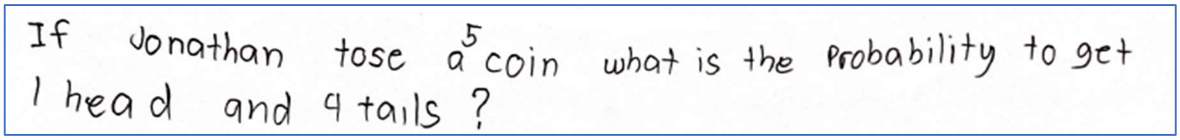
Table 3: Problem-Posing Performance of pre-service mathematics teachers

The demonstrated performance of the respondents in the problem-posing activity was properly analyzed using descriptive statistics. The mean and standard deviation were obtained and interpreted in a qualitative description reflecting poor to very satisfactory performance. Findings revealed that the overall problem-posing performance of the respondents is at satisfactory level (μ=32.29, SD=14.50) and shows a high variability of the results. When examining the combined scores in Task 1 and 2 in each competency area, Statistics and Probability and Number sense and Algebra is at Satisfactory level (μ=13.91, SD=5.199, and μ=13.19, SD=5.399, respectively). However, when it comes to Geometry and Measurement, respondents demonstrate a lack of competency as the results reveal that respondents demonstrated a Fair level of performance (μ=12.20, SD=6.877). Although the performance of the respondents in the Number sense and Algebra is at satisfactory level, respondents demonstrated a relatively low score in task 1. A consistent finding of fair performance of the respondents in task 1 in Geometry and Measurement imply a lack of demonstrated competency in figures and measurements.

Moreover, the overall performance of the preservice mathematics teachers is at satisfactory level, indicating that these future mathematics teachers possess the necessary skill in problem generation. However, the mastery in this concept was not achieved, as they may still lack the creativity and innovative approaches in problem-posing.

Qualitative Analysis of the Demonstrated Performance in Problem-Posing Activity

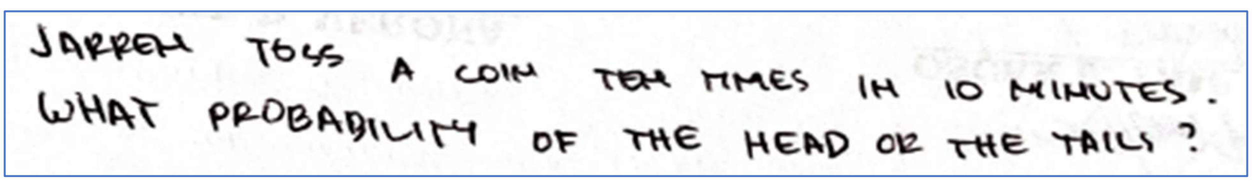
To properly evaluate the problem-posing performance of the preservice mathematics teachers, this study explored and assessed each response and noted all the observed deficiencies, lack of indicated domains, and notable approaches used in the problem-posing.



"If Jonathan ***tose*** *a 5 coin what is the probability to get 1 head and 4 tails?"*

Figure 1: Statistics and Probability in Task 1 of 1st year student

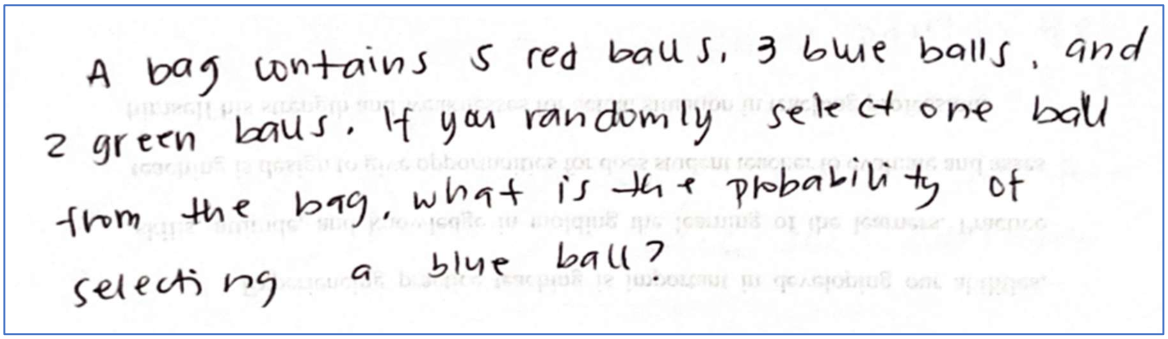
Several students' posed problems in the context of tossing a coin and rolling a die, which is used in teaching and learning in mathematics classrooms. Most of the examples used by an educator during the discussion of the probability of an event is the use of these examples as well. Because of the common nature of the concept, these examples are readily available in the textbooks used by the teachers. However, common errors were observed including grammatical errors and misspelled words, which significantly affects the presentation of the problem as it affects the clarity of thought. In the case of Figure 1, the word "toss" was misspelled to "tose," and the clarity of the thought was out of the context that the respondent wants to present it. In the researcher's understanding, the problem pertains to *"If Jonathan tosses five (5) pieces of coin, what is the probability of getting one (1) head and four (4) tails as an outcome?"* However, this problem still lacks depth and an authenticity to support learners in properly cultivating their critical and logical thinking. A similar problem presented by one 2nd year student (Figure 2).



"Jarren toss a coin ten times in 10 minutes. What probability of the or the tail?"

Figure 2: Problem-posed of 2nd year student in Statistics and Probability Task 1

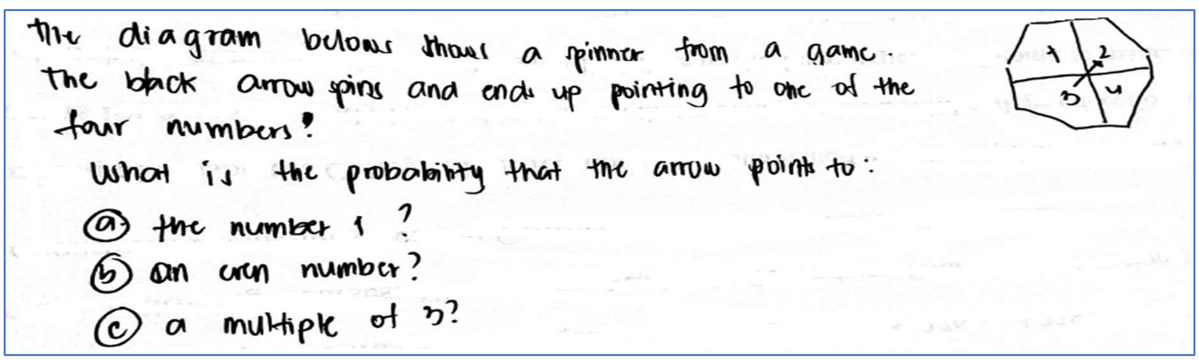
The problem was phrased clearly and presented an insufficient story to tell the context of the problem. Similar to the approach used in Figure 1, this student used a name to enhance the relevance of the problem. A slightly different approach made by the 3rd year student. The 3rd year student used a commonly posed problem regarding the probability of getting colored balls (object) in a pool of selections. This type of problem is commonly used in a mathematics classroom; thus, students tend to imitate this approach.


A bag contains 5 red balls, 3 blue balls, and 2 green balls. If you randomly select one ball from the bag, what is the probability of selecting a blue ball?

"A bag contains 5 red balls, 3 blue balls, and 2 green balls. If you randomly select one ball from the bag, what is the probability of selecting a blue ball?"

Figure 3: Problem-Posed in task 1 by 3rd year student

Although the presentation of data is complete, this problem (Figure 3) does not cater a complex analysis of problem-solving approaches. The structure of the problem mostly targets a simple exercise problem, but it does not conform to the mathematical principles that relates to the applicability in real life scenarios that learners could relate their experiences and prior knowledge to further enhance their understanding of the problem.


The diagram below shows a spinner from a game. The black arrow spins and ends up pointing to one of the four numbers!
What is the probability that the arrow points to:
(a) the number 1 ?
(b) an even number?
(c) a multiple of 3?

"The diagram below shows a spinner from a game. The black arrow spins and each up pointing to one of the four numbers. What is the probability that the arrow points to:

a. the number 1? b. an even number? c. a multiple of 3?"

Figure 4: Problem-posed in task 1 by 4th year student

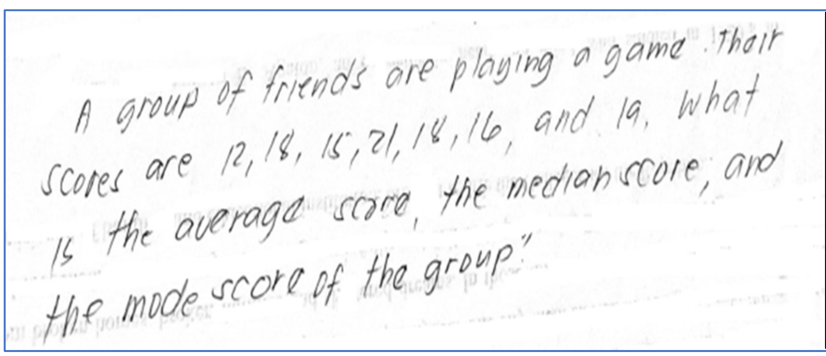
The approach used in Figure 4 seems promising as the illustration adds to the clarity of the problem. The learners could properly visualize the context, which leads to better comprehension. Although the words in the problem presentation are partially erroneous and the given numbers limit the complexity of the problem, this problem may be used as an activity; however, further enhancement is needed.

The problem lacks context. They assume students understand the mechanics of the spinner and equal probability, but do not explicitly state that each outcome is equally likely. For improvement, the problem posed must clarify the assumptions by adding a statement specifying that the spinner is divided into equal sections and that each number has an equal chance of being landed on. Consistent phrasing for each question (a to c) could also enhance the problem. Furthermore, the main goal in problem-posing is to encourage deeper thinking; hence, generating contextualized problems are crucial. For example, we can add a follow-up question here: *"If the spinner is spun 100 times, how many times would you expect the arrow to point to an even number? Justify your reasoning."* By doing this, we can promote good reasoning and thinking processes.

Task 2: Statistics and Probability

Most of the student's output in task 2 in statistics and probability does not vary, as the conceptual understanding revolves on simple statements of finding the mean, median, and mode.

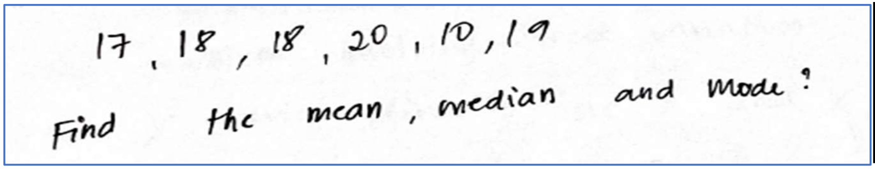
Figure 5 shows a little variation of the problem. The respondent simply added details to tell a story that serves as context and then proceeded to mathematical content. However, this problem shows potential ambiguity in what to do. The problem asks for multiple measures of central tendency, but it might be clearer if it specifies the steps expected, especially for learners new to these concepts. Also, to aid learners, it is a good strategy to give learners a prompt on what to do in the mathematical problem. This problem can include the definition of mathematical terms (mean, median, and mode); while these are common terms, some learners might need clarification or definitions.


A group of friends are playing a game. Their scores are 12, 18, 15, 21, 18, 16, and 19. What is the average score, the median score, and the mode score of the group.

"A group of friends are playing a game, their scores are 12, 18, 15, 21, 18, 16, and 19. What is the average score, the median score, and the mode score of the group"

Figure 5. Variation of presentation of mean, median, and mode

However, the main issue arises in Figure 6. The problem-posed was simply presenting a set of numbers and proceeding to ask the value of the mean, median, and mode.



"17, 18, 18, 20, 10, 19 Find the mean, median and mode?"

Figure 6: Common observation on the problem-posed in mean, median, and mode

Although, the structure of the problem (Figure 6) is valid for the exercise type as it is complete and solvable, this problem clearly shows an absence of authenticity of the problem and the clarity of instruction. The data values were listed but not explicitly labeled as a data set which leads to ambiguity of the problem. While the question asks for the "mean, median, and mode," it does not define these terms or guide the reader on how to calculate them. For some learners, this could cause confusion.

Geometry and Measurement

The overall mean in the Measurement and Geometry fell under the "fair" category, implying that the performance of the respondents is below the expected threshold of the competency that must be possessed by a teacher. Through further analysis and evaluation, respondents displayed insufficient contextual understanding of measurement; they pose a different approach. However, the content and the context of the problem does not properly execute.

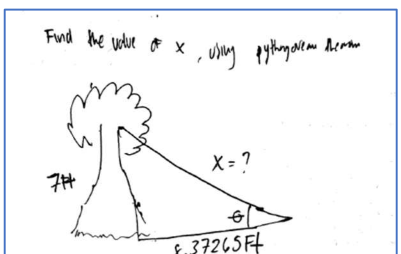


Figure 7.1

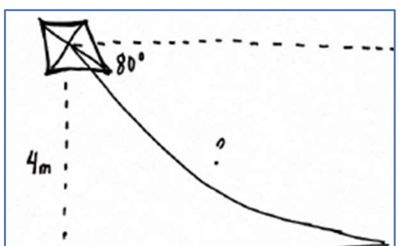


Figure 7.2

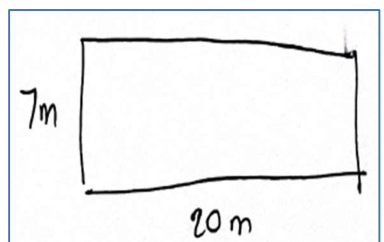


Figure 7.3

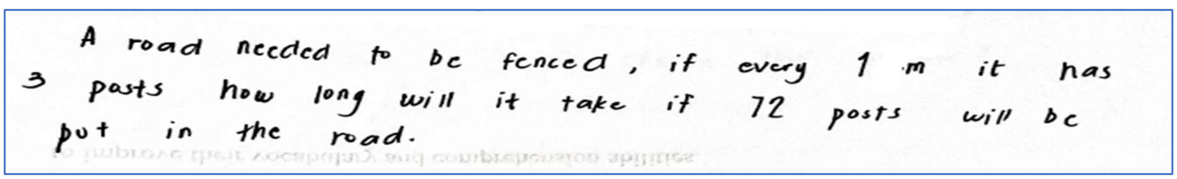
Figure 7: Examples of Inaccurate and Misaligned Student-Generated Illustrations in Geometry and Measurement Problem-Posing Task by 3 respondents.

This performance shows an insufficient grasp of knowledge in the proper presentation of a problem. Although the use of figures for mathematical notations added to the value of clarity, the over reliance on figures and illustrations is irrational as it does not provide the context of the problem, resulting in confusion and an incomprehensible structure of the mathematical problem. If the learners encountered this problem in an activity and exercises, this would bring puzzlement and may hinder the learner's development in mathematical content.

Furthermore, Figure 7.1 is explicitly asking about the value of x using Pythagorean theorem and the indicated values. That drawing is a right triangle, although it does not present it that way. Another is the misleading label; if it is a right triangle, a small square on the intersection between two sides can be added to indicate that one angle measures 90°. Furthermore, unnecessary inclusion of theta (θ) leads to another form of question which adds confusion to the aim of the problem. Moreover, the figure is inaccurate. The Pythagorean theorem pertains to the sides of the right, and the problem is asking for the hypothenuse of the right triangle. Solving for the value of x, $x = \sqrt{((7)^2 + (8.37265)^2\ )} \approx 10.913$, which is the longest side; however, the scale in the drawing does not visually reflect this relationship.

The same issues were observed in Figure 7.2, although it uses another approach by introducing an exterior angle and only one given side. To solve this problem, the concept of trigonometric functions is now involved. In this case, it is crucial that the drawing clearly shows that it has one right angle. By assuming that the intersection between two sides forms right angle, the problem is now solvable using the trigonometric concept $sin\ (\theta) = \frac{opposite}{hypothenuse}$.

Looking at the last Figure 7.3, the problem lacks clarity of the mathematical concept it is asking. Is the figure a rectangle? If so, is it pertaining on calculating the area or the perimeter of the rectangle? This figure clearly lacks the clarity of problem presentation; hence it is not a valid approach in problem-posing activities.


A road needed to be fenced, if every 1 m it has 3 posts how long will it take if 72 posts will be put in the road.

"A road needed to be fenced, if every 1 m it has 3 post how long will it take if 72 posts will be put in the road."

Figure 8: An increase performance in problem-posing skills

There are respondents who demonstrate a skill in problem-posing that can conceptualize a problem (Figure 8) that targets the critical-thinking skills of the learners. This problem could capture the learner's interest as they can relate to the problem as the context is encountered daily. However, despite of the edge of the problem, it still presents an ambiguity and confusion about the context was clearly seen. A further question may arise in the mind of the learner, "Why would you fence the road? Does that mean you are blocking it?" In problem-posing, the clarity and preciseness of the words are crucial as it will lead to an increase comprehension. Moreover, the mathematical content of the given problem is not precise; the phrase, "how long will it take," implies a time calculation, but there is no mention of the speed or rate at which posts are placed. The intent might be to calculate the total length of the road, but the wording is misleading. If the goal is to calculate the road length based on the number of posts, it is important to clarify whether posts are placed at the ends of the road or at regular intervals in between.

The findings clearly suggest the need for structured learning opportunities that refine the pre-service teachers' ability to integrate visual representations and contextual elements in problem construction. The demonstrated performance in Measurement and Geometry reveals that while learners can use figures to support mathematical problems, they often fail to ensure alignment between illustrations and the problem's mathematical goals. Therefore, the intervention must emphasize conceptual alignment, such as accurately representing geometric relationships (e.g., using right-angle indicators, consistent side lengths, and logical visual scaling). These errors highlight a gap not only in content knowledge but in pedagogical reasoning. Future educators must be trained to anticipate student confusion and eliminate sources of ambiguity in problem design.

Moreover, the performance in these tasks suggests that learners are not fully internalizing the communicative function of problem-posing—that is, the ability to clearly convey a mathematical challenge through coherent language and visual structure.

Number Sense and Algebra

The expectation towards this area of competency is slightly higher because mathematics majors usually enjoy the context of manipulating numbers. However, the results suggest that although learners are good in solving mathematical algebraic problems, respondents demonstrate a "fair" level of competency in the problem-posing activity in Task 1, which involves fraction. The common problem that was observed is the presentation of the division of two fractional numbers.

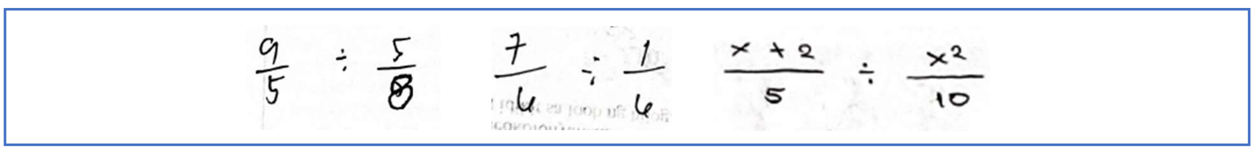
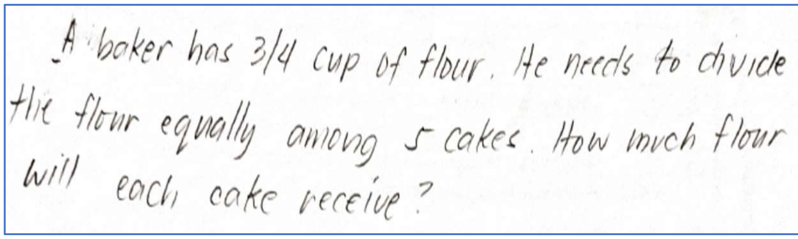


Figure 9: Missteps in Posing Fraction Division Problems in Algebraic Contexts

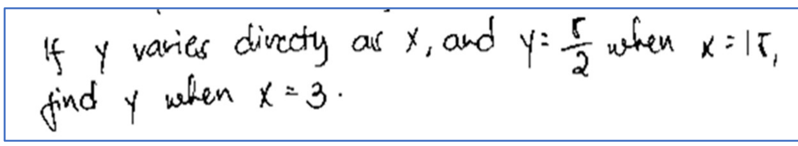
This approach is inappropriate (Figure 9). This kind of problem does not conform to the principle of problem-posing activities; it does not offer any context in problem-text criterion which creates a vagueness of the problem, and the main question of the problem is not explicitly known. These problems were usually used in the process demonstration in a mathematics discussion, in which teachers assumed the role of explaining the context of the process of division of fractions. This entails that this type of problem is a tool for understanding the mathematical content. However, when it comes to the approach of problem-posing, this problem presentation is not valid. Aside from non-appearance of words that discuss the problem, it does not conform to the solvability of the problem as the question and task for this type of problem-posed is unclear and ambiguous. This observation is common to lower year level students. The scenario is different from higher years, as they started to introduce concepts of verbal problems.



"A baker has ¾ cup of flour. He needs to divide the flour equally among 5 cakes. How much flour will each cake receive?"

Figure 10: Problem-posed by higher year student.

Figure 10's simple presentation of words added merit to the problem. It not only enhanced the presentation, but is also provided valuable information that could aid the learner's mind to comprehend the mathematical context. Aside from explicitly asking the learners to divide a certain number, incorporating a story enhances the solvability of the problem. Despite this increased performance, the innovative approach is still lacking. Due to the deficiency of depth in problem-presentation, the principle of reality was not obtained, and more importantly, the lapses of contextualize approach in high school learners is concerning.

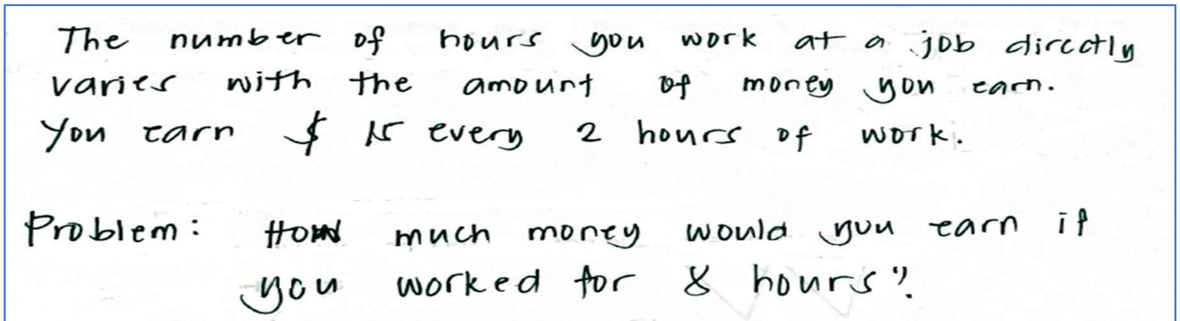


If y varies directly as x, and y =$\frac{5}{2}$ when x=15, find y when x=3.

Figure 11: Task 2, Problem-posed in Direct variation

A typical textbook problem appears in Figure 11 which shows a common problem observed in the respondents from 1st year to 4th year. This clearly implies that learners are textbook driven and are taking this pattern throughout their learning process. However, when we properly analyze the problem, the given proportion is incorrect. For y to vary directly as x, the ratio between y and x must remain the same for all values of x and y. Given y=kx, the constant of proportionality k is equal to y/x. If we compute for the given, $y = \frac{5}{2}$, and $x = 15$, we have $k = \frac{\left(\frac{5}{2}\right)}{15} = \frac{1}{6}$. Using this as value of k, the relationship becomes $y = \frac{1}{6}x$. However, when we substitute $x = 3$, the resulting value of y now is $\frac{1}{2}$. The problem fails to clarify that this computation aligns with the relationship described. Instead, it leaves room for misinterpretation, as some might expect that the given information forms a basis for another type of variation.

This issue in given presentation is very crucial in mathematical content, as this might lead to an inaccurate result. This approach may hinder the learner's development. Aside from sticking to a conventional approach, this mathematical concept remains abstract in the mind of the learners. Hence, it is imperative to construct a mathematical problem that builds a context with correct content.


The number of hours you work at a job directly varies with the amount of money you earn. You earn $ 15 every 2 hours of work.

Problem: How much money would you earn if you worked for 8 hours?

The number of hours you work at a job directly varies with the amount of money you earn. You earn $15 every 2 hours of work.

Problem: How much money would you earn if you worked for 8 hours?

Figure 12: Other form of direct variation in word problem

The mathematical problem (Figure 12) is straightforward, avoiding unnecessary complexity. This ensures students can focus on the mathematical relationship without being distracted by unrelated details. Moreover, the problem uses real-world context (working hours and earnings), making it relatable and engaging for students. Realistic scenarios help learners see the relevance of mathematics in daily life. Most importantly, it explicitly addresses the concept of direct variation, where one variable changes proportionally with another. This helps students understand the relationship between variables in practical settings. By eliminating unnecessary complexity, students can focus on the relationships between variables while appreciating the relevance of mathematics in daily life. This approach fosters engagement, critical thinking, and the practical application of mathematical skills.

Demographic Profile	Grouping Variable	Mean	SD	t, F	df	p-value
Sex	Male	39.75	12.295	3.301	73	0.810
	Female	38.95	15.361			
Year Level	1st year	27.07	16.020	8.791	3, 71	0.000
	2nd year	49.00	11.888			
	3rd year	37.44	8.031			
	4th year	41.65	12.397			

Table 4: Mean Comparison of the problem-posing performance across demographic profiles

It is crucial to emphasize the gender differences in the complex tasks of mathematical concepts as both genders may have different perceptions on the problem-posing approaches. Findings from independent samples t-test indicates that the mean differences of the gender in problem-posing performance is consistent, implying that the gender roles have nothing to do with the problem-posing approaches (p>0.05).

Furthermore, One-way Analysis of Variance (ANOVA) was performed to determine if there is a significant difference on the mean scores to the overall problem-posing performance when grouped according to year level. Results indicates that there is a significant difference on the academic year levels on the problem-posing performance ($F = 8.791, p < 0.01$). Moreover, the post-hoc analysis for these significant differences were explored. Performance in problem-posing activity revealed that the 2nd to 4th year students are better when compared to 1st year students; however, although the performance of 2nd year students is better when compared to 1st year students, this increased performance is not enough when compared to 3rd year and 4th year students. There is no significant difference between 3rd year and 4th year students.

This suggests that instructional strategies should focus on skill development rather than gender-based differences. This reinforces the idea that all students, regardless of gender, can become effective mathematical thinkers through equitable learning opportunities. Moreover, the increased performance of problem-posing performance in academic year level underscores the developmental nature of problem-posing skills, which is likely enhanced through increased exposure and experience in mathematics. These findings support the need for scaffolded and progressive learning experiences, ensuring students build the necessary cognitive and creative capacities over time.

DISCUSSION

Presenting a clear and coherent storyline allows readers to understand different scenarios. Without this clarity, an incomprehensible scene can lead to serious confusion. The same context applies to problem-posing; a good mathematical problem not only relies on the content presentation, but on properly merging the mathematical content to a good story that could capture the learner's interest and make them think critically (Yu & Yun, 2015). The more learners are engaged to material, their motivation and disposition to learn helps them to become successful in mathematics learning (Roche et al., 2021). This implies that giving learners' good material is the best initiative to expose learners to a comprehensive learning process.

However, the demonstrated performances by pre-service mathematics teachers unveil a call for an innovative approach in strengthening creativity and logical thinking. It is imperative to produce teachers that are empowered with knowledge in problem generation as it significantly relates to shaping learners' mathematical learning (Leung, 2013). However, an issue in technicalities, especially grammatical errors and unclear problems due to the poor problem presentation is widely observed. It is concerning, because of the objective nature of mathematics in which every context or even a simple word might significantly affect the meaning and approach of the mathematical problem (Baumanns & Rott, 2023). Thus, the presentation of the mathematical problem must be systematical and not cognitively demanding to avoid learner's confusion on the approach in the problem (Erath et al., 2018). Hence, it is important to deliberately develop the English language proficiency of the mathematics teachers as it might significantly improve the problem-posing performance of the learners leading to enhanced mathematics learning.

Moreover, the contextual understanding in mathematical problem-posing is limited. Adding names in the generated problem does not guarantee that the learners will relate to it. Also, the over reliance on textbook mathematical problems does not provide an innovation for teaching and learning (Kozakli Ulger et al., 2022). Posing nonproblem statements were also observed even though that the task is clear, highlighting the inattentiveness to details (Cai et al., 2015). The main concerns in problem generation is making the context relatable for the learners and ensuring the clarity of the mathematical content is properly presented (Ornek & Soylu, 2021). Koichu and Kontorovich (2013) emphasized that problem-posing activity is only valid if it aligns to the criterion of an authentic mathematical activity. Thus, teachers must be aware of their learning environment to be able to design a mathematical problem that address these concerns.

Preservice teachers lack reflection on problem-posing. They posed problems that were not contextually appropriate for the developing learners; this was observed through the ambiguity of the context of the problems. One possible reason, indicated by Koichu (2019), is the limited exposure in managing a real classroom environment. This may explain the possible advantage of the posed problem of the higher-year level students as they have already had classroom interactions that support their ideas in problem generation (Ozgen, 2019). Similarly, the use of illustrations as an assistive guide targets the visual learning approach that allows learners to comprehend mathematical concepts with clear representations, helping them break the mathematical content into more manageable chunks of knowledge (Jacobs, 2005). Involving figures in mathematical problems offers a holistic approach to facilitate the learner's mind through visualizing problem scenarios which opens an opportunity to deliver good mathematics learning by helping the learners overcome difficulties in understanding the abstract presentation of mathematical problems (Maula et al., 2024; Pehkonen, et al., 2016). Hence, the use of drawings and mathematical representations must be presented accurately.

Furthermore, providing clear instruction is important. It serves as a guide, helping students understand the expectations and processes involved in creating meaningful and coherent mathematical problems. Clarity reduces confusion and ensures that students focus on the task's objectives rather than struggling with ambiguity. Well-structured instructions provide a framework that encourages creativity while maintaining alignment with the desired learning outcomes. By explicitly outlining criteria such as the mathematical concepts to be included, the level of complexity, and the context of the problems, educators can support students in developing their problem-posing skills systematically (Zubieta & Lapinid, 2024). This may imply that designing knowledge from a perspective of the learner could significantly improve the mathematics learning outcome (Parks, 2020).

The development of the competency of the pre-service mathematics teachers is very important because their competency determines their skills and approach in mathematics teaching, which is directly related to learners' development. Leung (2013) emphasized that problems posed by a teacher can shape the mathematical learning of the students; thus, these deficiencies and lapses on problem-posing reflects the current performance of the pre-service mathematics that calls for an innovation to improve. This aligned with Cai et al. (2015) that found that teachers are prolific problem-posers when the set of information necessary for problem generation is provided; however they struggle when it comes to crafting a valid problem without the given prompts. Additionally, problem-posing must involve several steps: comprehension, translation, and finally editing and selecting to ensure that the problem-posed is valid and contextualized.

Problem-posing as a mathematical pedagogical approach opens an opportunity for a more exciting knowledge delivery. The development of these concepts signifies the attainment of mathematical literacy, as it allows individuals to identify mathematical issues within real-life contexts and translate them into solvable problems that require critical thinking and a deep understanding of mathematical concepts. It's not just about solving problems, but also about formulating problems effectively (Kozakli Ulger et al., 2022; Ozgen, 2019).

CONCLUSIONS

The insufficient performance of the Philippines in international assessments highlights the prevailing issues in mathematics education. This calls for a strategic shift toward the development of innovative pedagogical approaches. Among these, problem-solving and mathematical modeling present promising avenues for enhancing learners' cognitive and problem-solving abilities. However, the integration of problem-posing activities adds a critical dimension. It provides varied pathways for learning, where the learners' ability to generate problems serves as a reflection of their conceptual understanding, creativity, and mastery of mathematical content.

Similar to problem-solving, a contextualized approach is vital in problem-posing. Learning materials must be designed with learners' perspectives in mind that they can relate to, understand, and engage with meaningfully. The complexity of the task should align with their cognitive level. Although assessing learners' thinking through their posed problems may seem abstract, a careful evaluation of their thought processes and problem structures can offer a comprehensive view of their learning outcomes. Thus, there is a need to prepare future professionals who are equipped to explore and assess problem-posing effectively.

This study examined the competencies of pre-service mathematics teachers in problem-posing, revealing that their current level of performance does not meet the desired standard. Their outputs, when analyzed, expose gaps in both content and structure. Common issues include grammatical errors, incoherent problem construction, and a lack of contextual relevance—all of which could have been addressed at earlier educational stages. This is particularly concerning, as these individuals are training to become future educators. Additionally, inaccuracies in mathematical givens and illogical figure presentations signal a deeper issue: inadequate mastery of core mathematical concepts.

The recurring deficiency in problem-posing knowledge and skills indicates a pressing need for curriculum improvement. To create meaningful learning opportunities, mathematics education must evolve. Strengthening the problem-posing abilities of pre-service and in-service teachers is essential. Beyond content and pedagogy, developing an understanding of how learners think and approach mathematical problems can significantly enhance educational outcomes. This begins with self-awareness; understanding one's own learning process can provide insight into how students might approach problem-solving and problem-posing in diverse ways.

This study highlights the variety of strategies used by pre-service mathematics teachers, revealing both strengths and areas needing development. Teacher education programs must respond by offering methodologies that target these deficiencies. Contextualizing problem-posing as a key component of mathematical literacy may further enhance understanding and application of the concept.

To support this, a conceptual framework (Figure 13) was proposed, illustrating a developmental flow from problem-solving to problem-posing. The framework posits that engaging learners in rich, non-routine problem-solving activities lays the cognitive foundation for effective problem generation. This developmental sequence ensures that learners acquire strategic, logical, and structural competencies necessary for creating meaningful mathematical problems.

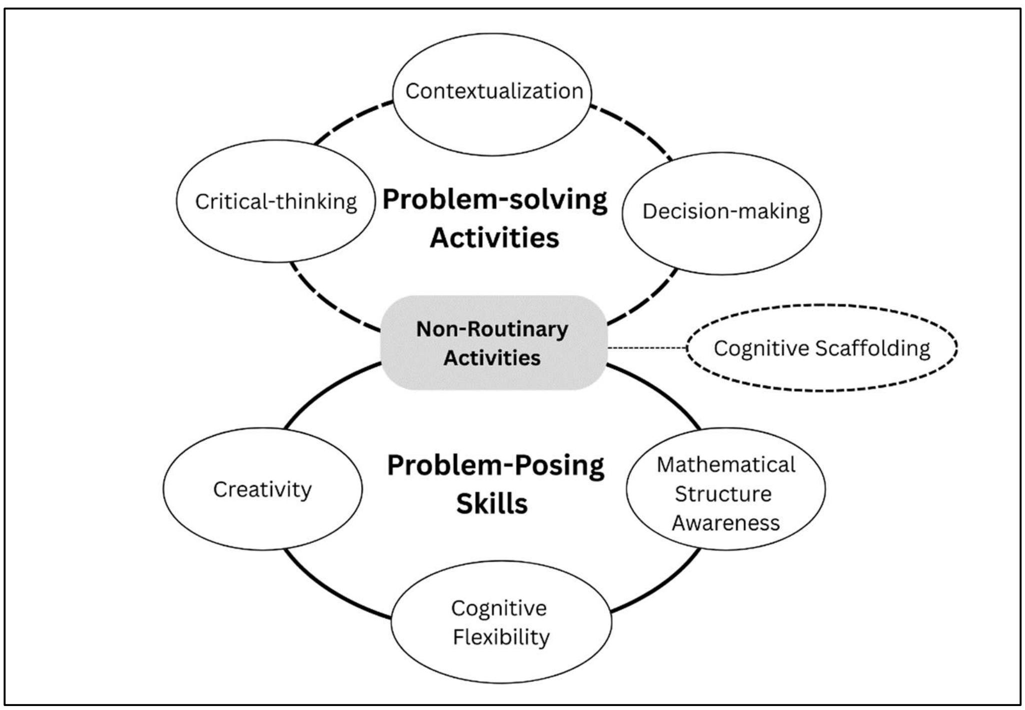


Figure 13: Linking Problem-Solving to Problem-Posing in Math Education

The proposed framework draws upon foundational educational theories—Vygotsky's Zone of Proximal Development (ZPD) and Bruner's concept of scaffolding—to illustrate how learners can gradually develop problem-posing skills through guided experiences. In mathematics education, this means learners benefit from structured problem-solving tasks that are slightly beyond their independent capabilities but achievable with guidance (Geteregechi, 2025; Santos et al., 2024).

Bruner's scaffolding theory complements this by highlighting the importance of temporary instructional support that can be gradually removed as learners internalize concepts and strategies. Applying this framework, students begin with non-routine problem-solving tasks that require contextualization, critical thinking, and decision-making, which emphasizes cognitive processes that strengthen mathematical understanding (van Velzen, 2016). As learners engage with these tasks, they build the foundational skills needed to transition into problem-posing, which demands creativity, cognitive flexibility, and an awareness of mathematical structures.

Thus, teacher education programs must embed explicit instruction on problem-posing strategies. This includes, (1) Guiding how to derive problems from given contexts, solutions, or mathematical principles; (2) Guiding learners through refining the structure, clarity, and relevance of problems; and (3) Embedding reflective exercises that deepen their understanding of the pedagogical value of problem generation.

In classroom practice, problem-posing empowers students to take ownership of learning, promotes mathematical discourse, and enables teachers to identify misconceptions and tailor instruction accordingly. Therefore, strengthening the problem-posing competencies of pre-service mathematics teachers is essential to developing more learner-cantered, reflective, and inquiry-based mathematics classrooms.

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APPENDIX
Free Problem-Posing Performance Assessment

Problem-posing activity in Statistics and Probability

Task 1: Pose a problem that deals about the probability of an event.

Task 2: Pose a problem about measures of central tendency.

Problem-posing activity in Geometry and Measurement

Task 1: Pose a problem that involves the length of measurements (mm, cm, and m) in it.

Task 2: Pose a problem pertaining to the distance of points in a cartesian plane.

Problem-posing activity in Number-sense and Algebra

Task 1: Pose a problem involving a division of fractions.

Task 2: Pose a problem where it shows a direct variation.