



Non-Routine Problem Solving in Mathematical Problem-Solving Questions for Elementary School Teacher Education Students

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Keywords:	Abstract
Problem-solving ability, non-routine questions, Mathematics problem-solving, student mathematics	This study examines the non-routine problem-solving skills of fifth-semester students in the Elementary School Teacher Education Program at Universitas Pendidikan Muhammadiyah Sorong within the context of mathematics learning. The development of non-routine problem-solving competence is essential for prospective elementary school teachers, as they are expected not only to master mathematical concepts but also to apply effective and systematic problem-solving strategies in instructional practice. This research employed a descriptive design involving fifth-semester the Elementary School Teacher Education Program students in the 2025–2026 academic year. Data were collected through a written test consisting of non-routine problem-solving tasks and unstructured interviews to explore students' cognitive processes and strategic approaches in greater depth. The data were analyzed through the stages of data reduction, data display, and conclusion drawing. The findings indicate that 60% of the students were able to solve non-routine problems successfully, while 40% had not yet implemented systematic solution procedures. Although the majority of students demonstrated adequate conceptual understanding, a substantial proportion showed weaknesses in planning and executing structured problem-solving strategies. These results imply the need for strengthening instructional practices that emphasize systematic and strategic problem-solving processes in mathematics courses, thereby enhancing students' readiness to address non-routine mathematical problems effectively.

INTRODUCTION

Background of the Study

The transformation of the education curriculum in Indonesia toward the Merdeka Curriculum has implications for increasing the skill demands that must be possessed by university students (Suryaman, 2020; Alman, Herman, Prabawanto, & Kurino, 2023). The Merdeka Curriculum emphasizes comfortable, innovative, and independent learning (Zakaria et al., 2025). The implementation of the Merdeka Curriculum highlights the provision of autonomy for teachers and students to design learning experiences aligned with students' potential, interests, and needs, while also adapting to contemporary developments and 21st-century challenges (Herman, Akbar, Alman, Farokhah, Febriandi, Zahrah, Febriani, Kurino, & Abidin, 2024). This adjustment aims to develop a more flexible curriculum that is relevant to global competencies and capable of promoting balanced mastery of science, technology, and character development. One of the 21st-century skills closely related to mathematics learning is problem-solving

ability. The objectives of mathematics learning emphasize students' ability to understand problems, design solution strategies, and draw logical conclusions (Dewi, Siregar, Agustina & Dewantara, 2024).

Problem of The Study

Teachers remain dominant as the sole source of knowledge, while students act passively as recipients of information. Such a learning model is insufficient to develop critical thinking skills and 21st-century competencies that are essential in facing global challenges (Alman et al., 2025). The low level of non-routine problem-solving ability often becomes an obstacle in learning because students struggle to map conceptual relationships and evaluate appropriate strategies according to the context of the given problems. Based on field observations, many Elementary School Teacher Education students experience difficulties in solving mathematics problems, particularly in Mathematics courses (Anugrahaeni, 2019). These difficulties arise because students do not fully understand the problems and do not optimally utilize reasoning and logical thinking in the solution process. As a result, some students make errors in solving problems. This condition indicates the need for guidance in mathematical problem-solving.

Research's State of the Art

Non-routine mathematical problems, which do not have direct solutions or fixed procedures, play an important role in developing critical thinking skills (Adelia, 2020). Unlike routine problems that follow standard methods, non-routine problems encourage students to think more creatively and flexibly in finding solutions (Indriana & Maryati, 2021; Özcan et al., 2017; Rita, 2022). Through practice in solving non-routine problems, students are trained to face new and complex situations, thereby enhancing higher-order thinking skills relevant to 21st-century needs (Putri et al., 2023; Alman & Purwanti, 2022).

Through problem-solving activities, students are actively involved in discovering and processing information to construct mathematical concepts or principles, thus creating meaningful learning experiences (Mulyono & Hapizah, 2018). Problem-solving ability is also one of the competencies assessed in the international Programme for International Student Assessment (PISA), which uses non-routine and contextual problems that require high-level reasoning. Although Indonesia has participated in PISA since 2000, evaluation results indicate that Indonesian students' mathematical problem-solving ability remains relatively low (Putri, 2018). The OECD in 2013 reported that 75.7% of Indonesian students had not reached the minimum standard of mathematical literacy at Level 2, and only 0.3% were categorized as high achievers (Diyarko, 2016; Epiyani, Rahmadeni, & Latifa, 2025).

Problem-solving ability is one of the main competencies that must be mastered in mathematics learning and has been included in graduate competency standards (Putri, 2018; Alfiandari, Alman, & Sahidi, 2022). Based on Minister of Education and Culture Regulation Number 64 of 2013, problem-solving is a mandatory competency aspect for students (Yusri, Permana, & Arnawa, 2021; Putri, 2018). According to Vilianti, Pratama, & Mampouw (2018), mathematical problem-solving requires systematic steps to achieve accurate solutions. This confirms that problem-solving ability is a higher-order cognitive skill (Patingki, Mohidin, & Resmawan, 2022). Recent research shows that students' difficulties in problem-solving often arise due to a lack of habituation in dealing with problems requiring higher-order thinking (Tanjung, 2025).

In mathematics learning, two types of problems are recognized: routine problems that can usually be solved through frequently practiced procedures, and non-routine problems that require more flexible and creative thinking strategies to determine appropriate solution steps (Suprayitno & Prihaswati, 2025). Strong problem-solving ability significantly contributes to higher mathematics learning achievement and provides benefits in other life contexts, as students are able to apply analytical thinking strategies and develop critical, logical, and systematic mindsets in addressing various challenges (Riyanti & Surya, 2025; Alman & Ituga, 2025).

Gap Study & Objective

Although numerous studies have emphasized the importance of non-routine problem-solving in enhancing higher-order thinking skills, further studies are needed to specifically analyze the non-routine problem-solving abilities of Elementary School Teacher Education students within particular institutional contexts. The Elementary School Teacher Education students, as prospective elementary school teachers, are expected to possess strong problem-solving skills, particularly in solving non-routine problems (Apriani, 2018; Kurino, Herman, Turmudi, & Alman, 2023). However, empirical findings indicate that students still experience difficulties in understanding problems and implementing systematic strategies. Therefore, this study aims to analyze the non-routine problem-solving abilities of fifth-semester Elementary School Teacher Education students at UNIMUDA Sorong in solving mathematical problem-solving tasks in order to obtain an empirical description of their mathematical thinking strategies.

METHOD

Type and Design

This study employed a qualitative research method. The qualitative approach was chosen because it allows researchers to obtain data in the form of written and oral descriptions derived from research subjects as well as directly observable behaviors (Creswell & Poth, 2018). Qualitative research methods are also used to examine phenomena occurring in natural settings, so that the data obtained reflect the actual conditions in the field (Moleong, 2020). The approach used in this study was a descriptive approach, which aims to describe in detail the phenomena and findings obtained during the research process (Sugiyono, 2023). In its implementation, the researcher described, recorded, analyzed, and interpreted findings related to students' non-routine problem-solving abilities (Creswell & Poth, 2018).

Data and Data Sources

The focus of this study was the ability of fifth-semester Elementary School Teacher Education, Universitas Pendidikan Muhammadiyah Sorong students to solve non-routine problem-solving tasks. The research data were obtained through direct observation of students' test results and through interviews to explore more deeply the thinking processes and problem-solving strategies used (Moleong, 2020). The characteristics of descriptive qualitative research are reflected in the type of data collected, namely words, descriptions, and supporting documentation rather than numerical data (Sugiyono, 2023). These data may originate from interview results, field notes, documentation, or other official documents relevant to the research (Creswell & Poth, 2018).

Data collection technique

The data collection techniques in this study were conducted through administering non-routine problem-solving tests to fifth-semester students and conducting in-depth interviews to identify the thinking processes and strategies used in solving the problems. Data collection was carried out directly within the Elementary School Teacher Education Program at Universitas Pendidikan Muhammadiyah Sorong during the odd semester of the 2025–2026 academic year.

Data analysis

The research subjects were fifth-semester students selected based on variations in the characteristics of their answers in solving non-routine problem-solving tasks. Students with similar answer patterns were grouped into the same category to facilitate the data analysis process (Moleong, 2020). Data analysis was conducted through processes of categorization, interpretation, and drawing conclusions from the findings obtained, resulting in a systematic description of students' non-routine problem-solving abilities.

RESULTS

The instruments used in this study included a problem-solving ability test sheet and an interview guide. The test sheet was used to assess the ability of fifth-semester Elementary School Teacher Education students at Universitas Pendidikan Muhammadiyah Sorong to solve non-routine mathematical problems. The test consisted of five non-routine essay questions designed to measure students' analytical skills, mathematical modeling, and higher-order thinking abilities (Rhosyida et al., 2018). All students were present during the test administration, ensuring a smooth research process and that the data obtained represented all research subjects.

The questions used were story-based problems related to real-life contexts. All five items were validated by three experts, consisting of one mathematics education expert and two mathematics lecturers in the higher education environment. The validation process resulted in one revision, particularly for question number 1, to clarify the wording of the question and correct language deficiencies in the item. After the revision, all items were declared valid and ready for use according to current instrument validation practices.

All students received the same five non-routine questions. The test results showed that most students were able to find the correct answers; however, they still experienced difficulties in modeling the problems into mathematical forms and in writing the solution steps systematically. Overall analysis indicated that approximately 60% of students were able to solve non-routine problems using a systematic process, while 40% had not yet applied structured solution steps. These findings indicate a variation in students' abilities to implement problem-solving strategies in an organized manner.

The interview guide was used to explore students' thinking strategies in solving non-routine problems more deeply. The interview questions were developed based on problem-solving ability indicators and were validated by a mathematics education expert. During the validation process, the guide was revised to align with the indicators and the assessment scale, following the procedures of current qualitative instrument development (Rosyada & Retnawati, 2021). The interview results revealed that students were able to explain the calculations and strategies they used, as well as understand the steps required to reach the solution. Students also reported that non-routine

problems had a higher level of difficulty compared to routine problems because they required more systematic solution steps.

DISCUSSIONS

The results of the study indicate that although the majority of students were able to obtain correct answers, not all students could present the problem-solving process systematically. The difficulties experienced by elementary school teacher education students, according to Anugrahaeni (2020), lie in developing mathematical critical thinking skills in problem-solving learning. The main challenges were found in the mathematical modeling stage, which involves the ability to transform story problems into representative mathematical forms, as well as in organizing the solution steps in a coherent and structured manner. Students' primary difficulties are related to reasoning, analysis, and the development of solution strategies. These findings underscore the importance of integrating literacy-based Higher Order Thinking Skills problems into daily mathematics learning (Devi, Nurhidayah, & Kurniasih, 2026). Research conducted by Pandiangan & Zulkarnaen (2021) revealed that the mathematical modeling steps performed by students in solving story problems involve mathematization for the representation and solution execution processes, while de-mathematization is applied in interpreting the solutions of story problems. This indicates that students have not yet fully mastered the higher-order thinking skills required to solve non-routine problems comprehensively.

These findings are in line with previous studies which state that non-routine problems demand higher-order thinking skills, creativity, and mathematical modeling, which often remain challenging for students (Rhosyida et al., 2018). Moreover, the interview results support the fact that students are aware of the higher level of difficulty of non-routine problems compared to routine problems, which require deeper, more flexible, and creative thinking strategies. This reinforces the literature indicating that non-routine problem solving requires a complex thinking approach and cannot be resolved solely through standard procedures.

Furthermore, the results of this study emphasize that habituation and training in solving non-routine problems must become a primary focus in mathematics learning. In particular, instruction should emphasize mathematical modeling, the development of logical reasoning, and practice in structuring solution steps systematically (Rhosyida et al., 2018; Suprayitno & Prihaswati, 2025). This approach will help students develop the critical and analytical thinking necessary to tackle various complex and contextual mathematical problems (Putri et al., 2023; Riyanti & Surya, 2025).

Thus, improving non-routine problem-solving skills is not only essential for students' academic success but also crucial in preparing them as competent future elementary school teachers. Students trained in systematic problem-solving strategies are expected to transfer these skills to their future students, thereby fostering a generation capable of critical, creative, and systematic thinking in accordance with the demands of the 21st century.

CONCLUSION

Based on the analysis and discussion, it can be concluded that the non-routine problem-solving ability of fifth-semester Elementary School Teacher Education at universitas Pendidikan Muhammadiyah Sorong students shows that approximately 60% of students were able to solve routine problems correctly, while 40% of students had not yet applied systematic solution steps in solving non-routine problems. Thus, students generally demonstrate good problem-solving skills; however, the level of skill required to solve non-routine problems is higher. This indicates that non-routine problems demand students to develop more complex problem-solving abilities. Furthermore, in solving non-routine problems, students have not fully followed Polya's problem-solving stages, namely: understanding the problem, devising a plan, executing the plan, and reviewing the solution.

Novelty and contribution

This study contributes empirically by providing a detailed examination of non-routine problem-solving skills specifically among Elementary School Teacher Education students in the context of a higher education institution implementing the Merdeka Curriculum. Unlike prior studies that focus broadly on problem-solving, this research highlights the specific challenges students face in mathematical modeling and structured reasoning. The findings offer insights for curriculum designers and educators in developing targeted interventions to strengthen higher-order thinking and systematic problem-solving skills in future elementary school teachers.

Limitation and future study

The study is limited to fifth-semester Elementary School Teacher Education students at UNIMUDA Sorong, which may affect the generalizability of the results to other institutions or academic levels. Future research could expand the scope by including multiple institutions, different student cohorts, or comparative studies between routine and non-routine problem-solving performance. Additionally, longitudinal studies could investigate the progression of non-routine problem-solving skills over time and the long-term impact of targeted instructional strategies.

Implication and suggestions

The results of this study emphasize the need for mathematics instruction to prioritize non-routine problem-solving practice, with particular attention to mathematical modeling, logical reasoning, and systematic solution planning. Educators are encouraged to integrate Higher Order Thinking Skills (HOTS) tasks and structured problem-solving exercises into the curriculum to prepare students for complex, real-world problems. Moreover, teacher training programs should provide guidance on how to scaffold non-routine problem-solving skills, ensuring that future elementary school teachers are capable of fostering critical, analytical, and creative thinking in their students in line with 21st-century competencies.

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