Analysis of the Needs for Developing a Problem-Solving Model to Improve Students' HOTS Skills

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ABSTRACT

This research is the initial stage of a problem-solving model development study aimed at improving students' Higher Order Thinking Skills (HOTS) in mathematics learning. The main focus at this stage is to conduct a needs analysis to determine the actual learning conditions, students' and lecturers' understanding of the mathematization and mathematical modeling processes, as well as their obstacles, expectations, and readiness for the implementation of the learning model to be developed. A questionnaire instrument was compiled based on five main indicators, and distributed to students and lecturers at universities. The data obtained will be analyzed descriptively. The method used in this study is a qualitative research method. Research data collection through questionnaires and interviews. The subjects of this study were Mathematics Education students at universities in Semarang City. The results of the study are 1). Many students have problem-solving abilities in the low and medium categories. 2). Current mathematics learning has not fully accommodated the development of students' HOTS, 3). There is a significant need to understand and implement the mathematization and modeling processes in learning. These results will be used as a basis for developing a problem-solving learning model based on mathematization and mathematical modeling. The next research is to develop a Problem-Solving Model to Improve Students' HOTS Abilities.

Keywords: Development Model, HOTS, Needs analysis, Problem solving

INTRODUCTION

Problem-solving skills are fundamental mathematical competencies that foster critical and systematic thinking. Problem-solving plays a crucial role in the mathematics curriculum because it fosters broader thinking skills (Purnomo & Mawarsari, 2014; Purnomo et al., 2022) . Numerous studies have explored the factors influencing and ways to develop these skills. Through a thorough analysis of existing research, we can identify problems, solutions, and learning models that can be applied to enhance these skills among students. Problem-solving is becoming increasingly crucial as students are required to face real-life challenges. Education is no longer merely a means of transferring knowledge; it is now required to foster students' critical and creative thinking skills, particularly in solving mathematical problems. Therefore, the development of problem-solving models is essential. Therefore, an in-depth study of the need for problem-solving models in mathematics education is necessary. A problem-solving learning model that enables students to actively participate in the learning process is crucial.

The gap between needs and actual abilities necessitates innovative problem-solving models. The needs analysis, as mentioned above, indicates that students lack a strong foundation for critical thinking within the context of HOTS, making conventional approaches inadequate (Purnomo, Suparman, & Kadarwati, 2020). Developing problem-solving models at all levels of education plays a crucial role in developing students' Higher-Order Thinking Competencies (HOTS). HOTS refers to cognitive abilities encompassing analysis, synthesis, and evaluation, as well as more complex problem-solving skills (Sulistyaningsih et al., 2021; Purnomo et al., 2022). HOTS is crucial not only for supporting academic achievement but also for preparing students to face real-world challenges. Analyzing students' mathematical skills within the context of HOTS is also crucial for further exploration. Demonstrated a positive relationship between students' problem-solving abilities and their success in solving HOTS-oriented problems (Mahanal et al., 2022). By providing problems that require analysis, synthesis, and evaluation, teachers can encourage students to consider the various possibilities available in solving problems.

Existing problem-solving models have weaknesses that need to be addressed. Based on the literature review and initial observations, several research gaps can be identified, including: 1). Limitations of Existing Problem-Solving Models. Widely used problem-solving models, such as the Polya model, have been proven effective in various contexts, but research shows that students still experience significant difficulties at each stage. This indicates the

need to enrich the model with another conceptual framework that is more adaptive to the characteristics of today's students. 2). Lack of HOTS-Based Problem-Solving Models in Higher Education. Much HOTS-related research still focuses on the high school level. Studies designing HOTS-based problem-solving models for higher education students are still rare in the literature.

One way to strengthen problem-solving models is through the process of mathematization. Mathematization involves transforming contextual phenomena into mathematical representations (horizontal) and expanding their mathematical understanding (vertical). This approach helps strengthen the connection between the real-world context and the mathematical model. The development of problem-solving models can be strengthened through mathematical modeling. Mathematical modeling requires students to understand real-world problems, construct models, analyze, validate, and interpret solutions—a chain process that supports contextual mathematical logic.

The development of problem-solving learning models based on mathematization and mathematical modeling is a strategic step in improving students' critical thinking and problem-solving skills at various levels of education. Given the importance of these skills in facing life's challenges, mathematics education must adapt to current developments and needs. In this regard, the material taught should not be merely abstract but connected to students' everyday experiences, thus improving their ability to model and solve complex mathematical problems.

Model development begins with an analysis of the factors influencing students' problem-solving abilities. Tukan et al. in their research analyzed the need for a problem-solving model that engages students in the process of using their existing knowledge and skills to apply them to real-world situations (Tukan et al., 2024). This research illustrates that student engagement in learning can improve problem-solving abilities. Success in solving mathematical problems is also closely related to student characteristics, including their procedural knowledge. Based on the above studies, it can be concluded that developing problem-solving models in mathematics education requires a holistic approach, combining theory, practice, and technology. An approach that focuses on real-life experiences and interactions between students is highly recommended to create a dynamic and enjoyable learning environment. Ultimately, the implementation of proven problem-solving models is expected to improve students' problem-solving abilities in facing academic and everyday life challenges. Combining Polya's approach, mathematization, and mathematical modeling into an integrated

model has the potential to support the development of HOTS more comprehensively. With clear and systematic steps from problem transformation, planning, to solution validation, students not only understand concepts but are also able to apply them in real-world contexts with higher-order thinking.

METHOD

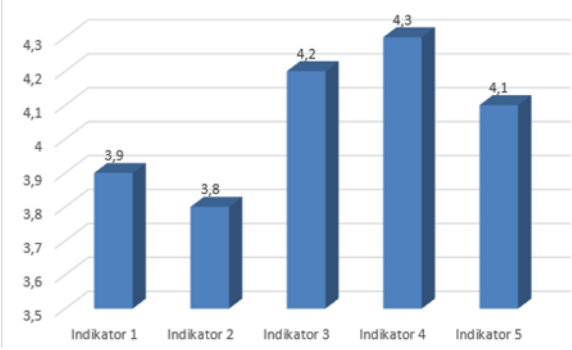
This study uses a qualitative approach with a descriptive research type. This approach was chosen to obtain an in-depth overview of the need to develop a problem-solving model to improve students' Higher Order Thinking Skills (HOTS). Qualitative methods allow researchers to explore data contextually, understand phenomena holistically, and gather information from the perspective of the research subjects (Creswell, 2014; Sugiyono, 2017). The research subjects were students of the Mathematics Education Study Program from several universities in Semarang City. Subject selection was carried out by purposive sampling, with the following criteria: 1). Active students in semesters 4–8 of the Mathematics Education study program; 2). Have taken courses that include mathematical problem solving material; 3). Willing to participate in filling out questionnaires and interviews. The number of research subjects will be adjusted to the need for data sufficiency (data saturation) in qualitative research.

Data were collected through two main techniques: questionnaires and in-depth interviews. Data analysis was conducted using the qualitative which include: 1). Data Reduction – selecting, focusing, and simplifying data from questionnaires and interviews. 2). Data Presentation – compiling data in the form of tables, diagrams, and descriptive narratives. 3). Conclusion Drawing and Verification – interpreting data to identify needs, obstacles, and potential for developing problem-solving models (Sukestiyarno, 2020). Data triangulation was conducted by comparing findings from questionnaires and interviews to ensure the validity of the research results.

FINDINGS AND DISCUSSION

The results of the lecture evaluation and analysis of the problem-solving model development needs indicate that students rated several key aspects related to Higher Order Thinking Skills (HOTS) and learning model development with varying scores. The evaluation results can be seen in the figure below.

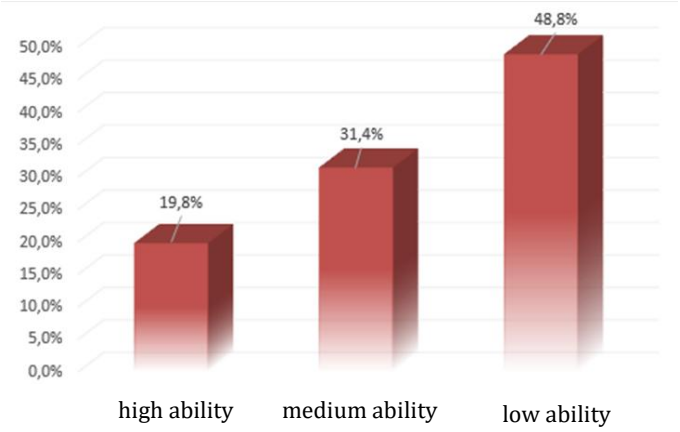
Figure 1: Lecture evaluation results



Indicator 1: Evaluation of lecture implementation obtained an average score of 3.9. This indicates that the implementation of lectures is generally considered quite good, but there is still room for improvement, especially in supporting the development of high-level problem-solving skills. Indicator 2: Analysis of the use of HOTS skills received the lowest score, namely 3.8, indicating that the implementation of HOTS in the learning process is not optimal. Students feel that they have not been fully involved in activities that require analytical, creative, and evaluative thinking. The need for problem-solving models received a high score of 4.2, which indicates that students really need a learning model specifically designed to help them master problem solving, especially those related to HOTS category questions.

Indicator 3: Analysis of HOTS problem-solving skills improvement achieved the highest score, 4.3, indicating a high urgency to improve these skills. Students recognize that these skills are essential for academic success and preparation for the challenges of the workforce. Indicator 4: HOTS improvement targets achieved a score of 4.1, indicating that students have high expectations for achieving higher-order thinking skills improvement through appropriate learning strategies. The second evaluation examines students' HOTS skills. The results of students' HOTS skills can be seen in the image below.

Figure 2: Results of students' HOTS abilities



Based on the research results presented in the bar chart, students' problem-solving abilities in solving problems show a varied distribution across three categories: high, medium, and low. The percentage of students in the high ability category is only 19.8%, which means that approximately one in five students are able to solve HOTS problems well and consistently. Students in this category generally have a strong mastery of concepts, good analytical skills, and are able to integrate information to produce effective solutions. Furthermore, as many as 31.4% of students are in the medium ability category. This group generally has sufficient conceptual understanding, but is not yet consistent in applying knowledge to complex situations. They tend to be able to solve some problems, but still have difficulty in developing a complete and comprehensive problem-solving strategy.

Meanwhile, the highest proportion was in the low-ability category, at 48.8%. Students in this category faced various difficulties in understanding and analyzing problems, applying concepts, and formulating appropriate problem-solving strategies. These low skills are likely caused by a lack of mastery of basic concepts, weak critical thinking skills, and minimal experience practicing solving problems that require high-level reasoning. Overall, these findings indicate that the majority of students, at 80.2%, are still in the low and medium-ability categories, so strategic learning efforts are needed to improve higher-order thinking skills, such as through the implementation of problem-based learning, project-based learning, and providing exercises that emphasize contextual and open-ended problem solving.

The results of this study indicate that students' problem-solving abilities, particularly in the HOTS context, are still at a level that needs improvement . The greatest difficulty was found in the evaluation stage of the results (Polya stage 4), which is in line with the

findings of Novilanti et al., (2021) that students tend to ignore the process of re-examining solutions. Difficulties in the mathematization process indicate weak skills in connecting real-world problems with mathematical representations. This finding that mathematization requires trained abstract thinking skills, which are often under-facilitated in conventional learning. Students' poor understanding of the stages of mathematical modeling also indicates that existing learning does not provide comprehensive experience in constructing, validating, and interpreting models (Oldenburg & Hung, 2010; Munzar et al., 2021).

Students' need for an integrative problem-solving model confirms a previously identified research gap: the lack of learning models that combine the strengths of Polya, mathematization, and mathematical modeling in an integrated manner. Such a model is expected to bridge student difficulties at every stage, while simultaneously encouraging the development of HOTS. Thus, the results of this study reinforce the urgency of developing an integrative problem-solving model based on an analysis of students' real needs and oriented towards improving HOTS at the university level. These findings lead to the conclusion that the development of a structured and relevant problem-solving model is essential to support students in solving HOTS questions. This model is expected to strengthen student involvement in learning, optimize critical and creative thinking processes, and improve evaluative skills in completing HOTS.

CONCLUSION

Based on the research results, the following conclusions were drawn: 1) Many students have low and moderate problem-solving abilities. 2) Current mathematics instruction does not fully accommodate the development of students' HOTS skills. 3) There is a significant need to understand and implement mathematization and modeling processes in learning. Based on the research results, it is necessary to develop problem-solving models based on mathematization and mathematical modeling processes.

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