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Factors That Influence Students' Ability To Solve Mathematics Story Problems

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Abstract. *This research aims to examine the factors that influence the ability of class IX junior high school students in Kotamobagu City, North Sulawesi Province, Indonesia, to solve story problems, both theoretical and applied. A total of two hundred and four students in the 2023/2024 academic year were selected using a double-phased cluster sampling technique. The research instrument used in this research is theoretical and applied mathematics story test questions created by researchers. The data obtained were analyzed using path analysis. The results of the analysis show that solving theoretical and applied mathematics story problems shows the same tendency, which is influenced both directly by mathematical numerical and verbal abilities and indirectly by the ability to create mathematical models. From these results, teachers must strive to improve numerical and verbal mathematical abilities because these two abilities, directly or indirectly through the ability to create mathematical models together, can improve students' abilities in solving theoretical and applied word problems.*

Keywords: *Theoretical and applied mathematics story problems, numerical ability, mathematical, verbal ability, ability to make mathematical models.*

INTRODUCTION

Mathematics questions are a tool used by students to develop thinking abilities and basic skills in solving real-life problems. As the aim of teaching mathematics is to provide students with experience in solving mathematical problems, this experience gives students the ability to solve real-world problems (Sumartini, 2015; Siagian, 2016; Wahyuningsih, 2019). Mathematical problems such as real-life word problems are important in real mathematics because they are a means of solving problems that serve to understand the real world (Rawa, 2017; Nafiah & Kurniati, 2018; Agustyaningrum & Pradanti, 2022).

Mathematics is an expression of the human mind that reflects active will, contemplative reason and the desire for perfection. Mathematical aesthetics are based on logic and analysis, intuition, construction, generalization and individuality. Based on this, a mathematics teacher must realize that he is a "talent scout," and as a result, he must focus on students (Mahendra, 2017; Syamsuddin, 2020; Rulyansah et al., 2022). Therefore, teachers must pay more attention to efforts to maintain and increase students' efforts related to cognitive, affective and psychomotor aspects, including efforts to transfer skills to students in solving mathematical problems (Aman, 2016; Huda, 2017; Mulia et al., 2021). The expected result is to reduce and

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eliminate students' "phobia" in studying mathematics (Haryani, 2019; Rosikin et al., 2020; Ibrahim & Amin, 2021).

Students will have difficulty understanding mathematical concepts if they do not know the exact meaning of each mathematical symbol and term written in the problems or mathematics textbooks they face. Sheppard reported that children at the concrete operations stage were able to solve a problem using simple language, not using complex language (Bachelor et al., 2018). Simple language is meant to be language that uses symbols (Masitoh, 2019; Anas & Sapri, 2022). The use of symbols in mathematics is intended so that mathematical objects can be written briefly, precisely and easily understood (Tyas et al., 2016; Ainurrohmah & Mariana, 2018). Regarding this concept, Hadamard and Vertheirmer point to another use of symbols, namely as a short way of writing that is common to several different mathematical structures (Marinda, 2020; Diva et al., 2022).

On the other hand, Kennedy explained that something very important in solving word problems is "translating" the problem situation into mathematical sentences (Bachelor et al., 2018). To be able to translate problem situations into mathematical sentences, adequate verbal understanding is required (Sarjana et al., 2018). Verbal abilities in mathematics include the ability to remember and understand the meaning of words or mathematical terms contained in sentences or questions (Paladang et al., 2018). If you make a mistake in reading or understanding just one word, the result is that the entire solution process will be wrong.

Numerical ability is a mathematical ability that includes the ability to perform calculations such as adding, subtracting, multiplying, and dividing, as well as the ability to manipulate numbers and mathematical symbols. Numerical ability is important, both for being able to perform calculations quickly and for solving arithmetic problems (Suyati & Putri, 2017; Bachelor et al., 2018; Amaliyah, 2020). Piaget's research, quoted by Coplan, shows that children can learn multiplication at the same time as learning about addition, and this occurs at approximately the age of seven (Adyanti, 2020). It is further explained that the concept of fractions develops at the age of (approximately) ten years, and the concept of proportion develops at the age of eleven or thirteen years (Pongpalilu et al., 2023).

Mathematical verbal abilities and numerical abilities are the basis for creating a mathematical model of a mathematical problem (word problem, story problem). Supporting this statement, Gagne argues that task analysis of the abilities expected from students studying mathematics is to reveal the three main phases, namely the ability to translate from verbal problems to mathematical expressions, carry out operations on the statements, and check the truth of the results (Yuliana, 2015). To be able to translate verbal problems into mathematical

expressions, verbal abilities and basic arithmetic operations (addition, subtraction, multiplication and division) are required (Irawan & Kencanawaty, 2017; Atikasuri & Kusaeri, 2024). Agreeing with Gagne above, Santrock believes that the steps that students must take to solve a problem/problem are: (1) limiting the range of questions, (2) developing effective strategies for finding solutions, (3) evaluating the solutions proposed, and (4) checking and redefining solutions and questions continuously (Yarmayani & Fitriani, 2017; Purwanto et al., 2019). Santrock's opinion clearly requires students to model problems or questions so that students can limit the range of questions and create effective strategies for finding solutions, as well as evaluate existing solutions (Juniantari, 2019).

Polya explained that in mathematics, there are two problems, namely: the problem of "discovering," whether theoretical or practical, abstract or concrete and the problem of "proving," of showing that a statement is true or false. It was further explained that the problem of "discovering" is more important in elementary mathematics, while the problem of "proving" is more important in advanced mathematics (Romli, 2016; Karnia & Ratnawulan, 2022). Santrock said that, in solving questions or problems, a student must develop an effective strategy (Azmi, 2016; Radiusman, 2020). The strategies in question include:

(1) Set sub-goals. Subgoals help students find useful sub-solutions to questions/problems. This reduces the questions into several sub-questions, making them easier to solve.

(2) Algorithm. An algorithm is a strategy that guarantees the solution to a problem. Algorithms provide a flow and outline for finding possible solutions. Parts of the algorithm can be formulas, instructions, and trials of all the estimated solutions.

(3) Heuristics. Heuristics are strategies that can be seen as solutions to a problem, but they do not guarantee that this solution actually solves the problem or issue. Heuristics can help students narrow down all possible solutions.

In applying the strategies above, students' ability to understand questions verbally, their arithmetic/numerical skills, and their ability to develop appropriate models to find solutions are really needed. The research question that arises is, do these factors influence students' ability to solve theoretical and applied mathematics story problems?

METHOD

The population in this study were students in class IX of junior high schools in Kotamobagu City in the 2012/2013 academic year. Two hundred and four samples were selected from the population using multiple-stage cluster sampling. The independent variables in this research are numerical ability, mathematical, verbal ability and ability to make

mathematical models. The dependent variable in this research is the ability to solve theoretical mathematics story problems and the ability to solve applied mathematics story problems.

In this study, five packages of multiple choice test questions were used, with the following explanation:

- Test 1, namely the mathematical verbal ability test, is used to measure students' ability to read, understand and understand mathematical symbols, which include number symbols, number operations, mathematical rules, mathematical sentences and abbreviations in mathematics. The mathematical symbols in question are limited to mathematical symbols, which are the basis for learning junior high school mathematics. This test consists of 30 questions with validity between 0.207-0.958. The reliability of this test is 0.701.
- Test 2, namely the numerical ability test, is used to measure students' ability to carry out calculation tasks such as addition, subtraction, multiplication and division of whole numbers and fractions (ordinary and decimal). This test consists of 32 numbers whose validity lies between 0.25-0.75. The reliability of this test is 0.815.
- Test 3, namely a test of the ability to make mathematical models, is used to measure students' ability to express or change sentences in story problems (theoretical or applied) into symbols or mathematical terms so that they become shorter and simpler. The mathematical symbols or terms are then arranged in a mathematical equation or inequality. This test consists of 25 numbers with validity between 0.207-0.650 and a test reliability of 0.661.
- Test 4, namely a test of the ability to solve theoretical mathematical story problems, is used to measure students' ability to solve mathematical story problems related to the mathematical problem itself (theoretical in nature). This test consists of 25 numbers with validity between 0.207-0.884 and a test reliability of 0.787.
- Test 5, namely a test of the ability to solve applied mathematics story problems, is used to measure students' ability to solve mathematics story problems related to problems in everyday life (applied in nature). This test consists of 24 numbers with validity between 0.207-0.801 and a test reliability of 0.790.

Data were analyzed using basic statistical analysis, such as average and standard deviation. Next, hypothesis testing was carried out using path analysis. A computer program assisted data analysis.

RESULT AND DISCUSSION

The results of data analysis show that numerical abilities and mathematical and verbal abilities, directly or indirectly through the ability to make mathematical models, together have a positive influence on student's ability to solve theoretical mathematics story problems (Figure 1). These three independent variables also show the same trend pattern toward students' abilities in solving applied mathematics story problems (Figure 2). The variance in scores for the ability to solve theoretical and applied mathematics story problems by the three predictors together is 54.57 and 54.51 percent, respectively.

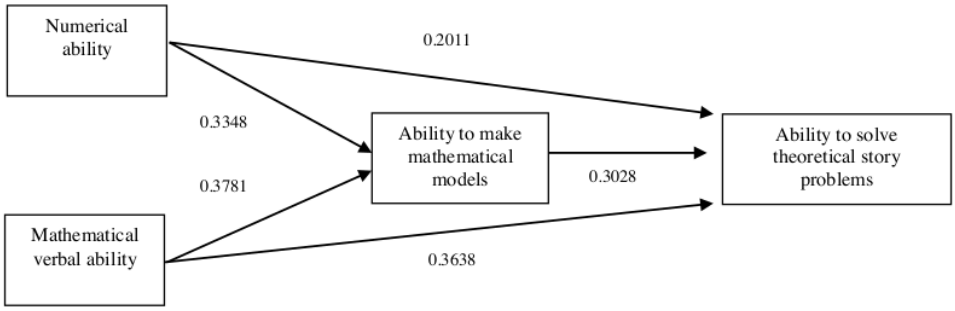

Figure 1. Factors that affect students' ability to solve theoretical story problems.

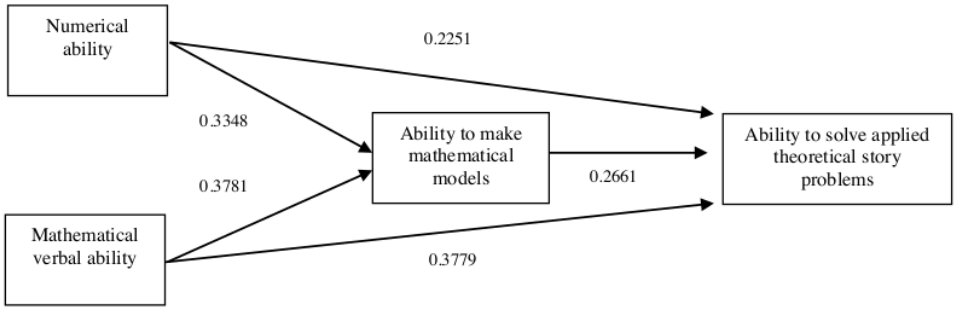

Figure 2. Factors that affect students' ability to solve applied story problems.

Based on the data above, numerical ability has a direct influence on the ability to solve theoretical and applied mathematics story problems. Numerical ability, through the ability to create mathematical models, indirectly influences the ability to solve theoretical and applied mathematics story problems. This means that students' skills in calculating (numerical abilities) must be trained and improved continuously so that students have the skills and experience to use these abilities to solve problems. Some characteristics of learning difficulties for students (Salkind, 2008) include reading disabilities and mathematical disabilities. Reading inability is the inability of students to understand problems word for word and the inability of students to

read quickly and accurately (verbal ability). Furthermore, students often need to gain experience in relating the context of the questions they face with the knowledge they have. Mathematical incompetence refers to students who need to improve in using the basics of mathematics in the calculation process to solve a mathematical problem.

Based on research by Beal et al. (2010) with a sample of 442 class IX students in Los Angeles, California, the results showed that many students still needed to improve their basic numerical skills. As many as 81 percent of students were only able to answer correctly 30 percent of the questions given, even though these questions were taken from class VI questions. Research conducted by Bernardo (2005) on 111 grade 4 students in the Philippines concluded that students' ability to read comprehensively and understand story problems (verbal ability) influenced solving story problems. Thus, students' abilities in computing (numerics) must always be the teacher's attention so that students can be successful in learning. Apart from that, students' ability to read and understand questions is very influential in solving mathematics story problems that students face. The results of Ballew and Cunningham (1982) in the United States of 217 sixth-grade elementary school students showed that the main difficulties in solving story problems included four things, namely the ability to compute, the ability to read, the ability to interpret problems and the ability to integrate the above abilities into problem-solving.

What is no less important is students' ability to model story problems into mathematical models (such as mathematical equations). This factor is because, based on research results, numerical ability and mathematical, verbal ability have an indirect influence on the ability to solve mathematical story problems through the ability to create mathematical models. Supporting the results of this research, Caldwell and Goldin (1987) explained that the basic concepts that are important in solving story problems are transformation and computation. The concept of transformation is related to changing or simplifying a problem by creating a mathematical model that is easy to understand and comprehend. At the same time, this effort helps with computing or solving problems.

CONCLUSION

Based on the results of the research and discussion, students' abilities in solving theoretical and applied mathematics story problems show the same tendency. This is influenced both directly by numerical and verbal mathematical abilities and indirectly by the ability to create mathematical models. From these results, it is recommended that teachers strive to improve numerical and verbal mathematical abilities. This is because these two abilities,

directly or indirectly, through the ability to create mathematical models together, can improve students' abilities in solving theoretical and applied story problems.

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