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Analysis of Tenth-Grade Students' Mathematical Logical Thinking Ability in Solving Three-Variable Linear Equation System Problems Viewed From Self-Confidence

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ABSTRACT

Mathematics is a subject that plays a role in training students' mathematical logical thinking ability. This ability is needed to understand information, formulate solution steps, and draw conclusions based on reasonable arguments. One aspect related to logical thinking ability is self-confidence. This research aims to describe the mathematical logical thinking ability of tenth-grade students in solving SPLTV (Systems of Three-Variable Linear Equations) problems, viewed from their self-confidence. This research is qualitative research with a descriptive method. The research subjects consisted of three students: one with high self-confidence, one with moderate self-confidence, and one with low self-confidence. The research instruments used included a self-confidence questionnaire, a mathematical logical thinking ability test, and interview guidelines. Furthermore, the data obtained were triangulated, and the research results show that in solving SPLTV problems: (1) Students with high self-confidence demonstrate mathematical logical thinking ability characteristics, namely being able to think coherently, provide arguments for each solution step, and draw accurate conclusions, (2) Students with moderate self-confidence demonstrate mathematical logical thinking ability characteristics, namely being able to think coherently and provide arguments for each solution step, but the conclusions they draw are less accurate, (3) Students with low self-confidence demonstrate mathematical logical thinking ability characteristics, namely not yet showing a coherent thought process, not being able to provide complete arguments, and not being able to draw accurate conclusions.

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ABSTRACT

Matematika merupakan salah satu mata pelajaran yang berperan dalam melatih kemampuan berpikir logis matematis siswa. Kemampuan ini diperlukan untuk memahami informasi, merumuskan langkah-langkah penyelesaian, dan menarik kesimpulan berdasarkan argumen yang masuk akal. Salah satu aspek yang berkaitan dengan kemampuan berpikir logis adalah kepercayaan diri. Penelitian ini bertujuan untuk mendeskripsikan kemampuan berpikir logis matematis siswa kelas VIII SMP dalam menyelesaikan masalah SPLTV (Sistem Persamaan Linear Tiga Variabel) ditinjau dari kepercayaan diri. Penelitian ini merupakan penelitian kualitatif dengan metode deskriptif. Subjek penelitian terdiri dari tiga siswa yaitu satu siswa dengan kepercayaan diri tinggi, satu siswa dengan kepercayaan diri sedang, dan satu siswa dengan kepercayaan diri rendah. Instrumen penelitian yang digunakan meliputi angket kepercayaan diri, tes kemampuan berpikir logis matematis, dan

pedoman wawancara. Selanjutnya data yang diperoleh dilakukan triangulasi, dan hasil penelitian menunjukkan bahwa dalam menyelesaikan masalah SPLTV: (1) Siswa dengan kepercayaan diri tinggi menunjukkan karakteristik kemampuan berpikir logis matematis, yaitu mampu berpikir runtut, memberikan argumen pada setiap langkah penyelesaian, dan menarik kesimpulan yang akurat, (2) Siswa dengan kepercayaan diri sedang menunjukkan karakteristik kemampuan berpikir logis matematis, yaitu mampu berpikir runtut dan memberikan argumen pada setiap langkah penyelesaian, namun kesimpulan yang diambil kurang akurat, (3) Siswa dengan kepercayaan diri rendah menunjukkan karakteristik kemampuan berpikir logis matematis, yaitu belum menunjukkan proses berpikir yang runtut, tidak dapat memberikan argumen yang lengkap, dan tidak dapat menarik kesimpulan yang akurat.

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Introduction

Education is a learning process to develop an individual's ability to interact with society. Education is also defined as a conscious and planned effort to develop students' potential so they are ready to face global challenges in the future (Faradina & Mukhlis, 2020). Law No. 20 of 2003 concerning the National Education System, Article 3, states that the national education goal is to develop the potential of students to become individuals who are faithful and devout to God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens.

In the educational process, various subjects are taught to increase students' knowledge and ability (Ningsih & Bharata, 2021). One of the subjects that is an important part of education is mathematics. Mastery of mathematics can accustom students to think critically, logically, and creatively, which is very important to apply in daily life (Noviani et al., 2020). Mathematics is an exact science that forms the basis of other sciences (Sari et al., 2021). According to Utami & Haerudin (2021), mathematics has an abstract object of study, which often makes it difficult for students to understand. As a compulsory subject at the primary and secondary school levels, mathematics plays a role in honing students' thinking abilities. Therefore, a thinking ability that isn't easy is required, because the thinking process involves developing ideas or concepts that lead to new thoughts.

One thinking ability that can be developed through learning mathematics is logical thinking ability. Logical thinking skill is a student's ability to draw valid conclusions based on logical rules, and to prove that these conclusions are true and reasonable according to their prior knowledge (Arifiya, 2023). Students are considered capable of logical thinking if they can draw conclusions from a problem based on logical patterns or rules (Octaria, 2017). In line with this, Ruhama et al. (2020) state that logical thinking ability are necessary for an individual to solve problems by drawing conclusions based on arguments consistent with problem-solving steps. By thinking logically, one can find causes and effects, and reasonable solutions to the problems faced (Anjani et al., 2022).

Logical thinking ability is closely related to problem-solving, as it involves a systematic and rational thought process to find solutions to a problem (Ningsih & Bharata, 2021). Sumartini (2016) defines problem-solving as the process of overcoming difficulties to achieve a desired goal. In mathematics, students need to have problem-solving ability to complete problem-based questions. Problem-solving ability allows students to connect various concepts, rules, and principles they've learned previously to find solutions to a problem they're facing (Amperawan et al., 2018).

One mathematical concept learned in 10th-grade high school is the System of Three-Variable Linear Equations (SPLTV). This topic typically presents problems in the form of word problems, which are mathematical problems presented in sentences and related to daily life (Yulianto et al., 2019). To solve three-variable linear equation system problems, especially word problems, students are required to understand the meaning and issues in the problem, formulate and construct mathematical models, and relate these problems to previously learned material to find accurate solutions (Hamid et al., 2023). Mathematical logical thinking ability is one crucial aspect students need to solve three-variable linear equation system problems. By thinking mathematically and logically, students can understand or analyze problems, generate various ideas, develop solutions, and draw conclusions from problems based on reasonable arguments (Selvi, 2018).

To develop mathematical logical thinking ability, especially in solving mathematical problems, students need to have confidence in their own abilities to avoid feelings of anxiety and doubt. This attitude can be interpreted as an individual's fighting spirit in solving problems (Rosita & Jaenudin, 2017). Wulandari et al. (2018) state that self-confidence is related to students' ability to solve mathematical problems, because self-confidence is one of the key requirements for solving them. Aisyah et al. (2018) also state that self-confidence plays an important role in supporting students' motivation and success in learning mathematics. This aligns with the Minister of Education and Culture Regulation (Permendikbud) Number 68 of 2018, which stipulates that one of the basic competencies students must possess in mathematics learning is self-confidence. Thus, self-confidence needs to be owned and developed by every student.

Based on observations the researcher conducted on several students at a high school in Pamekasan, there were differences in logical thinking ability that seemed to be related to students' self-confidence. Students who were confident in their abilities tended to be capable and quick in understanding information in three-variable linear equation system problems. They were brave enough to try various solution methods and didn't give up easily in finding solutions, even when facing difficulties. Conversely, students who lacked confidence in their abilities showed a hesitant mindset, often asking the researcher or friends for direction. They were less confident in choosing solution methods and felt confused when encountering difficulties during the problem-solving process.

Previous relevant research was conducted by Qiftiyah & Sulistyaningsih (2023), who described a connection between self-confidence and mathematical logical thinking ability in 11th-grade students at SMAN 1 Krian when solving contextual problems on the topic of circles. The results showed that students with high self-confidence had good logical thinking ability in solving mathematical problems. However, the findings from that study cannot be directly applied to conclude the same regarding the role of self-confidence in students' logical thinking for systems of three-variable linear equations (SPLTV), which has different characteristics and

levels of difficulty. This difference is crucial to note, considering that problems involving systems of three-variable linear equations are more complex and require different logical thinking ability, especially when presented as word problems (Patra & Pujiastuti, 2020).

Based on the description above, this research will provide a new contribution by describing mathematical logical thinking ability viewed from self-confidence. Therefore, the researcher is interested in conducting research with the title: "Analysis of Tenth-Grade Students' Mathematical Logical Thinking Ability in Solving Three-Variable Linear Equation System Problems, Viewed from Self-Confidence."

Method

The type of research used is qualitative research with a descriptive method. This research was conducted in the even semester of the 2024/2025 academic year at MAN 1 Pamekasan, with tenth-grade students from class XB as the research subjects. Data collection involved administering a self-confidence questionnaire, a mathematical logical thinking ability test, and interviews. The self-confidence questionnaire was given to determine each student's self-confidence category. The results of this questionnaire were then used to select one subject from each category. After the subjects were determined, the researcher administered a mathematical logical thinking ability test, designed based on relevant indicators. This test aimed to understand the students' mathematical logical thinking abilities in problem-solving for each self-confidence category. Interviews were conducted after the subjects completed the test to gather more information about their thought processes and identify the characteristics of logical thinking that emerged during the test. As for data analysis techniques, they involved data reduction, data presentation, and drawing conclusions.

The indicators developed to analyze students' mathematical logical thinking abilities in solving three-variable linear equation system problems can be seen in Table 1 below.

Table 1. Indicators of Mathematical Logical Thinking Ability in Polya's Problem-Solving Stages

Polya's Problem-Solving Stages	Characteristics of Mathematical Logical Thinking Ability	Indicators of Mathematical Logical Thinking Ability
Understa-nding the Problem	Coherence in Thinking	Stating all information from what is known and what is asked in the problem accurately
Devising a Plan	Coherence in Thinking	Outlining all the initial steps to be used for problem-solving
	Argumentation Ability	Outlining all problem-solving steps from start to conclusion.
Carrying out the Plan	Argumentation Ability	Solving problems precisely, with the ability to justify each step
	Drawing Conclusion	Providing precise conclusions for each step in problem-solving
Looking Back	Argumentation Ability	Providing logical reasoning to justify the final answer accurately
	Drawing Conclusion	Deriving a precise conclusion from the final answer

Source: Andriawan & Budiarto (2014)

Result and Discussion

Based on the results of the mathematical logical thinking ability test and interviews, the following data were obtained:

a. Students with high self-confidence

In terms of coherence in thinking, the subject can accurately state all

information that is known and asked in the problem. They can also systematically outline all the steps to be used in the problem-solving process, from creating assumptions to solving it using elimination and substitution methods. This indicates that the subject understands the content of the problem and can plan a solution strategy in a structured and directed manner. This finding is consistent with research conducted by Purnama & Mertika (2018), which states that students with high self-confidence are able to solve problem-solving questions well. These students can understand the presented problems by writing down what is known and asked, and are able to determine the necessary steps to solve the questions.

In terms of argumentation ability, subjects with high self-confidence can articulate logical reasons for the solution steps used, from the beginning to reaching a conclusion. They can also solve problems accurately and provide appropriate arguments for each step taken. This indicates that the subjects not only follow mathematical solution steps but also understand the interconnections between each step used. This finding aligns with research conducted by Belli & Annurwanda (2024), which states that students with high self-confidence are able to convey mathematical thinking clearly and appropriately, analyze strategies and mathematical thinking, and express ideas using mathematical language. In line with this, Wahyuddin (2020) explains that logical thinking enables a person to reason in order to build and structure thoughts to solve problems accurately. In other words, students need to be accustomed to providing logical reasons for each solution step so that in the future, they can assess and improve their own thinking.

In terms of drawing conclusions, subjects with high self-confidence can accurately draw a conclusion based on the solution steps taken, both at each step and in the final result. This indicates that the subjects not only understand the solution process but are also capable of drawing conclusions from the final solution logically and correctly. This finding is consistent with research conducted by Nurafni & Pujiastuti (2019), which shows that students with high self-confidence have an understanding of mathematical concepts and processes, and can solve problems completely with accurate calculation results. Octaria (2017) explains that a person capable of logical thinking possesses characteristics such as thinking according to the rules of logic, following a correct structure and sequence, being able to classify and group information, and having sharpness in drawing conclusions through logical reasoning.

b. Students with moderate self-confidence

In terms of coherence in thinking, the subject can accurately state all information that is known and asked in the problem. The subject can also outline all the solution steps to be used, from creating assumptions to performing elimination and substitution to solve the problem. This aligns with research conducted by Qiftiyah & Sulistyaningsih (2023), which states that students with moderate self-confidence can identify all information present in a problem and write down what is asked, as well as being able to relate the known information to mathematical concepts.

In terms of argumentation ability, subjects with moderate self-confidence can articulate logical reasons for all solution steps used from the beginning to reaching a conclusion. They can also solve problems and provide logical reasons for each step taken. Nevertheless, the final result obtained is less accurate due to errors in the

calculation process. This indicates that the subjects have understood the problem content and can think logically and systematically, but they are still less careful in performing calculations. This aligns with research conducted by Khoirunnisa & Malasari (2021), which states that students with moderate self-confidence are able to work on problems with detailed and coherent answers, but there are still errors in problem comprehension due to a lack of thoroughness, leading to inaccurate answers.

In terms of drawing conclusions, subjects with moderate self-confidence can draw a final conclusion based on the solution steps taken. They can also provide conclusions at each step. However, due to errors in the solution process, the final conclusion obtained is less accurate. This aligns with research conducted by Nugraha & Widiati (2023), which states that students with moderate self-confidence are able to formulate the main points of a problem and analyze the solution steps used. However, the answers obtained are still less accurate, leading to an inconsistent conclusion.

c. Students with low self-confidence

In terms of coherence in thinking, the subject can accurately state all information that is known and asked in the problem. The subject can also outline some steps to be used in the problem-solving process. However, these steps do not lead to an accurate result. This aligns with research conducted by Qiftiyah & Sulistyaningsih (2023), which states that students with low self-confidence are able to identify information and formulate questions related to the problem, but are not yet able to connect the known information to mathematical concepts. In line with this, Hamid et al. (2023) state that when solving word problems involving systems of three-variable linear equations, students often face difficulties, especially in creating mathematical models.

In terms of argumentation ability, subjects with low self-confidence cannot complete and articulate logical reasons for all the solution steps they intend to use. They can only provide logical reasons for a few of the steps taken. This is because the subjects do not understand the problem content, leading to inaccurate solution steps. This aligns with research conducted by Belli & Annurwanda (2024), which states that students with low self-confidence are not yet able to convey mathematical thinking appropriately, nor are they able to analyze and evaluate the strategies used.

In terms of drawing conclusions, subjects with low self-confidence cannot draw a conclusion at each step taken. They also cannot provide a final conclusion from the solution process because they cannot complete the problem. This aligns with research conducted by Kase et al. (2022), which states that students with low self-confidence are not yet able to correctly understand the problem. Although students can write down what is known in the problem, they make errors in the solution process and thus do not reach the final stage of drawing conclusions.

Conclusion

Based on the analysis of the data and discussion, the following conclusions are drawn: (1) Students with high self-confidence can meet all indicators in the characteristics of mathematical logical thinking, namely coherence in thinking, argumentation ability, and drawing conclusions. In terms of coherence in thinking, subjects can accurately state the known and asked information, and can also outline all the solution steps to be used in the problem-solving process. Regarding argumentation ability, subjects can solve and provide logical reasons or arguments

related to the problem-solving steps, from the initial planning to accurately finding the final result. For drawing conclusions, subjects can draw conclusions at each solution step, and can also accurately conclude the final result of a problem based on the entire process undertaken, (2) Students with moderate self-confidence only meet the indicators in the characteristics of mathematical logical thinking, specifically coherence in thinking. In terms of coherence in thinking, subjects can accurately state the known and asked information, and can also outline all the solution steps to be used in the problem-solving process. Regarding argumentation ability, subjects can solve and provide logical reasons or arguments related to the problem-solving steps, from the initial planning to finding the final result.

However, during the solution process, subjects make calculation errors, leading to less accurate results. For drawing conclusions, subjects can draw conclusions at each solution step, and can also conclude the final result of a problem based on the entire process undertaken. However, due to errors in the solution process, the conclusions drawn are less accurate, (3) Students with low self-confidence cannot meet all indicators in the characteristics of mathematical logical thinking. Regarding coherence in thinking, subjects can only accurately state the known and asked information. However, when outlining the solution steps to be used, they only mention a few steps. For argumentation ability, subjects cannot complete and provide logical reasons for all the solution steps to be used. They only give reasons or arguments for a few selected steps. In terms of drawing conclusions, subjects cannot draw a conclusion from the existing problem based on the solution steps taken.

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