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ANALYSIS OF MATHEMATICAL LOGICAL THINKING SKILLS IN SOLVING ARITHMETIC PROBLEMS: A STUDY OF INTROVERTED

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ABSTRACT

This study examines students' logical-mathematical thinking skills in solving arithmetic problems by considering introverted and extroverted personality types. A descriptive qualitative approach with a case study design was employed, involving four ninth-grade students selected through purposive sampling. Data were collected using a logical thinking ability test, the MBTI personality questionnaire, and structured interviews. The results showed that overall, students' logical-mathematical thinking skills were relatively low, with most participants categorized as "Very Low." Extroverted students demonstrated greater variation in performance, with one student achieving slightly higher logical thinking skills than the others. However, no significant differences were observed between introverted and extroverted students in their logical reasoning and problem-solving abilities. These findings suggest that personality type alone does not substantially determine students' logical-mathematical thinking skills; other factors, such as learning motivation, conceptual understanding, and instructional strategies, also contribute to these outcomes. This study highlights the importance of implementing tailored instructional approaches to enhance students' focus, motivation, and constructive feedback in supporting the development of logical thinking skills among students with diverse personality types.

Keywords: Arithmetic Problem Solving, Extrovert, Introvert, Logical-mathematical Thinking, Personality Types

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PRELIMINARY

Logical thinking is one form of thinking process that involves logic in its application (Monika et al., 2023). Meanwhile, logical-mathematical thinking ability refers to an individual's ability to use logic, numbers, and reasoning so that someone who masters this ability is capable and accustomed to thinking systematically, rationally, and consistently (Wulandari & Fatmahanik, 2020). Mathematical logical thinking skills can also be defined as the skill to solve problems using facts and data that align with logic (Ameylia & Kurniasih, 2022). (Irmaida, 2020) stated that logical thinking is a process of

reasoning about an object by connecting a series of opinions or knowledge possessed until a conclusion is found, and this process is carried out consistently. Logical thinking ability is one of the key abilities that influence mathematics learning (Assmarqandi et al., 2021).

However, students' logical thinking skills in Indonesia are still categorized as low due to several factors. One of the causes is the lack of flexibility in solving mathematical problems, as well as the overly rigid and formal approach (Mawaddah, 2017). As a result, students tend to get confused when faced with different types of problems. Logical thinking ability is required by students both during classroom learning, group discussions, and problem-solving, as it helps in linking elements from their surroundings that can be understood by reasoning, which can then be applied as logic to solve problems (Fauzan et al., 2020). (Septiati, 2018) emphasized that logical thinking is crucial in understanding and solving mathematical problems. Therefore, logical thinking ability is a very important skill that students must possess. To enhance students' logical thinking abilities, teachers must create a learning environment that supports the achievement of active, creative, and enjoyable learning goals through cooperative teaching methods (Maksumah, 2023).

Logical-mathematical thinking is highly necessary for students to develop their skills in learning mathematics, determining whether a line of reasoning is correct or incorrect based on prior knowledge or experience (Nisa & Warmi, 2023). (Novia Sari, 2020) stated that individuals also need logical thinking when making decisions, drawing conclusions, and solving problems. These activities can be related to both mathematical problems and everyday life challenges.

Every student has unique characteristics that must be acknowledged and considered by teachers during the learning process. Educators need to take into account the individual traits of students, including their personalities, as these traits affect the consistency of their feelings, thoughts, and behaviours (Utami & Haerudin 2021). Personality can be classified into several types, one of which is extroverted and introverted. An extroverted individual tends to have good interactions with the external world, is sociable and friendly, enjoys new environments, is always enthusiastic and active, dislikes monotonous activities, and more (Sari & Kurniasari, 2022). On the other hand, an introverted person are more inclined toward their inner world, have less interaction with the external world, are not easily sociable, tend to be reserved, dislike crowds, and thus find it difficult to socialize, which can make them more nervous when meeting others (Satya et al., 2022).

Extroverts are more outwardly focused and tend to open themselves up to the outside world, enjoying social interactions and crowds. Meanwhile, introverts are more

inwardly focused and tend to withdraw from the external world, preferring quiet places and solitude (Rudianti et al., 2021). Introverted individuals may be able to open up to those around them, but this depends on their personal experiences (Masni et al., 2021). In contrast, extroverted individuals are naturally open and easily socialize with their surroundings (Purba & Ramadhani, 2021).

Several previous studies on logical-mathematical thinking ability include research by (Devianti & Hakim, 2021). which examined students' logical-mathematical thinking abilities, particularly in the subject of social arithmetic. (Fitriyah et al., 2019) also studied logical-mathematical thinking but focused on problem-solving from the perspective of different learning styles with the same topic of social arithmetic. Another relevant study was conducted by (Ulfa, 2020), which discussed the introverted and extroverted personality types of students in solving word problems related to social arithmetic. However, this study did not analyze logical-mathematical thinking abilities but rather focused on mathematical problem-solving abilities. Other related research includes a study by (Damanik & Simanullangg, 2023) which also examined introverted and extroverted personality types but applied problem-based learning models on the same topic of social arithmetic, analyzing students' creative thinking abilities.

Based on the findings from previous studies, we identified a gap. lthough personality types play an important role in shaping students' cognitive processes, no previous research has specifically examined how introverted and extroverted personality types influence logical-mathematical thinking skills in solving arithmetic problems. Therefore, this study aims to fill that gap by analyzing logical-mathematical thinking skills from a personality perspective, providing a more integrative understanding of cognitive styles in mathematical problem solving. The goal of this study is to assess students' logical-mathematical thinking skills in solving arithmetic problems from the perspective of their personality types, providing valuable insights for determining effective teaching strategies that match students' personality types to improve their logical-mathematical thinking skills.

METHODS

The type of research used is descriptive qualitative research with a case study design. Data collection was conducted at MTsN 5 Kerinci. Fourteen students from class IX C were given a logical thinking ability test and a personality type instrument for introverts and extroverts. The subjects in this study consisted of four students, comprising two with introverted personality types and two with extroverted personality types. The selection of

subjects was carried out using purposive sampling, which is a non-random technique in which participants are deliberately chosen based on specific criteria relevant to the research objectives. In this study, the researcher selected students who had been identified as either introverted or extroverted through the MBTI results. This approach was intended to enable an in-depth analysis of logical-mathematical thinking skills by comparing participants with contrasting personality types. By selecting two contrasting personality types, the researcher was able to examine in depth how personality influences students' strategies and approaches in solving arithmetic problems.

Once the four students were selected as research subjects, interviews were conducted to gather information about each subject's logical thinking ability. The instrument used was the MBTI (Myers-Briggs Type Indicator) questionnaire, specifically for introverts and extroverts. The MBTI is designed to measure personality types and is the most widely used instrument (Srisulistiowati, 2014). The MBTI questionnaire consists of 28 statements with two answer options. The test given to students consisted of two questions covering five indicators, which included one main question. The logical thinking ability test comprised three questions, the main of which was social arithmetic.

The interview method used was structured interviews. This method was chosen to ensure that all respondents received the same questions, resulting in more organized and easily understandable responses. Interviews were conducted with several subjects based on their introverted and extroverted personality types.

The steps for presenting the data were carried out using method triangulation. Method triangulation involves comparing information or data through different approaches. In qualitative research, the researcher used interviews, observations, and surveys to obtain reliable and comprehensive information about certain data (Susanto et al., 2023). Method triangulation was performed by comparing the test results with the interview results and then describing the logical thinking abilities of the research subjects based on the logical thinking ability test results.

The indicators used in this research were adapted from (Harini, 2023) and consist of several key aspects of logical-mathematical thinking skills. These include the ability to explain meanings and definitions supported by reasonable answers and arguments, the skilss to make logical connections between different concepts and facts, and the ability to estimate and test based on sound reasoning. In addition, students are expected to solve mathematical problems rationally and to draw logical conclusions from the information or data presented.

Table 1. Scoring Rubric logical thinking skills

Criteria for Answer Evaluation	Score
The answer shows no or very incomplete logic, making it impossible to evaluate	0
The answer reflects a 'one-stop solution' with no intermediate argument	1
Individual steps are partially logically correct, but the overall argument lacks logical order, or steps are unsupported	2
The answer has good overall logic and reasoning, but there are small or one major step that is incorrect or missing	3
The answer is logical and complete but overly procedural, with some minor mistakes	4
The answer is correct, efficient, and shows precise details in all parts	5

(Source: Septiati, 2016*)*

In this study, logical-mathematical thinking skill refers to students' skills in solving social arithmetic problems. This skill is assessed using a logical-mathematical thinking test designed to measure the depth of students' thinking in this area. The criteria for grouping students based on their performance can be seen in the following table, which presents the classification of score percentages.

Table 2. Score Percentage Classification

Percentage	Category
80% - 100%	Very High
60% - 79%	High
40% - 59%	Medium
20% - 39%	Low
0% - 19%	Very Low

(Source: Aini, 2024)

RESULT AND DISCUSSION

The research subjects were selected based on the results of the MBTI personality type test, specifically for introverts and extroverts, which consisted of 28 questions with answer choices "a" and "b." If the subject chose "a," they were categorized as introverted, and if they chose "b," they were categorized as extroverted. From this test, data revealed that two students had introverted personalities, and two students had extroverted personalities. Structured interviews showed that students with introverted personalities tended to remain in calm situations and focused on their internal world, while extroverted students felt more comfortable in crowds and gained energy from social interactions.

Table 3. Logical-Mathematical Thinking Ability Test Results

Personality Type	Research Subject	Score	Percentage	Category
Extrovert	A1	11	22%	Low
	B1	1	2%	Very Low
Introvert	A2	6	12%	Very Low
	B2	6	12%	Very Low

Based on Table 3, the results of the logical-mathematical thinking ability test show that the extroverted subject (A1) obtained the highest score of 11 with a percentage of 22%, which falls into the "Low" category. Meanwhile, the other extroverted subject (B1) scored only 1 (2%), categorized as "Very Low". On the other hand, both introverted subjects (A2 and B2) scored 6, with a percentage of 12%, and were also categorized as "Very Low".

These results indicate that, overall, the logical-mathematical thinking ability of the four subjects is still relatively low. There is no significant difference between extroverted and introverted personalities in this context, as both personality types showed similarly low performance. Only one subject (A1) was classified as "Low", while the others fell into the "Very Low" category.

This finding suggests that personality is not the only factor influencing logical-mathematical thinking ability. Other factors, such as learning motivation, instructional strategies, and material comprehension, may also contribute to the outcomes (Awe & Benge, 2017). According to (Tabiin, 2017), logical-mathematical intelligence is one of the multiple intelligences that can be developed through appropriate practice and learning. Therefore, in mathematics instruction, it is important to apply approaches that align with the individual characteristics of students in order to enhance their logical-mathematical thinking skills (Syahputra, 2025).

1. Explaining Meaning and Definitions Based on Logical Answers and Reasonable Arguments

In the first indicator, students were expected to explain the meaning or definition of the concepts in the questions logically and supported by reasonable arguments. This includes the ability to break down the problem into known information and the question asked.

Based on observations, for the first test question, subject A1, in explaining the meaning or definition of the answer with reasonable arguments, followed a logical sequence when outlining what was known and what was being asked. This supports previous research indicating that students can write down information found in the problem (Wulandari & Fatmahanik, 2020). However, A1 did not complete the section asking for what was specifically questioned in the problem.

In contrast, B1 was unable to state what was known from the question and did not complete the section asking for the question itself, meaning B1 did not meet this indicator.

These observations were reinforced by A1's answer sheet, which included steps showing what was being asked and what was known.

This analysis demonstrates that the ability to logically explain and provide reasonable arguments varied between students, with some partially meeting the criteria while others struggled to fulfil the task. Here is the answer sheet result for question number 1 from student S1 :

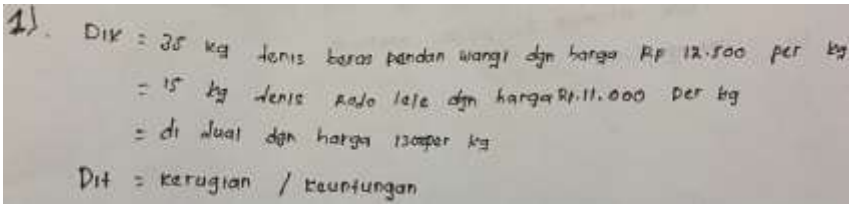

Figure 1. Shows student S1's answer to question 1, including known variables, prices, and a brief logical conclusion.

Meanwhile, based on the results of tests A2 and B2, It is evident that their answers were incomplete in specifying what was known and asked in the questions. This could be due to the students' insufficient understanding of the given questions. This is supported by previous research, which states that students are often not careful in reading and understanding sentences about what is known and asked in the questions, which becomes a reason for their difficulty in solving word problems (Sudirman et al., 2018). The student's ability to present logical and in-depth arguments based on correct definitions also reflects the level of critical thinking skills that are important in mathematics learning.

Based on the test results for the second question, students A1 and B1 did not provide answers when it came to explaining meanings or definitions based on logical answers and arguments. This is due to time constraints for the students to respond, and it could also be attributed to a lack of mastery of the tested material, anxiety, and concentration issues while solving the problem.

In the test results for student A2, it was found that A2 did not answer the second question. On the other hand, B2 was able to answer this question, although there were deficiencies in the student's response. This was due to time limitations and their understanding of the basic mathematical concepts relevant to the second question. Students who did not answer question number two likely did not have a sufficiently strong understanding to explain the concept accurately, as reflected in their lack of answers to the question. The observation results are also supported by B2's answer sheet, where the

student wrote the steps for solving the problem, specifying what was asked and what was known:

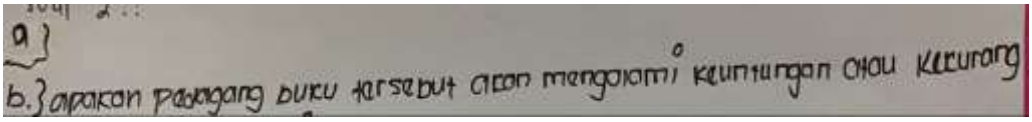

Figure 2. Shows student S1's answer to question 2, identifying the problem context and mentioning profit of loss

The answers written by student B2 show that B2 made an effort to address the problem. However, B2's responses are still not entirely accurate, as B2 did not fully explain what was asked and did not mention what was known from the question. This result indicates that although the student attempted to engage with the problem, there were difficulties in identifying and interpreting the key information required to solve it correctly. According to (Ayuwirdayana, 2019), many students struggle to clearly distinguish between known data and what is being asked in word problems, which often leads to incomplete or incorrect answers. This difficulty may also be related to insufficient comprehension of the problem context or limited experience with similar tasks. Furthermore, interviews conducted with B2 revealed that the student tended to focus on calculation steps without first ensuring a clear understanding of the problem statement. This supports the view of (Nasution, 2023), who emphasize that students often rush to solve mathematical problems procedurally without carefully analyzing the meaning of the questions. Therefore, B2's incomplete explanation can be attributed to a lack of thorough reading strategies and low confidence in articulating problem elements, which are critical skills in logical-mathematical thinking.

2. Creating Logical Connections Between Different Concepts and Facts

In this indicator, students are expected to be able to connect different concepts and facts, meaning that students should be able to relate what is known to mathematical operations and produce new facts as a result.

Based on the observations conducted by the researcher for the first question, student A1 successfully created logical connections between different concepts and facts. The student demonstrated their ability to calculate and multiply the price of each type of rice. Student A1 also added the two types of rice. On the other hand, student B1 provided incorrect answers when explaining the solution to the problem. This indicates that student B1 may not understand the fundamental concepts needed to answer the question The observation results are also supported by the answer sheet from student A1, which

demonstrates the second indicator, namely Creating logical connections between different concepts and facts:

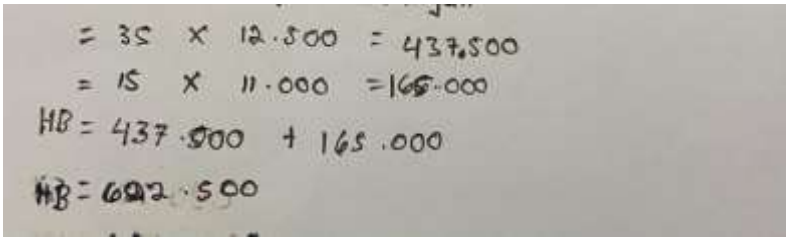

Figure 3. Shows Student A1's answer involving multiplication and addition to find the total cost, demonstrating the ability to connect mathematical concepts with real-world contex

The answer sheet provided by A1 shows that A1 was able to correctly perform the multiplication calculations for each type of rice and then accurately sum them. The answer sheet from A2 indicates that A2 was able to perform the multiplication calculations for each type of rice but did not sum the two types. This may be due to A2 not reading the question instructions carefully. Meanwhile, B2 calculated and performed multiplication to determine the price of each type of rice and also added the two types. However, B2 did not outline the steps for the multiplication and addition calculations for the two types of rice. (Hanipa et al., 2019), states that one reason students may misunderstand a problem is due to a lack of deep understanding of the question and insufficient attention to detail.

Based on the test results for the second question, students A1 and A2 did not provide answers for creating logical connections between different concepts and facts. This indicates that A1 and A2 failed to address this issue.

In the test results, A2 also did not answer the second question. On the other hand, B2 answered this question. This difficulty may be attributed to students often struggling to connect facts with concepts if they rely solely on memorization without understanding the logical relationships between concepts. A major factor in students' difficulty in understanding mathematics is their lack of willingness to study the subject. Many students view mathematics as a difficult subject with complex symbols and formulas that are hard to grasp (Fujianti, 2023). The observation results are also supported by B2's answer sheet, which demonstrates the second indicator: Creating logical connections between different concepts and facts:

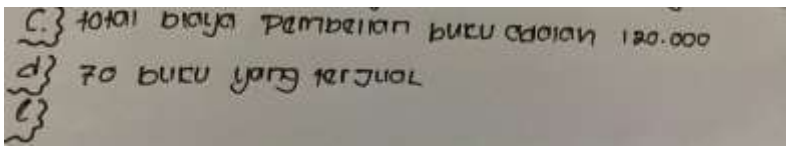

Figure 4. B2's answer shows an attempt to connect facts, but the logic is unclear and calculation steps are missing, indicating weak use of the indicator.

The answer sheet provided by B2 shows that B2 made an effort to address the problem, although the answers were not correct and the student did not outline the steps taken to arrive at their answers.

3. Making Inferences and Testing Based on Reason

In the third indicator, which focuses on the ability to make inferences and test hypotheses based on reasoning, students should be able to provide reasonable working hints and a process they have followed.

Based on observations made by the researcher, neither student A1 nor B1 was able to make reasonable inferences or test hypotheses for the first or second question, and the same applies to students A2 and B2. None of the students answered this problem. (Lubis & Wandini, 2023), suggest that this may occur due to a lack of understanding of basic arithmetic concepts, difficulty in linking basic concepts to more complex problems, incorrect use of formulas, and insufficient practice in problem-solving. Additionally, the ability to conduct logical testing is an important indicator of students' readiness to face more complex challenges in mathematics learning. (Yulia & Luqman, 2015), suggest that one approach to improving learning outcomes is for teachers to accommodate and facilitate students' ideas so they can illustrate and interpret various problems in mathematical language and statements, and solve these problems according to mathematical rules or methods.

4. Solving Mathematical Problems Rationally

This indicator focuses on the student's ability to solve mathematical problems using a rational approach. Based on the observations conducted by the researcher, A1 was able to provide the correct answer. However, the student did not explain the steps taken to solve the problem. On the other hand, B1 completed the problem according to this indicator, but the answer provided by B1 was incorrect.

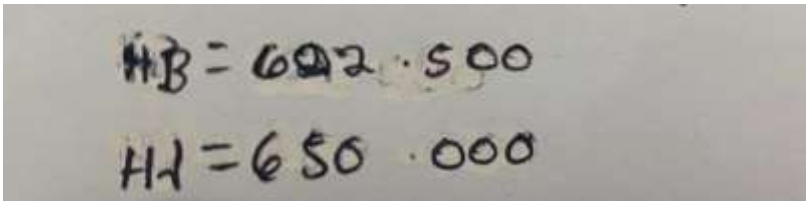

Figure 5. The observation results are also supported by the answer sheet from student A1, which demonstrates the fourth indicator, Solving mathematical problems rationally

Based on the test results, A2 answered part of the problem but did not complete it. Meanwhile, B2 also answered this problem, and like A1, B2 provided a correct answer. However, the student did not explain the steps taken to solve the problem. According to (Darmawan et al., 2019), students are capable of solving mathematical problems rationally. Rational problem-solving depends not only on accurate calculations but also on the ability to validate results with strong logic. Students still struggle to understand the problem, choose appropriate strategies for solving it, solve the problem correctly and systematically, check the accuracy of the chosen strategy, and verify the correctness of their solutions (Yulia & Suhendra, 2017).

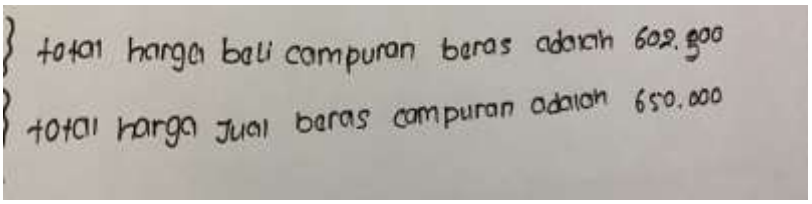

Figure 6. The observation results are also supported by the answer sheet from student B2, which demonstrates the fourth indicator: Solving mathematical problems rationally

Based on the observations conducted by the researcher on the second question, neither students A1 nor B1 provided answers. This is because these students did not attempt to answer the question from the beginning. The lack of time to complete the problem due to the student's difficulty in understanding the question led to no answers being provided.

In the test results, neither A2 nor B2 answered this question. Although B2 had completed previous problems, B2 did not proceed to answer this section. This indicates that they may not yet have a rational strategy for solving the problem, especially when it involves more variables. Students often understand and grasp the material only when the teacher explains, without further exploring their abilities, which is one of the existing issues (Ratnasari & Yulia, 2018). Mathematics instruction should be directed towards activities that can motivate students to understand the subject. If classroom teaching does not motivate students, it can result in lower learning outcomes (Yulia & Defina, 2015). According to (Sefiyani & Sucitra, 2024), factors contributing to students' difficulty in answering questions include a lack of understanding of basic concepts, unengaging teaching methods, and insufficient practice.

5. Drawing Logical Conclusions

A student is said to draw logical conclusions when they can understand the process of solving a problem from start to finish and can draw a reasonable conclusion from what has been completed.

The observation results show that only one student successfully answered the question from beginning to end with a correct final answer, namely student A1. Although this student did not write out the steps taken to reach the results, they provided the correct answer and concluded that the seller made a profit. (Agustin, 2016), states that students can conclude very well by explaining each step of the problem-solving process. Additionally, (Fitriyah et al., 2019), also noted in their research that students can make correct conclusions.

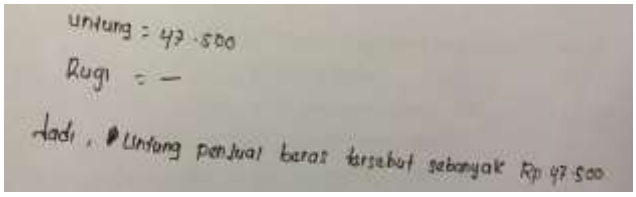

Figure 7. The observation results are also supported by the answer sheet from student A1, which demonstrates the fifth indicator, Drawing logical conclusions

Based on the observations made by the researcher on the second question, students A1 and B1 did not answer this question, indicating that they were unable to provide any conclusions. This suggests that they had difficulties in thoroughly analyzing the problem and were constrained by the limited time available to answer the second question.

In the test results, A1 did not answer the question. Although B2 had made an effort to answer previous problems, it still failed to draw a logical conclusion due to errors in calculations and incomplete responses to some parts of the problem. Difficulty in concluding is often due to students' inability to correctly interpret their calculations.

Overall, students' logical thinking abilities vary according to their personality types. Extroverted students showed significant variation in performance. In the available data, student A1 scored 11, which is 22% of the total score, placing them in the low category, while student B1 scored only 1, which is 2% of the total score, placing them in the very low category. This difference reflects how extroverted personality types can affect academic performance differently. Extroverts tend to be more active in social interactions and have high energy, which often influences their behaviour in learning environments. Student A1, with the highest score among extroverts, may have used social interaction and

group dynamics to enhance their understanding and motivation. They might have been more involved in class discussions, study groups, or collaborative projects that allowed them to contribute actively and receive immediate feedback from peers. Conversely, student B1, with a much lower score, may have struggled to effectively leverage their social energy in academic contexts. (Baskorowati, 2020) notes that mathematical concepts are often misunderstood, calculations frequently go wrong, and problem meanings are often misinterpreted. (Kholid & Jayanti, 2022) states that each student has a unique problem-solving approach. Even though they are extroverts, factors such as lack of concentration or difficulty in non-interactive situations may affect their performance. Cultivating students' interest in learning, especially mathematics, can be done in various ways. For example, providing a method of learning and learning media for students to achieve student learning outcomes in mathematics increases, and students who have an interest in and talent in it will more easily achieve success in learning activities (Fadillah, 2016).

Introverted students, on the other hand, showed similar results in the very low category, with students A2 and B2 each scoring 6 (12%). These students faced significant difficulties in developing their logical thinking skills, even though they tended to be more comfortable with individual study. The issues may be related to a lack of motivation, engagement, or adequate support in learning. Adjustments in teaching methods that increase active engagement and provide constructive feedback could help address these challenges and facilitate better development of logical thinking skills.

Overall, students face various difficulties in logical thinking abilities based on their personality types. Extroverted students often struggle with maintaining focus and time management, which hinders the consistent application of logical thinking skills. Disruptions from intense social interactions or lack of structure in learning can exacerbate these problems. Introverted students, on the other hand, face challenges in motivation and active engagement. They may feel less driven or receive inadequate feedback, which impedes their ability to develop effective logical thinking skills. Therefore, personalized approaches that cater to each student's personality type, including strategies to improve focus and motivation and provide constructive feedback, are necessary to address these difficulties and support their logical thinking development.

In this study, the results of the structured interviews were also analyzed to explore participants’ experiences and perceptions in more depth. Through the interviews, it was found that extroverted students often described feeling distracted by their surroundings and

preferred interactive activities, while introverted students expressed difficulties in staying motivated and engaging actively during problem-solving tasks. These insights from the interviews complemented the test results and helped explain why students faced different challenges in developing logical thinking skills.

CONCLUSION

Students with extroverted personalities show varied logical thinking abilities, where some may use social energy and group interaction to enhance their understanding. However, they often face challenges in maintaining focus and managing time, which can hinder the consistent application of logical thinking skills. Conversely, introverted students, though often more comfortable with individual study, face difficulties in motivation and active engagement. A lack of feedback and support in learning can impede their logical thinking development.

Therefore, students' personality types influence their mathematical, logical thinking abilities. Extroverted and introverted students face different challenges, highlighting the need for learning approaches tailored to each personality type. To optimally support the development of logical thinking skills, it is important to adopt strategies that enhance student focus and motivation and provide constructive feedback according to their personality types.

RECOMMENDATIONS

Future research should enhance the measurement of logical-mathematical thinking skills by combining tests with observations and interviews to better understand the influence of personality types. It is also recommended to explore factors such as learning styles, environment, and family support, as well as the effects of stress and time pressure. Developing valid assessment tools and personalized learning models is important. In practice, teachers are encouraged to apply differentiated instruction based on personality types. Introverted students may benefit from individual tasks, while extroverted students may respond better to group work. A supportive and varied learning environment can improve students’ logical thinking, motivation, and overall achievement.

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