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Analysis of Critical Thinking Skills in Solving Mathematical Problems Based on High School Students' Mathematical Ability

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Abstrak: This study aims to analyze high school students' critical thinking skills in solving mathematical problems, specifically on the topic of probability of an event, based on their mathematical ability level. This study used a qualitative method with a descriptive case study approach. The research subjects consisted of three students from SMA Negeri 1 Ingin Jaya, selected through purposive sampling, each representing high, medium, and low mathematical ability categories. Data were collected through basic mathematical ability tests, probability problem-solving tasks, semi-structured interviews, and documentation. Data analysis included data reduction, presentation, and drawing conclusions based on Facione's critical thinking indicators: interpretation, analysis, evaluation, and inference. The results showed that students with high mathematical ability were able to understand problems, develop strategies, evaluate steps, and draw logical conclusions. Students with medium ability were able to understand problems but remained weak in analysis and evaluation. Meanwhile, students with low ability experienced difficulties in almost all indicators. These findings confirm that mathematical ability is closely related to critical thinking skills. Teachers are expected to implement effective learning strategies to improve students' critical thinking skills in mathematics learning.

Keywords: Critical thinking; mathematical ability; problem solving; probability; high school students

Introduction

Critical thinking is an essential 21st-century skill emphasized in various curricula, including the Independent Curriculum (Curriculum Merdeka) in Indonesia. In mathematics, this skill helps students not only memorize formulas but also analyze, evaluate, and make logical decisions. Probability is a topic that highly demands critical thinking skills because students must understand abstract concepts, relate them to real-world situations, and draw appropriate conclusions. Initial observations at SMA Negeri 1 Ingin Jaya revealed that many students still experience difficulties in understanding and solving probability problems. These difficulties include misinterpreting information, choosing the wrong solution strategy, and being unable to evaluate results. Furthermore, various international studies, such as the PISA (Program for Student Assessment and Evaluation) study, indicate that Indonesian students still fall low in higher-order thinking skills, including critical thinking. This situation reinforces the urgency of researching and developing learning strategies that can improve students' critical thinking skills. Mathematics, although often considered difficult, has great potential as a means to foster logical, analytical, and critical thinking skills if managed with the right approach. Based on this background, this study aims to analyze high school students' critical thinking skills in solving mathematical problems on probability based on their mathematical ability level.

Literature Review

Critical Thinking in Mathematics Education

Critical thinking is a high-level thinking skill that encompasses interpretation, analysis, evaluation, and inference (Facione, 2020). In mathematics learning, critical thinking helps

students understand problems, formulate strategies, and evaluate solutions. Sumarmo et al. (2017) stated that critical thinking skills are important for developing systematic and logical thought patterns, enabling students to face both academic and everyday life problems. Furthermore, Susilawati et al. (2020) emphasized that critical thinking is key to students' success in mastering mathematics, as students are required not only to memorize formulas but also to provide logical reasons for their chosen answers. Several recent studies have also shown that the application of innovative learning strategies, such as problem-based and collaborative learning, can improve students' critical thinking skills (Handayani & Anggraini, 2023; Septiani et al., 2023).

The Relationship Between Mathematical Ability and Critical Thinking

Mathematical ability is closely related to critical thinking skills. Mairing and Aritonang (2018) found that students with high mathematical ability tend to be better able to analyze problems, choose appropriate strategies, and evaluate their results. Conversely, students with low mathematical ability are more likely to make interpretation errors and are less able to draw logical conclusions.

This is supported by Rosliani and Munandar (2022), who stated that mathematics learning that emphasizes systematic problem-solving plays a crucial role in developing critical thinking skills. Sari and Masriyah (2022) also added that mathematical ability serves as a foundation for students to practice analytical skills, so the higher a person's mathematical ability, the greater their chances of developing strong critical thinking skills. Thus, it can be concluded that critical thinking skills are not only the goal of mathematics learning but are also significantly influenced by students' mathematical ability levels.

1. Research Method

This research used a qualitative approach with a descriptive case study. It was conducted at SMA Negeri 1 Ingin Jaya in July–August 2025. The subjects consisted of three eleventh-grade students selected using purposive sampling, each representing high, medium, and low mathematics ability categories based on the results of a basic ability test.

The instruments used included a basic ability test, a probability problem-solving test, and semi-structured interviews. The use of interviews in this study was based on the consideration that they provide more detailed data. This aligns with Rahmi et al. (2025), who emphasized that detailed process monitoring is more effective than simply observing the final results. Interviews allowed researchers to confirm and deepen data from the essay test, resulting in a more accurate mapping of students' critical thinking abilities, and documentation, with the researcher as the primary instrument. The research procedures included instrument development and validation, administration of the basic ability test, provision of probability problems, and interviews to delve deeper into students' critical thinking processes. Data analysis was conducted using the Miles and Huberman model, which includes reduction, presentation, and conclusion drawing. The critical thinking indicators analyzed refer to Facione, namely interpretation, analysis, evaluation, and inference. Data validity was obtained through time triangulation by comparing test and interview results on different occasions.

2. Results and Discussion

This study analyzed the critical thinking skills of three students at SMA Negeri 1 Ingin Jaya on probability, each representing high, medium, and low mathematical ability categories. The analysis was based on Facione's critical thinking indicators: interpretation, analysis, evaluation, and inference.

Students with high mathematical ability demonstrated a good understanding of problem information and were able to write down steps for solving the problem in a coherent manner. For example, when given a simple probability problem, this student wrote down the sample space and calculated the probability correctly. In interviews, he was also able to explain the rationale for using a particular formula. This indicates that the interpretation, analysis, and inference indicators were met.

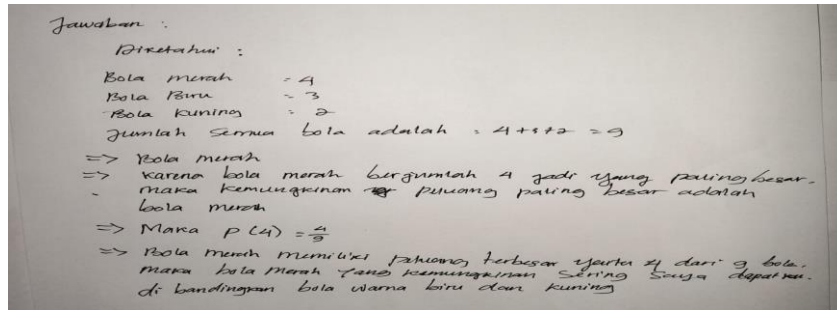


Image of Answers of Students with High Mathematical Ability for TPMP Question 1

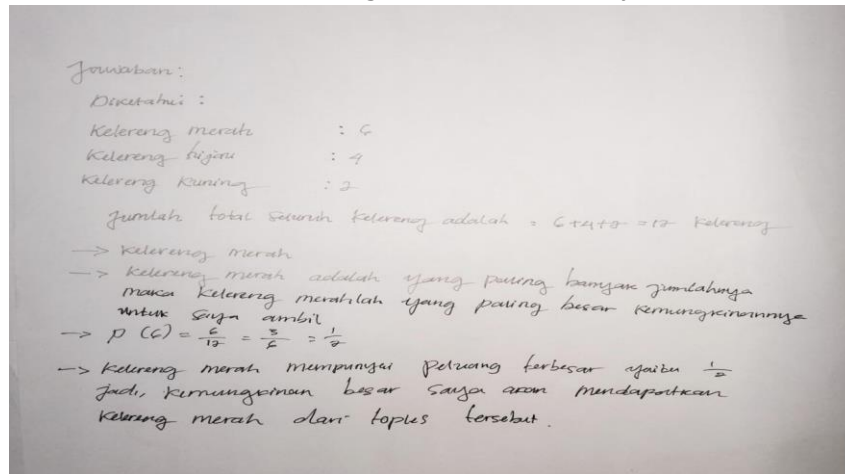
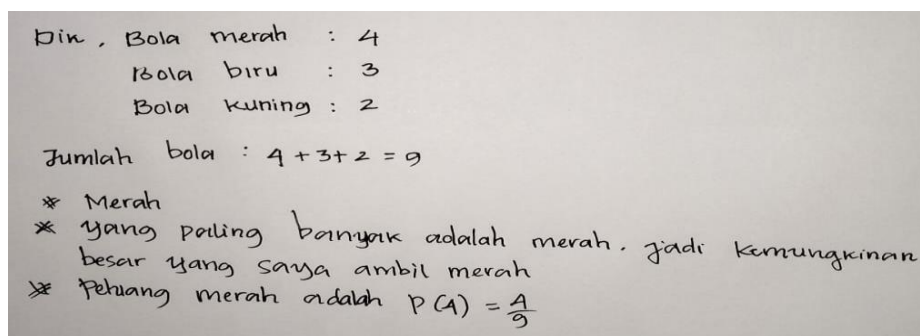
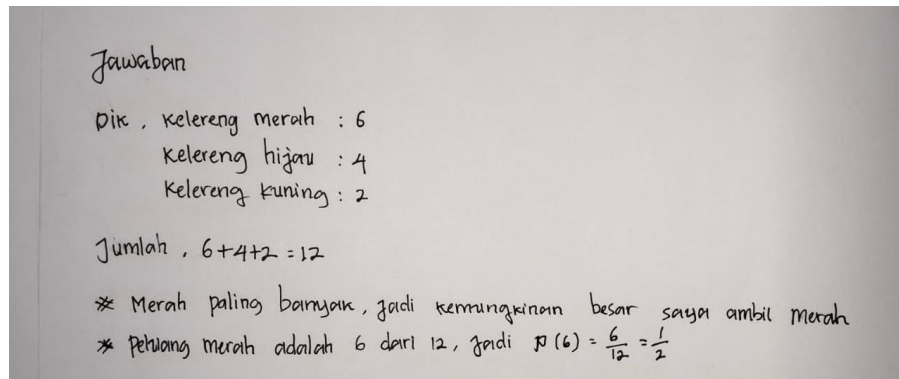


Image of Answers of Students with High Mathematical Ability for TPMP Question 2

A student with average ability is able to understand the problem but lacks thorough analysis. He can write down some of the solution steps, but sometimes makes mistakes in determining the sample space or performing calculations. During the interview, this student can explain the meaning of the problem but struggles to evaluate his answers. This indicates that his interpretation indicators are quite good, but his analysis and evaluation are still weak.

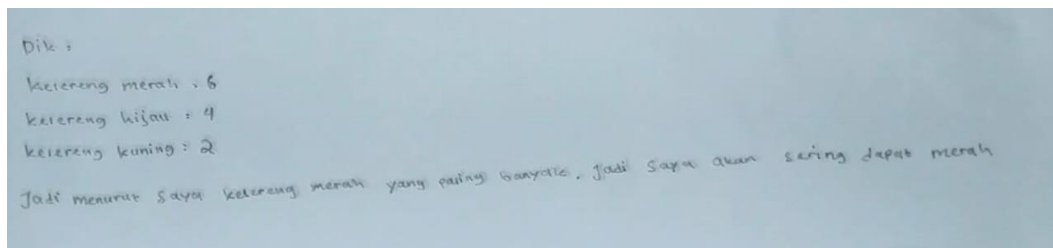


Picture of Student Answers with average ability for TPMP question 1

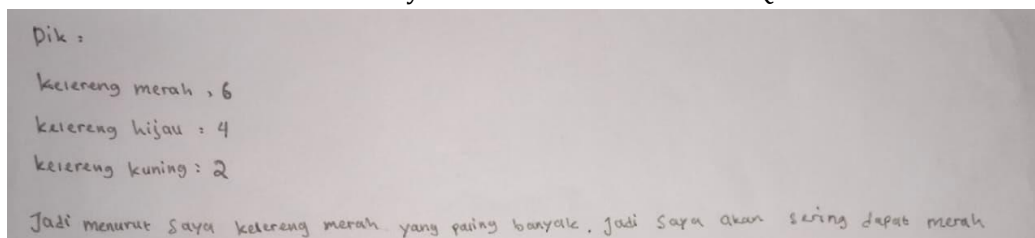


Picture of Student Answers with average ability for TPMP question 2

The low-ability student struggled from the beginning. He couldn't correctly define the sample space, so his chosen solution strategy was also inappropriate. In the interview, this student admitted to being confused and simply guessing the answer. This indicates that almost all critical thinking indicators were not met properly.



Picture of Low Ability Students' Answers for TPMP Question 1



Picture of Low Ability Students' Answers for TPMP Question 2

From the three subjects, it appears that the higher a student's mathematical ability, the better their critical thinking skills. This is in line with the view of Aryani et al. (2020) that mathematics learning helps students solve contextual problems and trains critical thinking skills. High-ability students were able to fulfill all four indicators of critical thinking, while students with medium abilities only partially, and students with low abilities were almost unable to fulfill these indicators. The results of this study are in line with the findings of Musriandi et al. (2020) who showed that most students still experience difficulties in selecting solution strategies, drawing conclusions, and dealing with non-routine problems. Therefore, the better a student's mathematical ability, the better their critical thinking skills. This finding is in line with the research of Rosliani & Munandar (2022) which states that mathematical ability is closely related to critical thinking skills.

3. Conclusions and Recommendations

Based on the research results, it can be concluded that students' critical thinking skills in solving mathematical problems on probability are significantly influenced by their mathematical ability level. Students with high ability are able to meet almost all critical

thinking indicators, from interpretation, analysis, evaluation, to inference. Students with average ability can understand problems, but remain weak at the analysis and evaluation stages. Meanwhile, students with low ability experience difficulties in almost all critical thinking indicators. Therefore, the higher a student's mathematical ability, the better their critical thinking skills. The following suggestions can be made:

1. Teachers are advised to use learning strategies that emphasize critical thinking skills, such as problem-based learning and group discussions, so that students become accustomed to analyzing and evaluating information.
2. Students are encouraged to more actively practice critical thinking skills by getting used to solving non-routine problems and being brave enough to present logical reasoning during the learning process.
3. For future researchers, it is recommended to expand the number of subjects and use different mathematical materials so that research results are more general and comparable across topics.

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