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# Analysis of Students' Mathematical Reasoning Ability in Solving Algebra Problems

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**Abstract:** This study aims to analyze students' mathematical reasoning ability in solving algebra problems at Universitas PGRI Pontianak. The research employed a descriptive qualitative approach involving 25 students in Algebra courses. Data were collected through algebra problem tests and analyzed using descriptive statistics and thematic interpretation. The findings reveal that 24% of students demonstrate high reasoning ability, 44% moderate reasoning, and 32% low reasoning. The most common difficulties students encounter are constructing logical arguments, generalizing solutions, and applying algebraic concepts to novel situations. The results indicate that students' reasoning ability remains constrained, particularly when addressing non-routine problems, which may affect their algebraic understanding and problem-solving skills. This study highlights the importance of integrating reasoning-based learning strategies in Algebra courses to enhance students' conceptual and procedural knowledge.

## Introduction

Mathematical reasoning is a fundamental component of learning mathematics, enabling students to draw logical conclusions, justify solutions, and connect concepts systematically. Reasoning ability is strongly associated with students' success in algebra, a branch of mathematics that serves as the foundation for advanced studies. Research has shown that students who possess stronger reasoning skills are more capable of solving complex mathematical problems and applying their knowledge to real-life contexts (Bergqvist, 2017; Cai et al., 2019).

In higher education, especially in teacher training institutions, the ability to reason mathematically is essential since it not only shapes students' mathematical competence but also prepares them to teach effectively in the future (Stylianides, 2016). Previous studies indicate that reasoning skills among mathematics education students remain varied and sometimes inadequate (Sumpter, 2016; Nurdiana & Sugiman, 2018). These inadequate skills raise the urgency for a deeper analysis of students' reasoning levels, particularly in algebra, which often presents difficulties due to its abstract nature.

Several recent studies have explored students' reasoning difficulties in algebra. Kaput (2017) argued that algebraic reasoning requires both procedural fluency and conceptual understanding, while students often rely excessively on procedures without grasping underlying concepts. Similarly, Kieran (2018) emphasized that reasoning in algebra involves generalizing patterns and structures, but students tend to struggle to recognize these generalizations. In the Indonesian context, Rahmawati and Surya (2019) found that university students often make logical errors when transitioning from arithmetic to algebraic thinking.

Other research has addressed reasoning in relation to problem-solving strategies. Lithner (2017) distinguished between imitative reasoning and creative reasoning, noting that many students depend on rote methods rather than constructing new arguments. Supporting this, Sari and Yuliani (2020) reported that pre-service teachers displayed limited reasoning ability when asked to justify their algebraic solutions. Additionally, Morselli (2019) highlighted that socio-cultural factors, such as classroom practices and teacher feedback, play a significant role in the development of reasoning ability.

In the past decade, the role of reasoning in mathematics education has been increasingly emphasized in curriculum and assessment standards (National Council of Teachers of Mathematics [NCTM], 2018). Studies by Widjaja and Stacey (2019) confirmed that reasoning contributes significantly to students' problem-solving capacity and mathematical communication. Similarly, Ersoy and Öksüz (2020) argued that without strong reasoning, students may succeed in performing routine exercises but fail in non-routine problem contexts.

Therefore, this study aims to analyze the reasoning ability of students enrolled in Algebra courses at Universitas PGRI Pontianak. By categorizing reasoning ability into high, moderate, and low levels, this study provides empirical insights into students' current reasoning status and the pedagogical implications for improving algebra learning.

## Methodology

This research employed a descriptive qualitative design supported by quantitative descriptive statistics.

**Participants:** The subjects of the study were 25 students enrolled in the Algebra course at Universitas PGRI Pontianak during the 2025 academic year.

**Instrument:** The main instrument was a test consisting of 5 open-ended algebra problems designed to assess various aspects of mathematical reasoning, including identifying patterns, constructing arguments, generalizing, and applying algebraic concepts.

**Procedure:** Students' responses were collected, categorized, and analyzed. Their reasoning abilities were classified into three levels: high, moderate, and low, based on accuracy, completeness of logical arguments, and creativity of reasoning.

**Data Analysis:** Data were analyzed descriptively by calculating frequency distributions and percentages for each reasoning category. Qualitative analysis was conducted to identify patterns of difficulties and strengths in students' reasoning.

## Results and Discussion

The analysis revealed the following distribution of students' reasoning ability:

**High reasoning** **:** 6 students (24%)
**Moderate reasoning** **:** 11 students (44%)
**Low reasoning** **:** 8 students (32%)

Figure 1 shows the distribution of students' mathematical reasoning ability based on test scores. It can be seen that most students are concentrated in the *moderate* category, while fewer students reach the *high* category

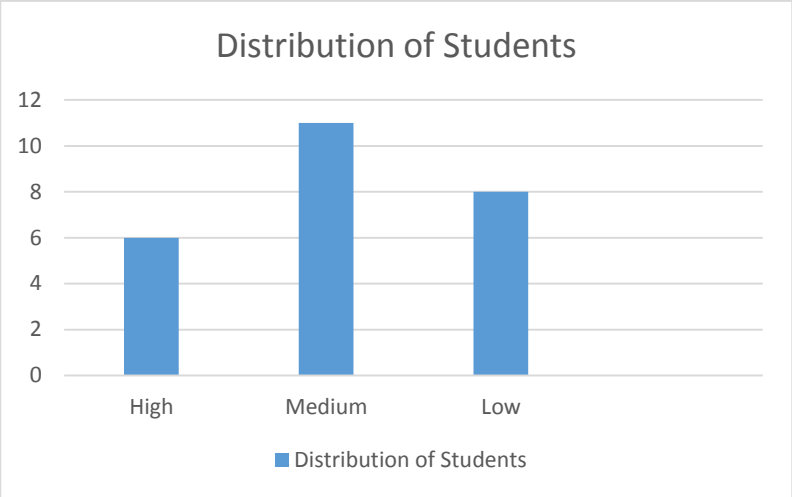


**Figure 1. Distribution of Students' Mathematical Reasoning Ability**

Meanwhile, Figure 2 illustrates the proportion of students' reasoning levels. From the chart, it is evident that 44% of students fall into the *moderate* reasoning category, followed by 32% in the *low* category, and only 24% in the *high* category.

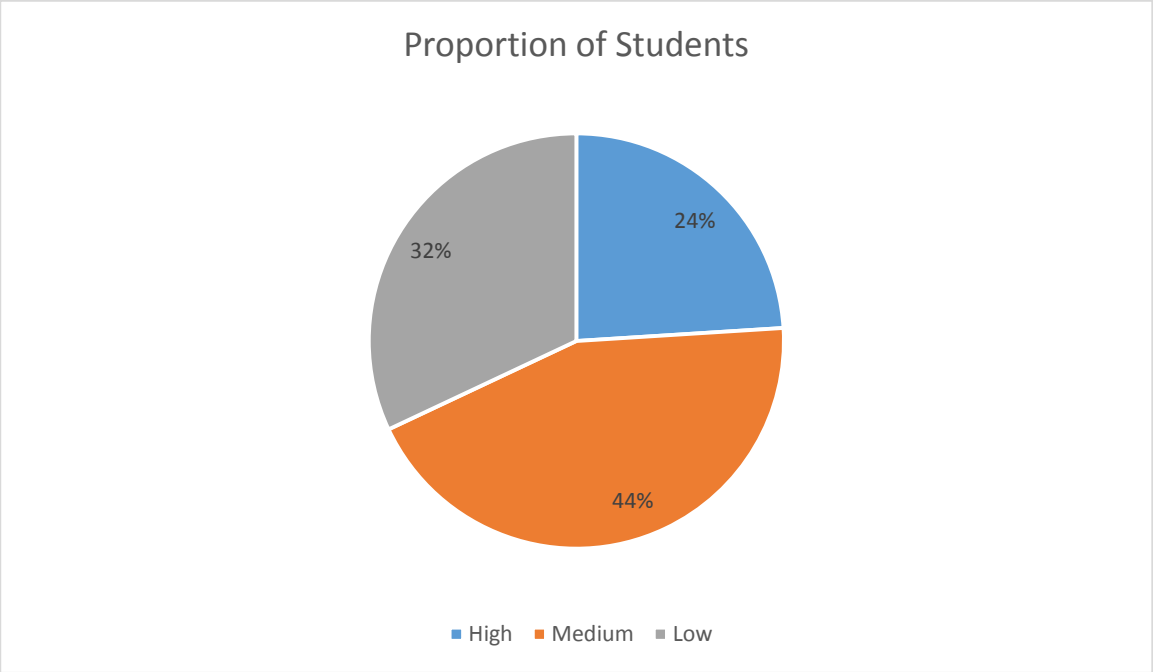


**Figure 2. Proportion of Students' Reasoning Levels**

The results indicate that most students fall into the low and moderate reasoning categories. Only a small proportion demonstrated high reasoning ability, which is characterized by the ability to justify solutions logically, connect concepts, and generalize results. Students in the low category often relied on rote methods and were unable to construct logical arguments.

The findings confirm earlier studies which suggest that students' reasoning ability in algebra remains limited. The dominance of low reasoning aligns with the findings of Lithner (2017), who observed that students tend to adopt imitative reasoning instead of constructing new arguments. Likewise, Sari and Yuliani (2020) showed that pre-service teachers often fail to justify their algebraic solutions comprehensively.

Another contributing factor is the emphasis on procedural fluency rather than conceptual reasoning. Kaput (2017) and Kieran (2018) argued that without sufficient conceptual grounding, students rely heavily on memorized procedures, which restricts their reasoning flexibility. In this study, many students showed difficulties in moving beyond procedural steps when asked to justify or generalize their answers.

Furthermore, the transition from arithmetic to algebraic thinking has been recognized as a significant obstacle (Rahmawati & Surya, 2019). The abstractness of algebraic concepts requires higher cognitive demand, and students often fail to transfer their prior knowledge into abstract reasoning contexts. Morselli (2019) also emphasized that classroom culture and teaching

approaches greatly influence reasoning development, which might explain the variation across students in this study.

Comparatively, Bergqvist (2017) and Cai et al. (2019) highlighted the importance of reasoning as a central mathematical competency. The low reasoning results observed in this study indicate that teaching strategies need to incorporate more opportunities for students to engage in justification, argumentation, and exploration of multiple solutions. These findings align with Ersoy and Öksüz (2020), who showed that reasoning-based tasks improve students' problem-solving and conceptual understanding.

Therefore, it can be concluded that although some students demonstrate high reasoning ability, the majority require targeted instructional support. This conclusion suggests the need for pedagogical interventions such as inquiry-based learning, problem-based learning, and the use of open-ended tasks that encourage reasoning development.

## Conclusion and Suggestions

This study concludes that most students in the Algebra course at Universitas PGRI Pontianak possess low to moderate reasoning ability, with only a few demonstrating high reasoning skills. The difficulties observed include constructing logical arguments, generalizing concepts, and applying algebraic knowledge in novel contexts.

**Suggestions:**

1. Lecturers should integrate reasoning-based tasks in Algebra courses, such as open-ended and non-routine problems.
2. Curriculum design should emphasize reasoning alongside procedural fluency to balance conceptual and operational mastery.
3. Further research is recommended to investigate the impact of specific instructional models (e.g., inquiry-based learning) on improving students' reasoning ability.

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