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Analysis of proportional reasoning ability of students with field independent learning style in solving comparative problems of value and inverse value in class VII of SMP Negeri 1 Botupingge

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Abstract
This study explores junior high school students' proportional reasoning abilities in solving direct and inverse proportion problems based on the field-independent (FI) learning style. A descriptive qualitative and exploratory approach was employed. Data were collected through proportional reasoning tests and semi-structured interviews. The participants were six seventh-grade students from SMP Negeri 1 Botupinge in the 2025/2026 academic year, selected purposively to represent high, medium, and low ability levels, all exhibiting FI learning tendencies. Data analysis focused on three indicators of proportional reasoning: understanding covariation, relative thinking, and conceptual reasoning. The findings reveal that high-ability students demonstrated consistent and well-developed proportional reasoning across most indicators. Medium-ability students were able to apply procedures correctly, but their conceptual understanding remained unstable. Low-ability students showed limited proportional reasoning and relied on mechanical strategies without adequately understanding quantitative relationships. These results indicate that, within a qualitative scope, variations in proportional reasoning ability are evident among students with an FI learning style. This study contributes to mathematics education by providing empirical insights into students' reasoning processes and highlighting the need for structured, conceptually oriented instructional approaches to strengthen proportional reasoning, particularly for students with medium and low abilities.

Keywords: Proportional reasoning, comparison, field independent, student ability, qualitative

1. Introduction

An important factor in educational success is a quality learning process to achieve high-standard and effective education(Pauweni et al., 2022). Quality education is crucial for fostering the

development of intelligent individuals who can compete in the future (Hasan et al., 2023). The benefits of technological developments for human life are very noticeable, one of which is in the field of education (Kobandaha et al., 2022). The advancement of science and technology today is also the result of the role of education and is closely linked to contributions from mathematics, as mathematics is a universal science that underlies modern technological development and plays a significant role in various disciplines while developing human thinking skills (Pauweni & Iskandar, 2021). Mathematics is a fundamental discipline that plays an important role in developing students' logical, analytical, and systematic thinking abilities (Hanifa et al., 2025). The development of science and technology has gradually changed human life, including the way we learn(Damayanti et al., 2023).

Mathematical problems related to daily life help students understand the benefits of learning but often do not have clear solution procedures, requiring reasoning skills (Putra et al., 2020). Reasoning is a crucial aspect of mathematics learning as it relates to the process of drawing logical and analytical conclusions (Taufik et al., 2021). This ability not only supports the acquisition of accurate knowledge but also trains systematic and rational thinking patterns.

One important form of reasoning in mathematics is proportional reasoning, which is the ability to understand and solve situations involving comparisons. This reasoning is essential for higher-level mathematical thinking and is often encountered in daily life, such as calculating map scales, determining price comparisons, or understanding the relationship between speed, distance, and time (Sitokdana et al., 2019). Proportional reasoning also requires understanding the structural similarity between two proportional relationships (Rahman et al., 2023).
Proportional reasoning is one of the essential forms of reasoning that students must develop in mathematics learning. Conceptually, proportional reasoning is difficult to define precisely; however, it generally refers to reasoning related to the concepts of ratio and proportion (Fadilla & Siswono, 2022). Proportional reasoning involves cognitive processes used to draw conclusions based on multiplicative relationships between quantities and develops through several levels, ranging from non-proportional thinking to fully multiplicative reasoning (Putri et al., 2025).

This type of reasoning enables students to understand and solve mathematical problems involving relationships among quantities, distinguishing it from additive-based arithmetic reasoning. Proportional reasoning reflects students' ability to interpret how changes in one quantity affect another within ratio and proportion situations through multiplicative structures (Fuat & Wulan, 2021). Furthermore, proportional reasoning can be viewed as a mental activity that coordinates two interrelated quantities through covariational relationships, both in direct and inverse proportional contexts (Rahaded & Tuasikal, 2025).

Proportional reasoning is a challenging competency for students in understanding direct and inverse proportion concepts in mathematics learning. A preliminary study conducted at SMP Negeri 1 Botupinge through interviews and discussions with mathematics teachers indicates that students' understanding of these topics remains low, as reflected in daily assessment results in

which most students have not met the minimum competency criterion (KKM). Students' difficulties are mainly related to weak conceptual understanding and limited ability to apply proportional relationships logically. These findings are consistent with previous studies reporting that students tend to rely on procedural strategies without adequate understanding of covariation and relative reasoning. Although students' difficulties in proportional reasoning have been widely examined, qualitative studies that specifically investigate this ability in relation to learning styles, particularly the field-independent learning style, remain limited. Therefore, this study aims to qualitatively analyze students' proportional reasoning abilities based on the field-independent learning style using a descriptive approach.One factor influencing this ability is learning style, particularly the field independent (FI) learning style. FI students tend to be analytical, independent, and less influenced by the environment, making them better able to understand concepts and solve problems systematically. Previous research has shown that FI students achieve better learning outcomes compared to field dependent students (Mailili, 2018), indicating that this cognitive style plays a role in proportional reasoning ability.

Proportional reasoning is a fundamental form of mathematical reasoning that plays a crucial role in students' understanding of relationships between quantities. Although proportional reasoning is conceptually difficult to define precisely, it is commonly understood as reasoning related to the concepts of ratio and proportion (Fadilla & Siswono, 2022). This type of reasoning involves cognitive processes used to draw conclusions based on multiplicative relationships and develops through several hierarchical levels, ranging from non-proportional reasoning to fully multiplicative thinking (Putri et al., 2025).

Proportional reasoning enables students to interpret and solve mathematical problems involving quantitative relationships, distinguishing it from additive-based arithmetic reasoning. It reflects students' ability to understand how changes in one quantity affect another within ratio and proportion situations through multiplicative structures (Fuat & Wulan, 2021). Moreover, proportional reasoning can be viewed as a mental activity in which students coordinate two interrelated quantities through covariational relationships, both in direct and inverse proportion contexts (Rahaded & Tuasikal, 2025).

Based on this background, the study titled "**Analysis of proportional reasoning ability of students with field independent learning style in solving comparative problems of value and inverse value in class VII of SMP Negeri 1 Botupingge**" was conducted to describe students' mathematical proportional reasoning ability from the perspective of the FI learning style.

2. Methods

This study employed a descriptive qualitative research design to explore junior high school students' proportional reasoning abilities in solving direct and inverse proportion problems based on the field-independent learning style. Qualitative research was selected to examine the

phenomenon in a natural setting, with the researcher acting as the key instrument (Sugiyono, 2023).

Data were collected using a proportional reasoning test and semi-structured interviews. The test was designed to assess students' understanding of covariation, relative thinking, and conceptual reasoning, while interviews were conducted to explore students' reasoning processes and clarify their written responses. Data analysis was carried out qualitatively through data reduction, data display, and conclusion drawing, guided by established indicators of proportional reasoning. This approach ensured the rigor and trustworthiness of the study.

3. Result and Discussion

Determination of Research Subjects

Table 1.
Categories of Students' Proportional Reasoning Ability Levels After Test Result Analysis

Solving Ability Category	Number Of Students
High	6
Medium	19
Low	5

Based on the analysis of proportional reasoning test results administered to all seventh-grade students, students were categorized into three levels of proportional reasoning ability: high, medium, and low (Table 1). The results show that 6 students were classified as having high ability, 19 students as medium ability, and 5 students as low ability. This categorization served as the basis for selecting research subjects. To ensure the suitability of subjects for qualitative analysis, the researcher consulted the mathematics teacher to obtain additional information regarding students' characteristics, particularly their ability to communicate reasoning processes during interviews. Based on test results and teacher recommendations, six students were purposively selected as research subjects, representing high, medium, and low ability categories and exhibiting a field-independent (FI) learning style (Table 2). This selection aimed to provide rich and meaningful qualitative data.

Table 2.
Research Subjects

No.	Name	Score	Category	Code
1	FSP	70,8	High	PPH1
2	SYK	76	High	PPH2

3	NG	52,8	Medium	PPM1
4	MS	52,8	Medium	PPM2
5	RR	16,7	Low	PPL1
6	RA	13,9	Low	PPL2

Data Triangulation Results

The triangulation of test results and interview data revealed clear differences in students' proportional reasoning abilities, which were closely related to variations in their field-independent (FI) learning characteristics. These differences were observed across three main indicators of proportional reasoning: understanding covariation, relative thinking, and conceptual reasoning in solving direct and inverse proportion problems.

High FI Students (PPH1 and PPH2)

Students classified as having a high FI tendency demonstrated strong and consistent proportional reasoning across all indicators. They were able to correctly identify proportional relationships and construct ratio-based mathematical models logically. In solving direct proportion problems, these students explicitly explained how changes in one quantity affected another in a multiplicative manner, indicating a solid understanding of covariation. Their written responses showed consistency between calculations and explanations, and interview data confirmed that they were aware of the reasoning behind the procedures used.

Although their overall performance was very good, some conceptual explanations were still expressed in general terms, particularly when dealing with inverse proportion contexts. Nevertheless, their ability to isolate relevant information and independently construct proportional models reflects the analytical and systematic characteristics of field-independent learners. These findings are consistent with previous studies suggesting that FI students tend to demonstrate logical, structured, and independent problem-solving behavior.

Medium FI Students (PPM1 and PPM2)

Students in the medium FI group showed proportional reasoning abilities that were predominantly procedural. They were able to perform calculations correctly and apply formulas appropriately; however, their understanding of the underlying proportional relationships was not yet stable. This limitation was evident in their difficulty explaining how changes in one quantity influenced another, especially in inverse proportion problems.

Interview data revealed that these students often focused on completing calculations rather than understanding the meaning of the relationships between quantities. Their reasoning relied heavily on memorized procedures, with minimal use of relative thinking or multiplicative reasoning. This indicates that, although medium FI students possess adequate basic computational skills, their conceptual understanding of proportionality still requires reinforcement.

Low FI Students (PPL1 and PPL2)

Students with a low FI tendency exhibited the most significant difficulties in proportional reasoning. They were unable to identify whether a situation represented a direct or inverse proportional relationship and did not demonstrate understanding of covariation or relative thinking. Their solutions were largely mechanical, consisting of disconnected computational steps without conceptual justification.

In interviews, students struggled to explain their answers and tended to rely on guesswork or memorizing formulas without understanding. This indicates limited cognitive flexibility in interpreting relationships between quantities. These characteristics align with learning style theory, which states that students with low FI tendencies rely more on surface features and external aids than on internal analytical processing.

Table 3.
Summary of Triangulation Results

Subject Group	Covariation Capability	Relative Thinking Ability	Conceptual Reasoning	Kategori Pemahaman	Main Characteristich
PPH1 ((High FI 1)	Good	Good	Fair (sometimes general)	High	Identify The Relationship Precise, able to use more than one strategy
PPH2 (High FI 2)	Very good	Very good	Good (though sometimes general)	High	Modeling Ratio is precise, consistent and logical
PPM1 (mediaum FI 1)	Part	Simply (more procedural)	Weak	Medium	Calculation is correct but does not understand the accept in depth
PPM2 (medium FI 2)	Base	Procedural	Weak	Medium	Can count but does not show propotional thinking
PPL1 (Low FI 1)	Don't Understand	Not visible	There isn't any	Low	Mechanical solution, without understanding ratio or concept
PPL2 (Low FI 2)	Don't Understand	Not visible	There isn't any	Low	Understanding the meaning of the relationship between quantities

Overall, the results indicate that students' proportional reasoning ability increases with the level of their field-independent learning tendency. High FI students demonstrated strong understanding of covariation, effective use of relative thinking, and more developed conceptual reasoning. In contrast, low FI students relied primarily on procedural strategies without conceptual understanding. These findings emphasize the importance of considering learning styles in mathematics instruction, particularly when teaching concepts that require proportional reasoning

4. Conclusion

This study examined junior high school students' proportional reasoning in solving direct and inverse proportion problems from a field-independent learning style perspective. The findings reveal clear differences across high, medium, and low ability categories based on three indicators: covariation, relative thinking, and conceptual justification.

High-ability students demonstrated consistent and well-developed proportional reasoning, supported by analytical and independent thinking characteristics. Medium-ability students showed correct but predominantly procedural reasoning, with limited conceptual understanding. In contrast, low-ability students experienced substantial difficulties across all indicators, indicating an absence of proportional thinking.

Overall, the results directly address the research objective by providing a descriptive profile of variations in students' proportional reasoning based on ability level within a field-independent learning context.

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