# Analysis of Mathematical Proportional Reasoning Ability Based on Field Dependent and Field Independent Cognitive Style

**A Taufik[1], N Nurhayati[2], A T Prayitno[3], B Tresnawati[4], R Syafari[5]**

[12345]Departemen Mathematics Education, Universitas Kuningan, West Java, Indonesia;

{[1]azin.taufik@uniku.ac.id, [2]nunu.nurhayati@uniku.ac.id, [3]anggar.titis.prayitno@uniku.ac.id, [4]belatresnawati@gmail.com, [5]rahayu.syafari@uniku.ac.id}

**Abstract.** This study aims to describe the results and the analysis of students' mathematical proportional reasoning abilities in terms of field dependent and field independent learning styles. This research was conducted in class VII A MTs Nurul Huda Beringin in September Odd Semester Academic Year 2020/2021 with a total of 9 students. The research subjects were selected by purposive sampling as many as 4 students, namely 2 students who had a field dependent cognitive style and 2 students who had a field independent cognitive style. The research method used descriptive qualitative with a case study research design. The data collection used the Group Embedded Figures Test, mathematical proportional reasoning ability test, in-depth interviews and observation. The data analysis is done by reducing the data, presenting the data, and drawing conclusions. The technique of checking the validity of the data used the technique triangulation method. The results showed that: (1) There were 7 students who had a field dependent cognitive style and 2 students who had a field dependent cognitive style; (2) Students with a field dependent cognitive style, namely the WL and IS subject are at level 0 non-proportional reasoning, both subjects have been able to meet the indicators of finding values or quantities to compare, however it has not met the indicators to find a relationship between value or quantity, and use appropriate procedures in calculating comparisons. Students with the independent field cognitive style, namely the LH and DK subjects are at level 3 formal proportional reasoning, both subjects have been able to meet the indicators of finding values or quantities to compare, find the relationship between values or quantities, and use appropriate procedures in calculating comparisons

**Keywords:** Mathematical; Cognitive; MTs Nurul Huda

## 1 Introduction

Reasoning is one of the abilities that plays an important role in learning mathematics. Reasoning is an important element in the mathematics learning process [1]. Reasoning has an important role in mathematics because it serves as the foundation for other standard processes [2]. Reasoning and mathematics are two things that cannot be separated from each other because solving mathematical problems requires reasoning, while reasoning skills can be trained by studying mathematics. Mueller and Maher stated generally, researchers concur that reasoning and proof form the foundation of mathematical understanding and that learning to reason and justify is crucial for growth in mathematical knowledge [3]. Reasoning as a thought process in drawing conclusions in the form of precise knowledge and this thought

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process has certain characteristics, namely the existence of a pattern in logical thinking and an analytical thinking process [4]. The ability of reasoning in mathematics learning is very diverse, one of which is proportional reasoning ability.

Proportional reasoning is very important and needs to be mastered by students, so that students are able to solve math problems from elementary and advanced levels [5]. Proportional reasoning is a basic thing for students that must be understood in developing a wide variety of topics such as fractions, decimals, percentages, scales, ratios and proportions [6]. The results showed that the students of class IX Junior High School in West Bandung, there are no students who have been able to achieve the indicator of students' mathematical proportional reasoning ability in performing mathematical manipulation of solving problems in triangular and rectangular [7]. While [8] the results of research on class VII students in one city of Jambi showed that students with auditory learning styles in general have not qualify the indicators of students' mathematical proportional reasoning abilities and have not used their proportional reasoning abilities in solving story problems, especially in worth comparison material. Proportional reasoning is a mental activity or knowledge that can understand the relation of change (comparison) of one quantity to another through a multiplicative relationship.

Students' errors in completing the proportional reasoning test sheet are in the form of conceptual errors namely not using the concept of comparison in solving problems, and procedural errors namely not using proper and systematic procedures in accordance with the concept of comparison in students' mathematical proportional reasoning abilities. Another thing that is a factor of this error is the difficulty in understanding the definition, representing a mathematical model, and understanding the basic concepts of the problem [9], [10]. The results of preliminary studies and observations that have been carried out at MTs Nurul Huda Beringin through interviews and discussions with mathematics teacher that the students' mathematical proportional reasoning ability is still low, this is indicated by the score on daily tests which is still below the Minimum Completeness Criteria (KKM) and the average of students still have difficulty manipulating algebra that contains variables.

Junior high school students should have the mathematical proportional reasoning ability well as a prerequisite for understanding the next mathematical material. But in reality, many students do not yet have knowledge of mathematical proportional reasoning skills in solving a problem because in essence students have different abilities in processing the information obtained. [11], [12] states that it refers to someone in understanding, recording, thinking, and using information to understand a task or various types of environmental situations according to their experiences. These differences are known as cognitive styles.

Cognitive styles are ways of receiving a different impulse or stimulation and thinking about learning [13]. Cognitive style can be defined as a person's unique way of receiving, remembering, thinking and responding to information received [14]. This was also confirmed by [15] defined cognitive style as the relatively stable strategies, preferences and attitudes that determine an individual’s typical modes of perceiving, remembering and problem solving. Cognitive styles are very diverse, but cognitive styles that are suitable to be applied in research that involve thinking processes in solving mathematical problems are field dependent (FD) and field independent (FI) cognitive styles.

The filed dependent cognitive style (FD) usually tends to understand a problem it gets globally, and it is difficult to free oneself from the surrounding environment or is more influenced by the environment [4]. While the independent field cognitive style (FI) usually tends to think more analytically in understanding a problem it gets and is not easily influenced by the surrounding environment. In the teaching and learning process that the condition of

students' knowledge is very influential on learning success, so in this study, it discusses more deeply about the field dependent (FD) and field independent (FI) cognitive styles. Because in general the cognitive style is needed by students in solving a problem in mathematics learning.

The research conducted aims to analyze students' mathematical proportional reasoning abilities in terms of field dependent (FD) and field independent (FI) cognitive styles in mathematics learning with worth comparison material so that the teacher can compile a mathematics learning plan and provide treatment to students in accordance with their cognitive style in improving students' mathematical reasoning abilities.

## 2 Method

This research uses qualitative research with a case study research design. Case study is research that examines contemporary phenomena as a whole and comprehensively in actual situations or conditions [16]. The research method used is descriptive qualitative and aims to analyze students' mathematical proportional reasoning abilities in terms of the field dependent (FD) and field independent (FI) cognitive styles in mathematics learning. The research was conducted at MTs Nurul Huda Beringin in September the odd semester of the 2020/2021 school year. The subjects in the study were 9 students of class VII A. Sampling in this study using purposive sampling technique by taking 4 students, namely 2 students who have a field dependent cognitive style and 2 students have an independent field cognitive style. Data collection techniques using Group Embedded Figures Test, mathematical proportional reasoning ability test, in-depth interviews and observations.

The data analysis technique in this study used data analysis techniques according to the Miles and Huberman Model, namely data collection, data reduction, data presentation and conclusion drawing [17]. Test the validity of the data using the triangulation technique, [18] technique triangulation or method triangulation is an attempt to check the validity of the data, or to check the validity of the research findings, method triangulation can be done by using more than one data collection technique to get the same data.

## 3 Result and Discussion

Based on the results of the Group Embedded Figures Test to 9 students of class VII A, the results showed that there were 7 students who had a field dependent cognitive style and 2 other students had a field independent cognitive style. The results of the Group Embedded Figures Test scores are presented in the following table.

**Table 1.** Field Dependent and Field Independent Cognitive Style Classification

| No | Name | Score | Cognitive Style |
|---|---|---|---|
| 1 | DK | 14 | Field Independent |
| 2 | LH | 11 | Field Independent |
| 3 | PM | 7 | Field Dependent |
| 4 | WL | 6 | Field Dependent |
| 5 | ANR | 6 | Field Dependent |
| 6 | NR | 6 | Field Dependent |

| | | | |
|---|---|---|---|
| 7 | FH | 6 | Field Dependent |
| 8 | IS | 8 | Field Dependent |
| 9 | AL | 4 | Field Dependent |

Furthermore, to describe students' mathematical proportional reasoning abilities in solving math problems based on field dependent and field independent cognitive style, a proportional reasoning ability test was conducted. The following shows the results of the students' proportional reasoning ability test.

**Table 2.** Qualification of Students' Mathematical Reasoning Ability

| No | Name | Cognitive Style | Test Score | Mean |
|---|---|---|---|---|
| 1 | DK | Field Independent | 100 | 95 |
| 2 | LH | Field Independent | 90 | |
| 3 | PM | Field Dependent | 30 | |
| 4 | WL | Field Dependent | 50 | |
| 5 | ANR | Field Dependent | 40 | |
| 6 | NR | Field Dependent | 40 | 47,14 |
| 7 | FH | Field Dependent | 40 | |
| 8 | IS | Field Dependent | 50 | |
| 9 | AL | Field Dependent | 40 | |

Based on the mathematical proportional reasoning ability test, it was found that students with a field dependent cognitive style had an average of 47.14 while students with an independent field cognitive style had an average of 95. Based on the consideration of the results of the Group Embedded Figures Test and the results of the mathematical proportional reasoning ability test then the interview subjects were selected, including 2 students who have an independent cognitive style field namely the subject of LH and DK, and 2 students who have a field dependent cognitive style namely the subject of WL and IS. After that conducted interviews and observations to 4 subjects.

Researchers analyzed the results of tests of proportional reasoning abilities, interviews and observations, it was concluded that the LH and DK subjects were at level 3 formal proportional reasoning. LH subjects have been able to meet the indicators of finding values or quantities to compare, finds a relationship between values or quantities, and use appropriate procedures in calculating comparisons. Students who have a field independent cognitive style are at level 3 of formal proportional reasoning. This is in line with the opinion [19] which states that one of the characteristics of proportional thinkers is having an understanding of covariation, namely studying the understanding of the relationship between two quantities that have the same variation and the suitability between the two variations of the variable can be seen. In the process of solving problems, the LH and DK subjects have been able to state propositions in variables and solve them by cross multiplication, because at level 3 formal proportional reasoning students can use variables in propositions and can use cross multiplication solving or fraction equality [20]. Based on the opinion of [21] the correct results in solving proportional problems, one of which is by using operator and equation strategies.

Students with a field independent cognitive style have good analytical skills so they can solve proportional reasoning problems well, this agrees [22] that individuals with field independent cognitive style tend to be more analytical in a problem or material received. One of the characteristics of the field independent cognitive style is that it has a tendency to prefer mathematics and natural science subjects [23]. Another opinion [24] states that students with a

field independent cognitive style find it easier to reduce things that are difficult or complex, and easier to solve science problems, like understanding science and mathematics.

While the subjects of WL and IS are at level 0 of non-proportional reasoning, the subject of WL has been able to qualify the indicators of finding values or quantities to be compared but has not qualified the indicators of finding a relationship between values or quantities and indicators using the right procedures in calculating comparisons. On indicators find the relationship between values or quantities and use procedures, both subjects are using the wrong strategy. This is in line with the opinion [20] which states that level 0 non-proportional reasoning has the characteristic of not being able to recognize multiplication relationships, using the wrong operating numbers and strategies, and can't connect the two sizes.

This is in accordance with the characteristics of the field dependent cognitive style that is not liking mathematics [23]. Students who have a field dependent cognitive style are stronger in remembering information their get in social science, such as in interpersonal interactions with lessons, students with a field dependent cognitive style find it easier to understand material related to history, literature, language and social science [24].

The errors of the WL and IS subjects in solving proportional reasoning test questions included conceptual errors, procedural errors, and transformation errors. This is in line with the opinion [8] which states that students' mistakes in completing the proportional reasoning test sheet are in the form of conceptual errors, namely the not using the concept of comparison in solving problems to support their proportional reasoning, and procedural errors, namely the not using proper and systematic procedures in accordance with the concept of comparison in using students' mathematical proportional reasoning abilities.

The most dominant types of errors made by students are comprehension errors and transformation errors [25]–[28]. The researcher gave scaffolding to the WL and IS subjects in order to help both subjects solve proportional reasoning problems. Both subjects require complete and detailed instructions, this is the same as the opinion [23] which states that the field dependent cognitive style requires more instructions to learn something. Basically, the provision of scaffolding in learning needs to be prepared in a structured manner, so that when students experience problems, the teacher can handle them well [29].

## 4 Conclusion

Based on the results of research and discussion, it can be concluded that:

1. The types of cognitive style of the 9 students at MTs Nurul Huda Beringin were 7 students who had a field dependent cognitive style and 2 students had a field independent cognitive style.
2. Students with a field dependent cognitive style, namely the subject of WL and IS are at level 0 non-proportional reasoning, both subjects have been able to qualify the indicators of finding values or quantities to compare but have not qualified the indicators of finding a relationship between values or quantities, and using appropriate procedures in compute comparisons. Students with field independent cognitive style, namely the LH and DK subjects are at level 3 formal proportional reasoning, the two subjects have been able to qualify the indicators of finding values or quantities to compare, finding relationships between values or quantities, and using appropriate procedures in calculating comparisons.

## References


[1] A. Afandi, "Profil Penalaran Deduktif Siswa Smp Dalam Menyelesaikan Masalah Geometri Berdasarkan Perbedaan Gender," APOTEMA J. Progr. Stud. Pendidik. Mat., 2016, doi: 10.31597/ja.v2i1.123.

[2] D. R. Kusumawardani, "Pentingnya Penalaran Matematika dalam Meningkatkan Kemampuan Literasi Matematika," vol. 1, pp. 588–595, 2018.

[3] M. Mueller and C. Maher, "Learning to reason in an informal math after-school program," Math. Educ. Res. J., 2009, doi: 10.1007/BF03217551.

[4] A. D. Susandi and S. Widyawati, "Proses Berpikir dalam Memecahkan Masalah Logika Matematika Ditinjau dari Gaya Kognitif Field Independent dan Field Dependent," Numer. (Jurnal Mat. dan Pendidik. Mat., 2017, doi: 10.25217/numerical.v1i1.122.

[5] D. N. Sari and H. L. Mampouw, "Analisis Kemampuan Penalaran Proporsional Siswa Sma Dalam Memecahkan Masalah Matematika," J. Pendidik. Mat., vol. 5, no. 2, pp. 110–122, 2019.

[6] S. Dole, "Ratio Tables to promote Propotional Reasoning," vol. 13, no. 2, pp. 18–23, 2008.

[7] T. R. Suprihatin, R. Maya, and E. Senjayawati, "Jurnal Kajian Pembelajaran Matematika," J. Kaji. Pembelajaran Mat., vol. 2, no. 1, p. 10, 2018, [Online]. Available: http://journal2.um.ac.id/index.php/jkpm.

[8] I. P. Sari and Sufri, "Analisis Penalaran Proporsional Siswa dengan Gaya Belajar Auditori dalam Menyelesaikan Soal Perbandingan Pada Siswa SMP Kelas VII," Edumatica, vol. 04, no. 02, pp. 48–55, 2014.

[9] M. Riyadi, N. Nurhayati, N. Adiastuty, and H. H. Anwar, "Penggunaan Buku Teks Matematika: Studi Kasus Mahasiswa Pendidikan Matematika Universitas Kuningan," JES-MAT (Jurnal Edukasi dan Sains Mat., 2017, doi: 10.25134/jes-mat.v3i1.470.

[10] S. Sumarni and A. T. Prayitno, "Kemampuan Visual-Spatial Thinking Dalam Geometri Ruang Mahasiswa Universitas Kuningan," JES-MAT (Jurnal Edukasi dan Sains Mat., 2016, doi: 10.25134/jes-mat.v2i2.349.

[11] E. Brown, T. Brailsford, T. Fisher, A. Moore, and H. Ashman, "Reappraising Cognitive Styles in Adaptive Web Applications," 2006.

[12] M. Kozhevnikov, "Cognitive Styles in the Context of Modern Psychology: Toward an Integrated Framework of Cognitive Style," Psychol. Bull., vol. 133, no. 3, pp. 464–481, 2007, doi: 10.1037/0033-2909.133.3.464.

[13] L. Vendiagrys and I. Junaedi, "Analisis Kemampuan Pemecahan Masalah Matematika Soal Setipe Timss Berdasarkan Gaya Kognitif Siswa Pada Pembelajaran Model Problem Based Learning," Unnes J. Res. Math. Educ., vol. 4, no. 1, pp. 34–41, 2015.

[14] K. Indriana and A. Shodiqin, "Analisis Kemampuan Metakognitif Calon Guru Matematika Dalam Kognitif Impulsif Berjenis Kelamin Perempuan," pp. 238–243, 2017.

[15] R. T. Pithers, "Cognitive learning style: A review of the field dependent-field independent approach," J. Vocat. Educ. Train., vol. 54, no. 1, p. 132, 2002, doi: 10.1080/13636820200200191.

[16] I. Gunawan, Metode penelitian kualitatif. Jakarta: Bumi Aksara, 2013.

[17] Sugiyono, Metode Penelitian Kuantitatif, Kualitatif dan R&D. Bandung: Bandung: Alfabeta, 2016.

[18] B. S. Bachri, "Meyakinkan Validitas Data Melalui Triangulasi Pada Penelitian Kualitatif," Teknol. Pendidik., 2010.

[19] T. N. Irawati, "Mengembangkan kemampuan guru matematika dalam membuat soal penalaran proporsional siswa SMP," in Seminar Nasional Matematika dan Pendidikan Matematika, 2015.

[20] C. W. Langrall and J. Swafford, "Three Balloons for Two Dollars: Developing Proportional Reasoning," Math. Teach. Middle Sch., vol. 6, 2000.

[21] R. Johar, S. Yusniarti, and Saminan, "The analysis of proportional reasoning problem in the Indonesian mathematics textbook for the junior high school," J. Math. Educ., 2018, doi: 10.22342/jme.9.1.4145.55-68.

[22] D. A. Ngilawajan, "Proses Berpikir Siswa SMA dalam Memecahkan Masalah Matematika Materi Turunan Ditinjau Dari Gaya Kognitif Field Independent dan Field Dependent," Pedagog. J. Pendidik., 2013, doi: 10.21070/pedagogia.v2i1.48.

[23] S. Nasution, Berbagai Pendekatan dalam Proses Belajar dan Mengajar. Jakarta: Bumi Aksara, 2008.
[24] W. H Mailili, "Deskripsi Hasil Belajar Matematika Siswa Gaya Kognitif Field Independent dan Field Dependent," ANARGYA J. Ilm. Pendidik. Mat., 2018, doi: 10.24176/anargya.v1i1.2371.
[25] A. T. Prayitno, "Proses Berpikir Mahasiswa Dalam Membuat Koneksi Matematis Pada Soal Pemecahan Masalah," JES-MAT (Jurnal Edukasi dan Sains Mat., vol. 4, no. 1, p. 67, 2018, doi: 10.25134/jes-mat.v4i1.913.
[26] Y. M. Sari and E. Valentino, "An Analysis of Students Error In Solving PISA 2012 And Its Scaffolding," JRAMathEdu (Journal Res. Adv. Math. Educ., 2017, doi: 10.23917/jramathedu.v1i2.3380.
[27] A. Taufik, "Diagnosis Kesulitan Mahasiswa Di Universitas Kuningan Dalam Pembuktian Menggunakan Induksi Matematika Beserta Upaya Mengatasinya Menggunakan Scaffolding," JES-MAT (Jurnal Edukasi dan Sains Mat., vol. 2, no. 1, pp. 41–54, 2016, doi: 10.25134/jes-mat.v2i1.280.
[28] R. Zulkarnaen, "Kesalahan Siswa dalam Menyelesaikan Soal Penalaran Proposional," in Seminar Matematika dan Pendidikan Matematika UNY, 2018, vol. 6, pp. 49–54.
[29] A. Taufik and N. Adiastuty, "Penerapan Pembelajaran Matematika Yang Melibatkan Kecerdasan Majemuk Dengan Pendekatan Saintifik," JES-MAT (Jurnal Edukasi dan Sains Mat., vol. 3, no. 1, p. 45, 2017, doi: 10.25134/jes-mat.v3i1.469.