

ANALYSIS OF STUDENTS' DIFFICULTIES IN SOLVING PROPORTIONAL COMPARISON PROBLEMS

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ARTICLE INFO

Article history

Received: 2024-05-15

Revised: 2024-06-13

Accepted: 2024-06-25

Keywords

Students' difficulties, teaching methods, proportional comparison, mathematics education.

ABSTRACT

This study aims to analyze the difficulties students face in solving problems related to proportional comparison. This study employs a case study method based on the errors made by students in solving problems related to proportional comparison. Four students were selected as a theoretical sample from a group of 34 seventh-grade students at the junior high school in Tasikmalaya. These students were chosen due to their complex levels of errors, which included procedural errors, incomplete solutions, and mistakes in determining mathematical formulas. The results of the study indicate that students experience difficulties in solving proportional comparison problems, including: (1) difficulty in understanding mathematical language, (2) difficulty in understanding word problems, (3) the influence of mathematics anxiety, and (4) differences in learning styles. Interviews and classroom observations revealed that factors such as less varied teaching methods, a lack of contextual practice, and low learning motivation contribute to the difficulties experienced by students. The discussion of the research results emphasizes the importance of more interactive and contextual teaching approaches to enhance students' understanding of the concept of proportional comparison. The implications of this study highlight the need for the development of more innovative teaching materials and the use of educational technology to help students overcome these difficulties.

Penelitian ini bertujuan untuk menganalisis kesulitan peserta didik dalam menyelesaikan masalah perbandingan senilai. Penelitian ini menggunakan metode studi kasus yang bermula dari kesalahan yang dilakukan peserta didik dalam menyelesaikan masalah perbandingan senilai. Empat orang peserta didik dijadikan sebagai sampel teoretis dari 34 orang peserta didik kelas VII di SMP Negeri di Tasikmalaya, dengan tingkat kesalahan yang paling kompleks, mencakup: kesalahan dalam prosedur, penyelesaian yang tidak lengkap, dan kesalahan dari menentukan rumus matematika. Pengumpulan data dalam penelitian dilakukan dengan cara: tes tertulis, wawancara mendalam, dan observasi kelas. Instrumen yang digunakan dalam penelitian, meliputi: seperangkat soal tes matematika, kisi-kisi wawancara, serta lembar observasi. Analisis data dilakukan dengan teknik analisis tematik untuk mengidentifikasi tema-tema utama terkait kesulitan peserta didik. Hasil penelitian menunjukkan bahwa peserta didik mengalami kesulitan dalam menyelesaikan masalah perbandingan senilai, meliputi: (1) kesulitan memahami bahasa matematis, (2) kesulitan memahami soal cerita, (3) pengaruh kecemasan matematika, dan (4) perbedaan gaya belajar. Wawancara dan observasi kelas

mengungkapkan bahwa faktor-faktor seperti metode pengajaran yang kurang variatif, kurangnya latihan yang kontekstual, dan motivasi belajar yang rendah turut berkontribusi terhadap kesulitan yang dialami peserta didik. Diskusi hasil penelitian menekankan pentingnya pendekatan pengajaran yang lebih interaktif dan kontekstual untuk meningkatkan pemahaman peserta didik terhadap konsep perbandingan senilai. Implikasi dari penelitian ini menunjukkan perlunya pengembangan materi ajar yang lebih inovatif dan penggunaan teknologi pendidikan untuk membantu peserta didik dalam mengatasi kesulitan tersebut.

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How to Cite:

Tito, A. S. P., Muhtadi, D., Sukirwan, & Suhaya (2024). Analysis of Students' Difficulties in Solving Proportional Comparison Problems. *Journal of Authentic Research on Mathematics Education*, 6(2), 145-155. <https://doi.org/10.37058/jarme.v6i2.11498>

1. INTRODUCTION

Proportional comparison is one of the essential topics in mathematics education at the junior high school level (Davis, 2022). Understanding the concept of proportional comparison is crucial in mathematics learning because it not only supports advanced mathematical understanding but also has relevance to everyday applications and various disciplines, such as physics, economics, and social sciences (Fitriyani et al., 2023). The concept of proportional comparison is often used in practical situations, such as calculating proportions in cooking recipes, analyzing statistical data in scientific research, and so forth.

However, several studies indicate that many students experience difficulties in understanding and applying the concept of proportional comparison (Ali et al., 2021; Castillo & Fernández, 2022; Riaddin, 2022; Zubaidi & Velusamy, 2024). According to Zubaidi & Velusamy (2024), students often struggle due to a lack of understanding, difficulties in applying mathematical formulas, and limitations in identifying problems within relevant contexts. Additionally, teaching methods that lack variety and contextualization, as well as low learning motivation, also contribute to students' difficulties in understanding the concept of proportional comparison (Ali et al., 2021; Riaddin, 2022).

Castillo & Fernández (2022) revealed that the main difficulty experienced by students is the lack of understanding of the basic concept of proportional comparison, where students often do not comprehend comparisons involving two or more quantities that change proportionally. Students are often confused about how to write the comparison in fractional form, which should be the numerator and which should be the denominator (Azhar et al., 2021; Burr et al., 2022). This confusion extends to formulating the solution for the comparison in equivalent fractional form. Another common error is the use of basic mathematical operations involving multiplication and division. According to Legarde (2022), students' ability in basic mathematical operations, such as

multiplication and division, greatly influences their understanding of proportional comparison. Students who are weak in these basic operations tend to experience greater difficulty in understanding the concept.

Silva & Santos (2020) identified the important role of relating the concept of proportional comparison to context. Context encompasses phenomena that are easily understood by students because they relate to the students' immediate world. Context serves as a starting point for learning, guiding students to connect the real world with their knowledge. According to Hidayat et al. (2020), context has proven to be more successful in enhancing students' understanding and interest in learning.

This study aims to analyze the difficulties faced by students in solving proportional comparison problems. The research results are expected to make a significant contribution to the development of more effective and efficient teaching methods to enhance students' understanding of the concept of proportional comparison. Therefore, research that analyzes and addresses difficulties related to the understanding of proportional comparison is crucial to creating an effective learning environment and supporting optimal mathematical development for students.

2. METHODS

This study employs a case study method by analyzing the difficulties experienced by students originating from their mistakes in solving proportion problems. The research procedure includes three main steps: (1) administering a written test to identify the students' level of understanding, (2) conducting in-depth interviews with selected students based on test results to gain deeper insights into the difficulties they faced, and (3) classroom observation to monitor the dynamics of learning and the interactions between teachers and students. Data analysis was carried out using thematic analysis techniques, where data from written tests, interviews, and observations were qualitatively analyzed to identify key themes related to student difficulties. The analysis results were then systematically organized to provide a comprehensive picture of the factors contributing to students' difficulties in understanding and applying the concept of proportion. Through this approach, the study aims to provide a better understanding of the challenges faced by students and offer recommendations for more effective learning strategies.

2.1. Research Subject

The research sample consists of 34 eighth-grade students from a public junior high school in Tasikmalaya who made errors in solving proportion problems.

2.2. Data Collection

Data collection was conducted through written tests to measure the understanding of the proportion concept, in-depth interviews to explore the difficulties experienced by the students, and classroom observations to observe the learning process.

2.3. Data Analysis

Data analysis was carried out using thematic analysis techniques, where data from written tests, interviews, and observations were qualitatively analyzed to identify key themes related to student difficulties. The analysis results were then systematically organized to provide a comprehensive picture of the factors contributing to students' difficulties in understanding and applying the concept of proportion. Through this approach, the study aims to provide a better understanding of the challenges faced by students and offer recommendations for more effective learning strategies.

3. RESULTS AND DISCUSSION

3.1. Results

The results of this study indicate that students experience various difficulties in solving proportional comparison problems. These difficulties can be categorized into four main aspects: (1) difficulty in understanding mathematical language, (2) difficulty in comprehending word problems, (3) the influence of mathematics anxiety, and (4) differences in learning styles.

Difficulty understanding mathematical language

The first difficulty experienced by students is understanding mathematical language. Some students make mistakes in writing the ratio of known numbers to the numbers being sought. As a result, students cannot arrive at the correct answer. These errors can be seen in Figure 1 below.

The image shows a student's handwritten work on a blue background. It includes the following calculations:

$$\bullet \frac{75}{100} \times 500 = \frac{37500}{100} = 375\%$$

The student has written the fraction $\frac{75}{100}$ and multiplied it by 500. The result is written as $\frac{37500}{100}$, which is then simplified to 375% . There are some additional scribbles and a double underline under the final answer.

Figure 1. The Answers of Students Experiencing Difficulty Understanding Mathematical Language

To examine the causes of errors made by students, the following is a transcript of the interview between the researcher and participant S1.

Dialog 1

-
- Researcher : "Do you find it difficult to understand the terms in the problem?"
- S1 : "Yes, Madam. I find it difficult to understand those terms."
- Researcher : "Which part do you find difficult?"
- S1 : "I often get confused about how to write the answer in the form of a fraction or equation. Additionally, the explanations in the book are sometimes too complicated and use many terms that I don't understand."
-

From the results of answers, it was found that students experience difficulties in understanding mathematical language related to the topic of proportional comparison. They often feel confused because the terms and notations used seem unfamiliar to them. Additionally, students also have difficulty interpreting the concept of proportional comparison expressed in the form of fractions or equations (Ramadianti et al., 2019). For example, the concept "if $\frac{a}{b} = \frac{c}{d}$, then $a \times d = b \times c$ ". This concept is difficult for students to understand if explained textually without adequate visualization or illustration. Furthermore, explanations in textbooks that use many technical terms can exacerbate students' confusion (Munasinghe et al., 2021). These factors can hinder students' understanding and make it difficult for them to apply the concept of proportional comparison in various mathematical contexts.

Difficulty understanding the context of word

Another common difficulty faced by students is in understanding the context of word problems. Many students feel confused when they have to translate situations in stories into relevant mathematical equations. Some students often make mistakes in interpreting information and writing incorrect equations. Such errors result in their inability to find the correct solution to the problem. These errors can be seen in Figure 2 below.

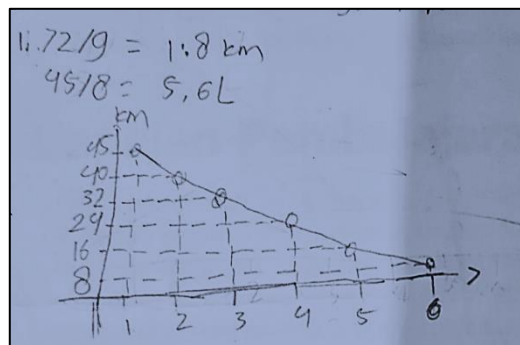


Figure 2. The Answers of Students Experiencing Difficulty Understanding the context of word

To examine the causes of errors made by students, the following is a transcript of the interview between the researcher and participant S2.

Dialog 2

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 Researcher : "How about this number?" [The researcher pointed to question number 2]
 "Hmm... I'm confused, Madam. I often get confused with word problems."
 S2 : "What difficulties do you experience?"
 "When reading word problems, I often get confused about which
 Researcher : information is important and don't know how to convert it into a
 S2 : proportional comparison. Sometimes I also have trouble understanding
 the meaning of the word problems."

From the results of answers and interviews, students experience difficulties in understanding word problems in the topic of proportional comparison, often caused by students' inability to identify important information and translate that information into appropriate mathematical forms. Students feel confused by the context of the story and struggle to determine the steps needed to solve the problem (Herman et al., 2022; Alam et al., 2020). In problems involving comparisons of prices and quantities of items, students do not know how to start or formulate the correct equations from the given information (Pascual, 2022). These difficulties are exacerbated by a lack of understanding of keywords and terminology used in word problems. Therefore, students require guidance in deciphering word problems, identifying key information, and systematically devising problem-solving steps.

Influence of Mathematics Anxiety

The difficulty commonly experienced by students is due to the influence of mathematics anxiety. Some students feel anxious when faced with mathematics problems, which leads to their inability to concentrate properly and make mistakes. Because of excessive anxiety, the answers obtained by students are incorrect, and they cannot solve the problems correctly. The impact of this anxiety can be seen in Figure 3 below.

The image shows a student's handwritten work on a piece of paper. At the top, there is a proportional comparison: $\frac{9}{x} = \frac{72}{45}$. A large 'X' is drawn over this equation. Below it, the student has written the equation $72x = 405$. Then, they have written $x = \frac{405}{72}$. Finally, they have written the result $x = 5,625$.

Figure 3. The Answers of Students with Errors Due to Mathematics Anxiety Influence

To examine the causes of errors made by students, the following is a transcript of the interview between the researcher and participant S3.

Dialog 3

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Researcher : *"What about question number three, S3?"*

S3 : *"I'm afraid the answer is wrong, Madam."*

Researcher : *"Why do you feel afraid?"*

S3 : *"I'm often afraid of getting the answer wrong and not understanding the concepts explained in class. I also have trouble concentrating and often make mistakes when setting up comparisons or creating equations."*

.....

From the results of students' responses and interviews, mathematics anxiety can significantly impact students' understanding of the proportional comparison material. When students feel anxious, they tend to have difficulty concentrating, resulting in errors

in constructing comparisons or creating equations (Klados et al., 2019). Fear of making mistakes and worries about not being able to understand the concept well can exacerbate anxiety, causing students to panic when faced with difficult problems (Permatasari & Prasetyawati, 2023). This inhibits their ability to think clearly and systematically, thus affecting their performance in mathematics. Therefore, it is important for students to receive appropriate guidance and support from teachers to improve their confidence and understanding (Rauf & Malik, 2022).

Learning Style Differences

Another difficulty experienced by students is differences in learning styles. Some students find it easier to understand material through visualization, while others are better with verbal explanations or hands-on practice. This can result in students being unable to follow lessons well and making mistakes in solving problems. These errors can be seen in Figure 4 below.

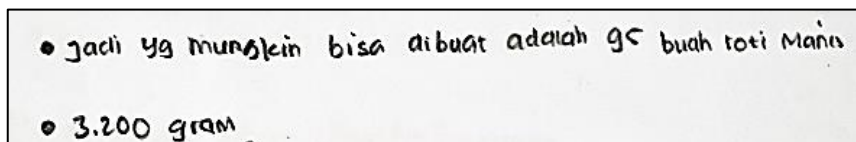


Figure 4. The Answers of Students with Errors Due to Differences in Learning Styles

To examine the causes of errors made by students, the following is a transcript of the interview between the researcher and participant S4.

Dialog 4

.....
 Researcher : *"Do you have any difficulties, S4?"*
 "Yes, Madam. I find it hard to understand when learning in class because
 S4 : *it doesn't match my learning style, so I don't understand the material*
 being taught."
 Researcher : *"Can you explain further the difficulties you experience?"*
 S4 : *"I understand better when learning through videos or pictures. But in*
 class, the material is only explained verbally or through writing on the
 blackboard, Madam."

From the results of students' responses and interviews, it can be seen that students' difficulties in understanding proportional comparison material are often caused by differences in learning styles between students and the teaching methods used in the classroom. Students with a visual learning style may struggle if the material is presented only orally or through writing without the aid of visualizations such as diagrams or graphs (Skulmowski, 2023). They need visual representations to understand the concepts of ratio and proportion more clearly. Additionally, the lack of detailed example problems can make it difficult for students to follow the steps of problem-solving. Therefore, Abulhul (2021) mentions that it is important to use various teaching methods

that can accommodate different learning styles so that students can understand the material better and more effectively.

3.2. Discussion

From the research findings, it is important to emphasize the application of more interactive and contextual teaching approaches to improve students' understanding of the concept of proportional comparison. This study shows that traditional teaching methods, which are often less varied and not contextual, have proven ineffective in helping students develop a deep and practical understanding of complex mathematical concepts (Hussein & Csikos, 2023; Zeljić *et al.*, 2023).

Interactive teaching approaches involve students actively in the learning process, so they do not only become passive recipients of information but also participate in discussions, experiments, and problem-solving. This allows students to construct knowledge more meaningfully through direct experience and reflection on that experience (Gijsbers *et al.*, 2020). For example, the use of educational technology such as interactive learning software and simulations can enhance student engagement and help them understand the relationships between quantities better, as well as apply the concept of proportional comparison in various practical situations (Misra, 2021; Roulston *et al.*, 2019).

Furthermore, contextual teaching approaches emphasize the relevance of the material being taught to real life, enabling students to see the practical applications of the mathematical concepts they learn. Gijsbers *et al.* (2020) stress that authentic contexts can enhance students' confidence in the relevance of mathematics, helping them see practical applications of mathematical concepts in real life. With this approach, students can more easily identify and interpret problems within relevant contexts (Cañizares *et al.*, 2022).

Additionally, the results of this study also highlight the importance of developing innovative and technology-based teaching materials to help overcome learning difficulties (Andrade *et al.*, 2023). The use of innovative educational media and technology, such as visual aids and technology-based applications, has proven effective in enhancing conceptual understanding as well as student engagement and motivation in learning mathematics (Fitriani *et al.*, 2023).

Overall, this study is expected to make a significant contribution to the development of more effective and efficient teaching methods for enhancing students' understanding of the concept of proportional comparison. Therefore, research that delves into these factors is expected to provide specific guidance for the development of effective learning strategies (Ningrum *et al.*, 2022; Nogues & Dorneles, 2022; Tazkiya, 2023).

4. CONCLUSIONS

This study indicates that students experience various difficulties in understanding and applying the concept of proportional comparison. These difficulties are due to a lack of deep understanding of fundamental concepts, challenges in applying formulas, low ability to identify problems in relevant contexts, and inadequate basic arithmetic skills.

Factors such as less varied teaching methods, lack of contextual practice, and low student motivation also contribute to these difficulties. Therefore, there is a need for more interactive and contextual teaching approaches, the development of innovative teaching materials using educational technology, and training for teachers in effective teaching methods to address these challenges and enhance students' understanding of the concept of proportional comparison.

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