MATHE*dunesa*

Homepage: https://ejournal.unesa.ac.id/index.php/mathedunesa/index
Email: mathedunesa@unesa.ac.id

p-ISSN: 2301-9085; e-ISSN: 2685-7855
Vol. 15 No. 2 Tahun 2026
Halaman 306-327

Profile of Students' Proportional Reasoning in Solving Mathematics Problems Based on Field Independent-Dependent Cognitive Style

Riandika Davis Kurnia Putra[1*], Susanah[1]

[1]Mathematics Education, State University of Surabaya, Surabaya, Indonesia

DOI: https://doi.org/10.26740/mathedunesa.v15n2.p306-327

Article History:
Received: 6 March 2025
Revised: 17 January 2026
Accepted: 23 February 2026
Published: 19 May 2026

Keywords:
Proportional reasoning, Cognitive Style, Field Independent, Field Dependent

***Corresponding author:**
riandikadavis.21063@mhs.unesa.ac.id

Abstract: This study aims to describe the profile of students' proportional reasoning in solving mathematical problems in terms of field independent and field dependent cognitive styles. Proportional reasoning is a logical thinking process in developing strategies that involve understanding covariation and multiplicative relationships in situations of comparing two or more quantities. The subjects of this study were one student with a field independent cognitive style and one student with a field dependent cognitive style who were of the same gender and had the same level of mathematical ability. The instruments used were mathematical problem assignments and interview guidelines. The instruments used have been consulted with the supervising lecturer and validated by partner teachers. The analysis focused on indicators of proportional reasoning: understanding covariation, recognizing proportional situations, applying multiplicative strategies, and using ratios correctly. The results of this study indicated that the independent student demonstrated a strong grasp of covariation, effectively recognized proportional situations, employed unit rate strategies for problem-solving, and accurately understood ratio usage. Conversely, the dependent student also understood covariation but struggled with recognizing proportional situations, could not determine comparison types, used unit rate strategies, and had a less accurate understanding of ratios due to illogical reasoning.

INTRODUCTION

Reasoning is really needed in learning mathematics. Ball et al. (2008:29) stated that "mathematical reasoning is the foundation for the construction of mathematical knowlegde.". In line with NCTM (2000) which states that reasoning is one of the process standards in mathematics learning. According to Sobur (2015), reasoning is a thought process in drawing a conclusion in the form of knowledge. Sobur (2015) added that someone is said to have reasoning if they have the characteristics of logical thinking and analytical thinking. Through reasoning activities, students are accustomed to being able to think logically, critically, analytically, and systematically in dealing with problems, so that they can solve them and find the right solution to the problem (Hidayat et al., 2017). Reasoning makes math learning meaningful because it focuses on making ideas, constructing knowledge, and making conclusions. If student reasoning is not emphasized in the mathematics learning process, it will only be just mathematics material, without knowing the meaning of mathematics itself.

One type of reasoning in mathematics is proportional reasoning. Proportional reasoning is a form of reasoning in mathematics that involves covariation and multiple comparisons (Nelson et al., 2022). Proportional reasoning refers to the coordination of two quantities related to the relation of change (worth or inverse value) of one quantity to another (Irpan, 2010). Lamon (in Misnasanti et al., 2017) stated that "proportional reasoning involves the deliberate use of multiplicative relationships to compare quantities and to predict the value of one quantity based on the values of another". In line with Izzatin (2021) who states that "proportional reasoning involves understanding the multiplicative relationship between two or more quantities". Lamon (in Walle et al., 2009) revealed four characteristics of someone who reason proportionally, namely (1) having an understanding of covariation, (2) recognizing proportional situations, (3) developing multiplicative strategies, (4) and understanding the conditions for using ratios. The more of these characteristics a student has, the higher the student's proportional reasoning.

Proportional reasoning is one of the important processes in students' mathematical development because it is a stepping stone for learning advanced mathematical topics, such as algebra, geometry, statistics, probability, and so on (Vanluydt et al., 2021). In line with Dole et al. (2012:195) who stated that "...scale, probability, percent, rate, trigonometry, equivalence, measurement, algebra, the geometry of plane shapes, are assisted through ratio and proportion knowledge". Most of these materials are secondary school materials. This makes proportional reasoning something that deserves attention in that phase. Langrall & Swafford (2000:254) stated that "proportional reasoning is one of the most important abilities to be developed during the middle grades". In line with NCTM (in Ayan & Isiksal-Bostan, 2019) which states that "the ability to reason proportionally develops in students throughout grades five to eight". This means that the middle school years are crucial for the development of proportional reasoning. On the other hand, Allain (2001) states that "in Piaget's stages of development, proportional reasoning is considered to usher in the beginning of the formal operations stage". This stage is the age where most students are pursuing secondary school education. However, research by Yuliani et al. (2021) and Rahman et al. (2023) found that some junior high school students have not been able to fulfill the proportional reasoning indicators, so that their proportional reasoning is still relatively low and not well developed.

One way that can help and train students' proportional reasoning is solving math problems (Sumartini, 2015). Challenging problems for students can force students to use their reasoning to find solutions to these problems. In line with Sumartini (2015) which states that students' proportional reasoning can improve better if learning is supported by giving problems compared to conventional methods. The same thing was also conveyed by Saputra (2013) who stated that the provision of mathematical problems has a significant positive effect on the development of proportional reasoning. Mathematical problems can be questions or problems that show the existence of a challenge that cannot be solved by a routine procedure that is already known before (Fauziyah, 2016). NCTM (2000: 52) states

that problem solving means engaging in a task for which the solution method is not known in advance. In order to find a solution, students must draw on their knowledge, and through this process, they will often develop new mathematical understandings. This means that in order to find a solution, the process of solving mathematical problems must use the knowledge possessed to develop new mathematical knowledge. Polya (2004) proposed four steps in the process of solving mathematical problems: (1) understanding the problem, (2) making a solution plan, (3) solving the problem, and (4) looking back.

There are many factors for each individual in solving math problems related to proportional reasoning, one of which is cognitive style (Hidayat et al., 2017). Cognitive style is a typical way of a student in learning related to the way of receiving and managing information, attitudes towards information, and habits related to the learning environment (Wijaya, 2016). This allows differences in perception and reasoning activities of students in learning activities and problem solving. Cognitive style also affects the preferred method for selecting, understanding, and processing new information based on reality. Witkin (1973) divides cognitive style into two, namely field dependent and field independent. Someone with a field dependent cognitive style is someone who thinks globally, accepts structures or information that already exists, has a social orientation, chooses a profession that is social skills, tends to follow goals and information that already exists, and tends to prioritize external motivation. Meanwhile, someone who has a field independent cognitive style is someone with the characteristics of being able to analyze separate objects from their environment, able to organize objects, have an impersonal orientation, choose a profession that is individual, and prioritize motivation from within themselves (Nugraha & Awalliyah, 2016). That is, the difference in cognitive style allows differences in perspective and ability to analyze information. Field independent students will be more 'analytical' than field dependent students. This difference in nature allows an influence on students' proportional reasoning, because the ability to analyze is the main capital of students in reasoning, especially proportional reasoning. This is supported by Suryadi's research (2017) which states that the level of proportional reasoning of field independent students is higher than that of field dependent students. Similar results were also expressed by Taufik et al. (2021) who stated that field dependent students have not been able to reason proportionally well, while field independent students are several levels above them. These explanations underlie the interest of researchers to describe the profile of proportional reasoning of students in solving math problems in terms of cognitive style field dependent and field independent.

METHOD

This research is descriptive research with a qualitative approach that aims to describe the proportional reasoning profile of field independent and field dependent students in solving mathematics problems. The instruments in this research are Mathematics Problem Tasks (MPT), and interview guidelines that are arranged based on proportional reasoning indicators. The instruments used have been consulted with the supervising lecturer and validated by partner teachers. The data analyzed in this study is the data from MPT answers

and MPT-based interviews. Subjects in this study consisted of one seventh grade student each with cognitive style field dependent (SD) and field independent (SI). Subjects were selected by considering the equality of mathematical ability level, gender, ease of verbal communication based on recommendations from teachers, as well as students' willingness to participate. Witkin (1971) developed a test instrument to divide students with field dependent and field independent cognitive styles, namely GEFT (Group Embedded Figures Test). In addition to some of the criteria mentioned, the willingness of prospective subjects and recommendations of mathematics teachers are also a consideration for researchers to select subjects. The selected subjects were given MPT to work on individually. MPT contains a math problem as follows.

Motorbike A and Motorbike B are two sport-genre motorbikes that are currently popular with the younger generation. Motorbike A has a maximum tank capacity of 12 liters, while Motorbike B has a maximum tank capacity of 10 liters. When the tank is fully filled, Motorbike A can travel a distance of 432 km. Meanwhile, Motorbike B can travel a distance of 400 km.

a) Which motorbike is more fuel efficient? Explain your opinion!

b) If with x liters of gasoline, Motorbike A can travel a distance of 288 km, how far can Motorbike B travel with the same gasoline?

Figure 1. Math Problem in MTP

Each research subject will be seen for their proportional reasoning through the steps of MPT work that they have done. To reveal the proportional reasoning profile of the research subjects, interviews were conducted with the stages of data reduction, data presentation, and conclusion drawing. The data analysis technique of MPT-based interview results is based on the stages of problem solving and proportional reasoning indicators according to the following table.

Table 1. Indicators of Proportional Reasoning in Solving Math Problems

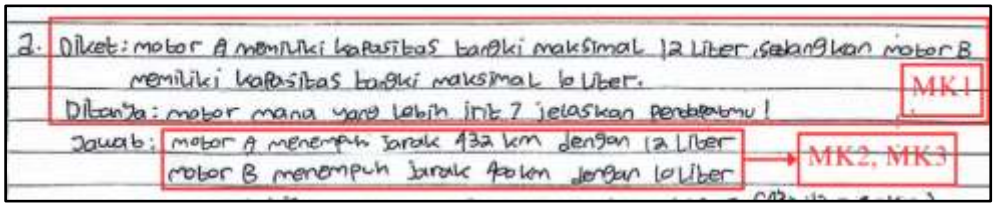
Stages of Problem Solving	Proportional Reasoning Indicators	Observed Aspects	Code
Understanding the Problem	Understanding Covariation	Identify the information contained in the problem.	MK1
		Identify quantities that change and do not change.	MK2
		Discover the relationship of change between quantities.	MK3
Making a Solution Plan	Recognizing Proportional Situations	Determine the steps to solve the problem.	MP1
		Discover the multiplicative relationship between quantities.	MP2
		Determine the type of comparison.	MP3
	Using the Multiplicative Strategy	Determine the multiplicative strategy that will be used to solve the problem.	MS1
Solving the Problem	Using the Multiplicative Strategy	Using the chosen strategy to execute the problem.	MS2
	Understanding the Use of Ratios	Create ratios and proportions correctly.	MR1
		Explain the reason for the formation of the ratio appropriately and reasonably.	MR2
Looking Back	Using the Multiplicative Strategy	Using a strategy other than the one chosen to solve the problem.	MS3
	Understanding the Use of Ratios	Make a conclusion in the form of a solution to the given problem.	MR3

RESULT AND DISCUSSION

Proportional Reasoning of Independent Students in Solving Mathematics Problems

Independent Students in Understanding Problems

The following are the answer sheets and interview transcripts of field independent students in solving MPT related to understanding the problem.



Translate:

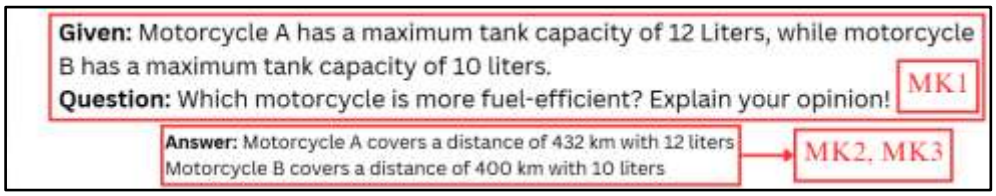
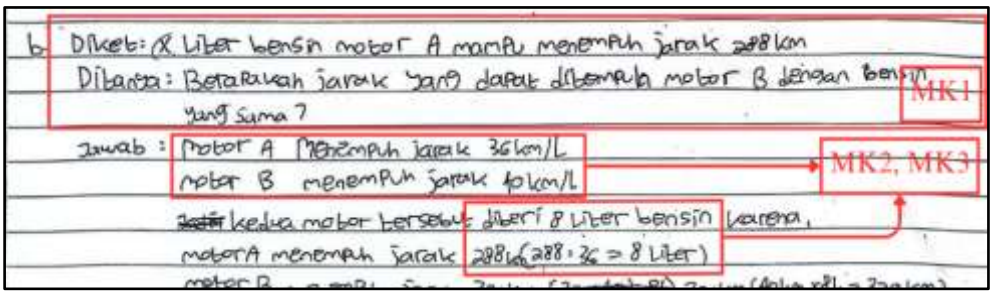


Figure 2. Pieces of SI's Answer Sheet on Problem A Related to Understanding the Problem

P:	*From this first question, how do you understand the information in the question?*	
SI:	*First I read the question, then I read the information above it, finally I understood a little, then I wrote down what I knew according to the reading.*	*MK1*
P:	*How do you determine the values to be changed are distance and amount of gasoline?*	
SI:	*Because the question is which motorbike is more fuel efficient, it is definitely related to gasoline, while the amount of gasoline here is definitely related to the distance that can be covered.*	*MK2, MK3*
P:	*Why do you think the amount of gasoline and distance are related?*	
SI:	*Because it is clear that the more gasoline, the further the distance that can be covered.*	*MK3*

Based on the answer sheet and interview transcript, it can be seen that SI identified information by analyzing the problem first. After that, SI looked for the information needed to solve the problem in the reading provided. Seen in the answer sheet and transcript marked with code MK1, SI also involved the context of the problem to determine the quantity that changes and does not change in the problem. This can be seen in the answer sheet and transcript marked with code MK2. On the answer sheet and transcript marked with code MK3, SI obtained the quantity relationship by linking the changes between quantities with the context used.



Translate:

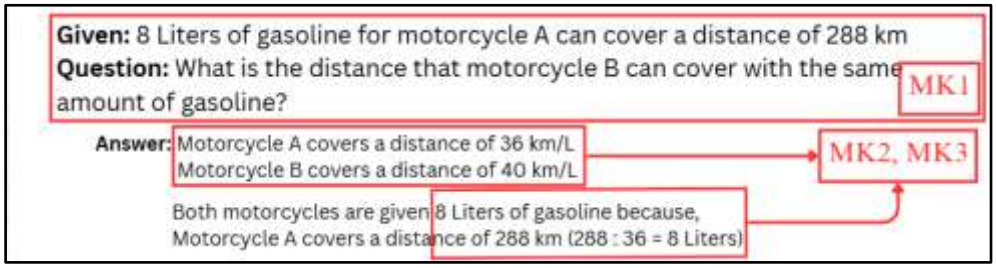


Figure 3. Pieces of SI's Answer Sheet on Problem B Related to Understanding the Problem

P:	*How do you understand the problem?*	
SI:	*So the question is how far can Motorbike B travel with the same amount of gasoline? I assume that the amount of gasoline referred to is x.*	*MK1*
P:	*Then here you also write Motor A traveled 36 km, and Motor B traveled 40 km. How did you get it?*	
SI:	*I got that from the previous question.*	*MK2*
P:	*How do you relate this information to finding the value of x?*	
SI:	*Because the context is the same, there is the amount of gasoline and distance, so it is still related.*	*MK3*

Based on the answer sheet and interview transcript, it can be seen that SI identified information by analyzing the problem first. After that, SI looked for the information needed to solve the problem in the reading provided. Seen in the answer sheet and transcript marked with code MK1, SI also involved the context of the problem to determine the quantity that changes and does not change in the problem. This can be seen in the answer sheet and transcript marked with code MK2. On the answer sheet and transcript marked with code MK3, SI obtained the quantity relationship by linking the changes between quantities with the context used.

Independent Students in Making a Solution Plan

The following is SI's answer sheet and interview transcript in solving MPT related to making a solution plan.

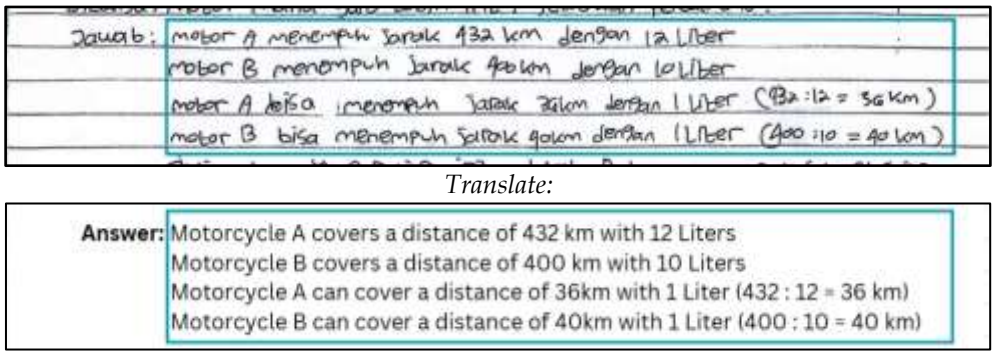
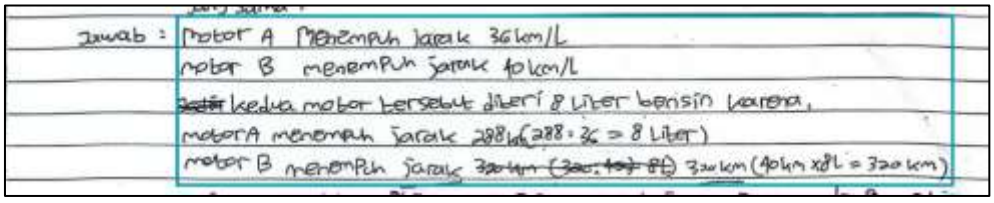


Figure 4. Pieces of SI's Answer Sheet on Problem A Related to Making a Solution Plan

P:	*From the answer you wrote, what steps did you take to solve this problem?*	
SI:	*I assume that whichever motorbike can go further with the same gasoline is the more fuel efficient one, so I made the gasoline the same at 1 litre.*	*MP1*
P:	*Why is the operation used division?*	
SI:	*Cause I think the most suitable division. If the operation is not suitable, the comparison will not be right.*	*MP2, MP3*
P:	*In your opinion, is this a type of direct proportion or inverse proportion? And why is this type of comparison that you use?*	
SI:	*I think this is a direct proportion.*	*MP3*
P:	*Why do you use this method? And how do you determine it?*	
SI:	*Because in my opinion, this way is the easiest.*	*MS1*

Based on the answer sheet and interview transcript, it can be seen that SI did not involve any variables in determining the problem solving steps. The first step taken was to equalize the amount of gasoline of the two motorcycles to 1 liter and then compare which motorcycle was able to travel farther with the amount of gasoline of 1 liter. This can be seen in the answer sheet and transcript marked with code MP1. This step also shows that SI has found the multiplicative relationship between quantities. This is clarified in the interview transcript marked with code MP2. SI found that the operation or in this case the multiplicative relationship that is suitable to answer the problem is division. The reason given by SI explained his process in determining the type of comparison. This can be seen in the answer sheet and transcript marked with MP3 code. The multiplicative strategy used by SI in this problem is the unit rate strategy, which is a strategy to determine the value of a quantity used to find the value of another quantity.



Translate

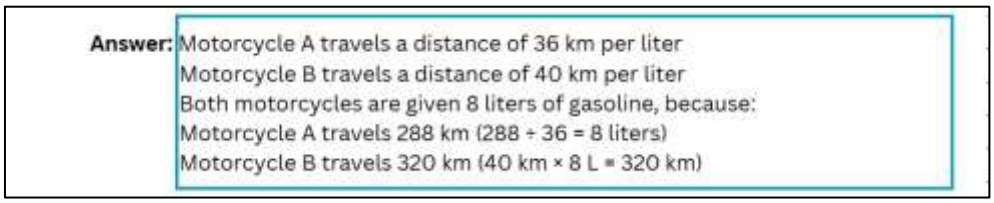


Figure 5. Pieces of SI's Answer Sheet on Problem B Related to Making a Solution Plan

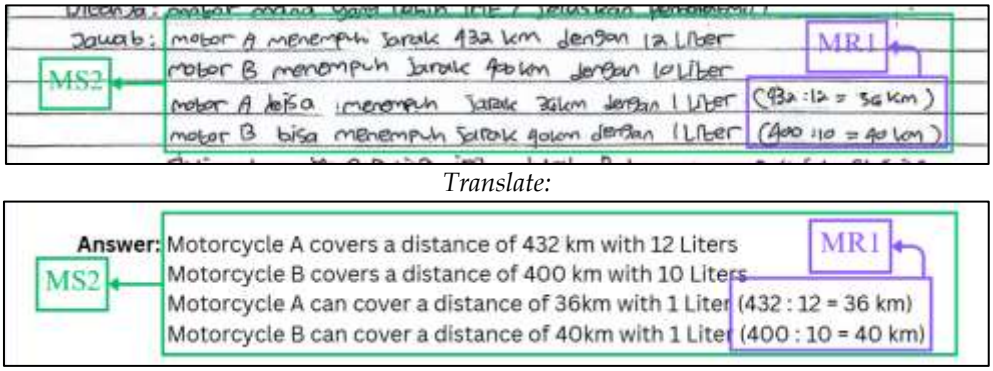
P:	*From the answer you wrote, what steps did you take to solve this problem?*	
SI:	*The first step I did was to find the value of x. After finding x 8, I just multiplied it by 40. So I found the distance that Motor B can travel with x liters of gasoline is 320 km.*	*MP1*
P:	*How do you get x to be equal to 8? And why multiply by 40?*	
SI:	*I find the value of x by dividing 288 by 36. (writing 288 : 36 = 8 liters) I find x is 8. Then I also find that Motor B can travel 40 km with 1 liter of gasoline. So with the same gasoline, it means just multiply 40 by x, x is 8, so 40 times 8. (writing 40 km × 8L = 320 km) I find the distance is 320 km.*	*MP1, MP2*
P:	*Why is the operation used here (288:36) division, while this one (40×8) is multiplication? Why not another operation?*	
SI:	*Here (288:36) is the division, because I think the division is the most suitable. Because what is being discussed is the amount of gasoline, if using other operations, the value will be unclear. If this one (40×8) is the opposite of this one (288:36), so just multiply it.*	*MP2, MP3*
P:	*In your opinion, is this a type of direct proportion or inverse proportion? And why is this type of proportion that you use?*	
SI:	*Just like before, I think this is a direct proportion.*	*MP3*
P:	*Why do you use this method? And how do you determine it?*	
SI:	*Because I don't think there is any other way.*	*MS1*

Based on the answer sheet and interview transcript, it can be seen that SI was very minimal in writing down how to work on the problem. The first step SI took was to find the value of x by dividing the known distance value in the problem by the distance Motor A can travel per liter, then multiplying it by the distance Motor B can travel per liter to get the answer to the problem. This can be confirmed through the transcript marked with code MP1. The steps also showed that SI had found the multiplicative relationship between

quantities. This is clarified in the interview transcript marked with code MP2. After that, SI found that the operation or in this case the multiplicative relationship that is suitable for answering the question is division when finding the value of x and multiplication when finding the distance that can be traveled by Motorcycle B. The reason given by SI explains SI's process in determining the type of comparison. This can be seen in the answer sheet and transcript marked with MP3 code. The multiplicative strategy used by SI in this problem is the unit rate strategy, which is a strategy to determine the value of a quantity used to find the value of another quantity.

Independent Students in Solving the Problem

The following is SI's answer sheet and interview transcript in solving MPT related to making a solution plan.



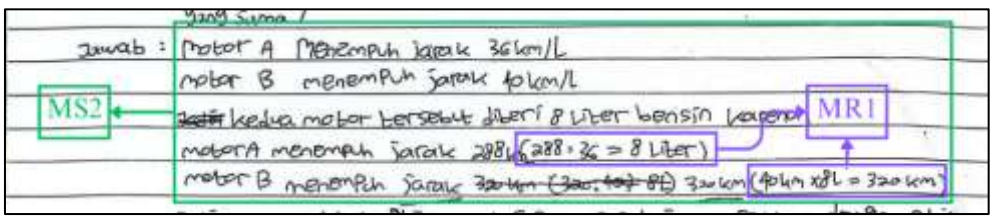
Translate:

Figure 6. Pieces of SI's Answer Sheet on Problem A Related to Solving the Problem

P: Why do you think this division is correct? (pointing to the answer sheet marked with code MR1)

SI: In my opinion, since this is an equal comparison. I will reduce the gasoline to 1 liter, then I divide the amount of gasoline and the distance that both motorbikes can travel by the maximum gasoline capacity of each motorbike. *MR2*

Based on the answer sheet marked with code MS2, SI managed to execute the multiplicative strategy well. This can be proven by forming the ratio correctly, as shown in the answer sheet with code MR1, so as to get the desired result. The reason for the ratio formation by SI is to consider the direction of comparison which is connected to the context of the problem. In other words, the ratio formed is the result of determining the type of comparison that has been determined previously. This is shown in the transcript and answer sheet marked with codes MR1 and MR2.



Translate:

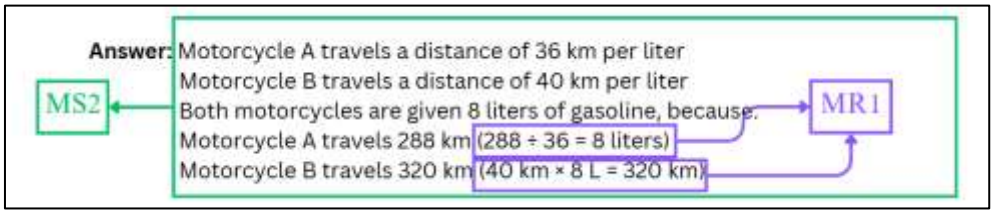


Figure 7. Pieces of SI's Answer Sheet on Problem B Related to Solving the Problem

P: *Why can you assume this division and multiplication are correct?*
SI: *Here (288:36) is division, because I think division is the most suitable. If you use other operations, the value will be unclear. If this one (40×8) is the opposite of this one (288:36), so just multiply it.* *MR2*

Based on the answer sheet marked with code MS2, SI managed to execute the multiplicative strategy well. This can be proven by forming the ratio correctly, as shown in the answer sheet with code MR1, so as to get the desired result. The reason for the ratio formation by SI is to consider the direction of comparison which is connected to the context of the problem. In other words, the ratio formed is the result of determining the type of comparison that has been determined previously. This is shown in the transcript and answer sheet marked with codes MR1 and MR2.

Independent Students in Looking Back

The following is SI's answer sheet and interview transcript in solving MPT related to looking back.

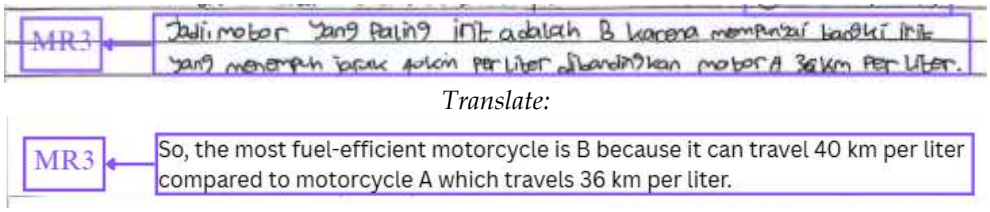


Figure 8. Pieces of SI's Answer Sheet on Problem A Related to Looking Back

P: *Is there any other way you can use to solve this problem?*
SI: *Maybe by equating the amount of gasoline with another number, say a larger number.* *MS3*
P: *How to draw a conclusion from this question?*
SI: *I return to what was asked.* *MR3*

Based on the answer sheet and interview transcript, SI explained that there was still a possible way to solve the problem, namely by equating the quantity of gasoline with a larger number. The strategy proposed by SI is probably equivalent fractions, which is a strategy of using the concept of multiplication to find fractions that are equivalent to the fraction needed in the problem.

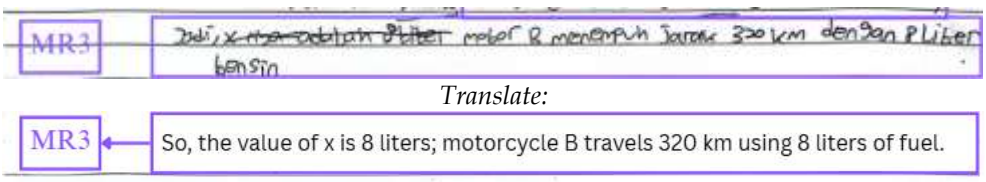


Figure 9. Pieces of SI's Answer Sheet on Problem B Related to Looking Back

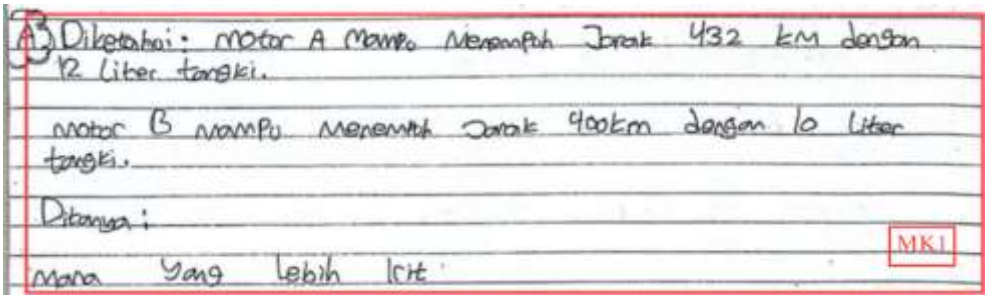
P: *Is there any other way you can use to solve this problem?*
SI: *I can't think of any other way.* *MS3*
P: *How to draw a conclusion from this question?*
SI: *I return to what was asked.* *MR3*

Based on the answer sheet and interview transcript, it can be seen that the strategy used is the only strategy that SI can use. This is confirmed in the transcript marked with MP3 code. In making the conclusion, SI reviewed the information asked in the problem, then connected it with the information that had been obtained. This can be seen in the interview transcript and answer sheet marked with code MR3.

Proportional Reasoning of Dependent Students in Solving Mathematics Problems

Dependent Students in Understanding Problems

The following is the answer sheet and interview transcript of SD in solving MPT related to understanding the problem.



Translate:

Known: Motorcycle A can travel a distance of 432 km using 12 liters of fuel.

Motorcycle B can travel a distance of 400 km using 10 liters of fuel.

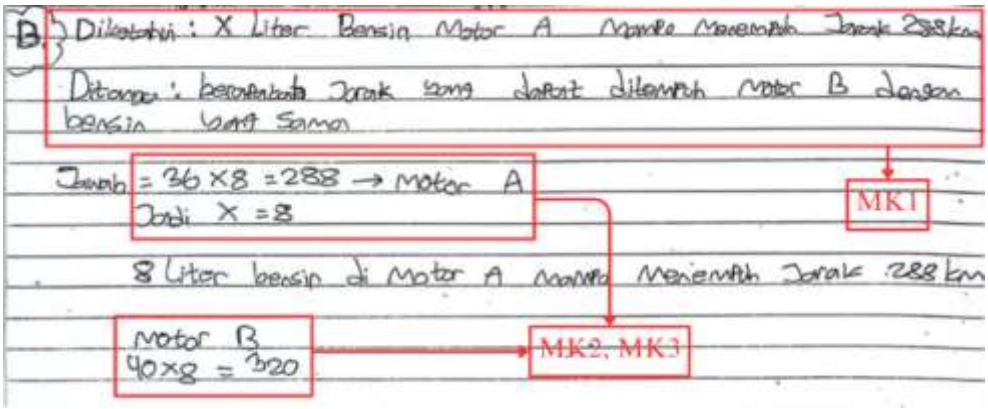
Asked:

Which one is more fuel-efficient? MK1

Figure 10. Pieces of SD's Answer Sheet on Problem A Related to Understanding the Problem

P:	*From this first question, how do you understand the information in the question?*	
SD:	*First, I read the information in the question, then I write down the information that is known. After that I write down what is asked.*	MK1
P:	*Do you think the information you wrote is important? Why?*	
SD:	*I think all of them are important. To find out which bike is more fuel efficient, I have to find out the distance that both bikes can travel on 1 liter of gasoline.*	MK1, MK2
P:	*How do you determine the values to be changed are distance and amount of gasoline?*	
SD:	*Since the known information is the distance and the amount of gasoline. Then, I thought of connecting the two.*	MK2, MK3
P:	*Why do you think that the amount of gasoline and the distance traveled are related?*	
SD:	*Since we know the amount of gasoline and the distance that can be traveled, there is no other information. So I assume that the two values are related.*	MK3

Based on the answer sheet and interview transcript, it can be seen that SD identified the information by reading and writing all the known information first, then tried to understand the problem and connect the information she wrote to work on the problem. This can be seen in the answer sheet and transcript marked with code MK1. In identifying the quantity that changes and does not change, SD considers that the quantity that must be changed is the quantity written in the problem. This can be seen in the answer sheet and transcript marked with code MK2. In the answer sheet and transcript marked with MK3, SD tried to connect the information to find the relationship between the quantities in the problem.



Translate:

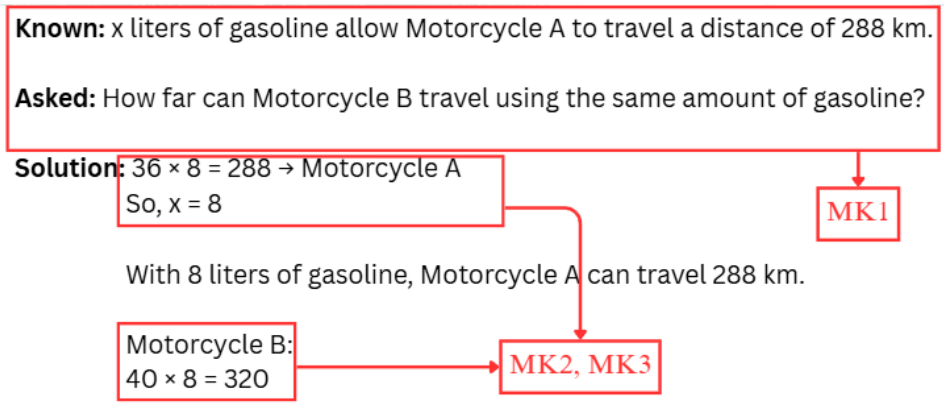


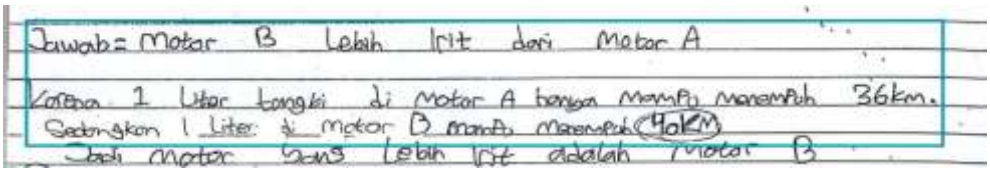
Figure 10. Pieces of SD's Answer Sheet on Problem B Related to Understanding the Problem

P:	*Next question, how do you understand the information in the question?*	
SD:	*Same as before.*	MK1
P:	*Then, how do you understand the problem?*	
SD:	*It is known that x liters of gasoline on Motor A can cover a distance of 288 km, and the question is how far Motor B can cover with the same gasoline, so what is meant is with x liters of gasoline, how far can Motor B cover. So I find x first.*	MK1
P:	*Then here are the values 36 and 40. How did you get them?*	
SD:	*From the previous question.*	MK2
P:	*Why do you use that information?*	
SD:	*Because with that information I can find the value of x and there is no other information that can be used, so I use that information to find the value of x.*	MK2, MK3
P:	*How do you relate that information to finding the value of x?*	
SD:	*So, I can find the value of x by multiplying it by 36 which gives 288.*	MK3

Based on the answer sheet and interview transcript, it can be seen that SD identified the information by reading and writing all the known information first, then tried to understand the problem and connect the information she wrote to work on the problem. This can be seen in the answer sheet and transcript marked with code MK1. In identifying the quantity that changes and does not change, SD considers that the quantity that must be changed is the quantity written in the problem. This can be seen in the answer sheet and transcript marked with code MK2. In the answer sheet and transcript marked with MK3, SD tried to connect the information to find the relationship between the quantities in the problem.

Dependent Students in Making a Solution Plan

The following is the answer sheet and interview transcript of SD in solving MPT related to making a solution plan.



Translate:

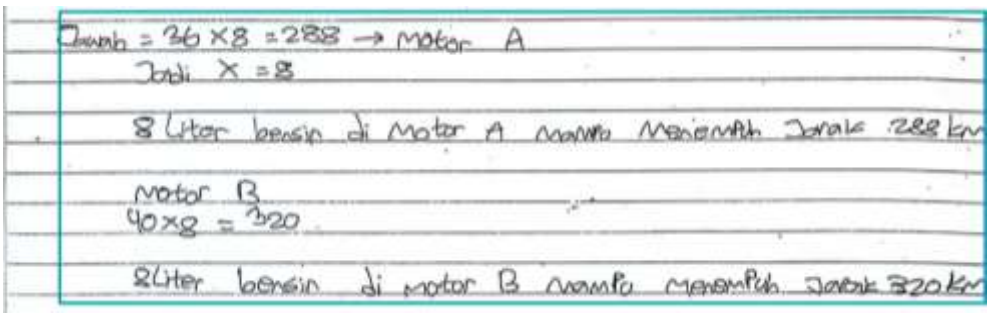
Answer: Motorcycle B is more fuel-efficient than Motorcycle A.

Because 1 liter of fuel in Motorcycle A can travel 36 km, while 1 liter of fuel in Motorcycle B can travel 40 km.
Therefore, the more fuel-efficient motorcycle is Motorcycle B.

Figure 11. Pieces of SD Answer Sheet on Problem A Related to Making a Solution Plan

P:	*From the answer you wrote, what steps did you take to solve this problem?*	
SD:	*To work on this problem, I looked for the distance that both motorbikes could travel with 1 liter of gasoline, then I compared them. The one that could travel further was the more fuel efficient one.*	MP1
P:	*How do you equate the gasoline to 1 liter?*	
SD:	*So, with a 12 liter tank, Motorbike A can travel a distance of 432 km. So I look for the value multiplied by 12, the result is 432. We get 36. So with 1 liter of gasoline, Motorbike A can travel a distance of 36 km. In the same way, with 1 liter of gasoline, Motorbike B can travel a distance of 40 km.*	MP1, MP2
P:	*Why is the operation used multiplication? Why not another operation?*	
SD:	*Because I think changing from 12 to 432, and 10 to 400, the most suitable operation is multiplication.*	MP2
P:	*In your opinion, is this a type of direct proportion or inverse proportion? And why is this type of comparison that you use?*	
SD:	*I don't think it's a matter of proportion, I don't think it's about comparison like this.*	MP3
P:	*Why did you use this method? And how did you determine it?*	
SD:	*Because there is no other way.*	MS1

Based on the answer sheet and interview transcript, it can be seen that SD did not involve any variables and was very minimal in writing how to work on the problem. The first step taken was to equalize the amount of gasoline of the two motorcycles to 1 liter, then compare which motorcycle was able to travel farther with the amount of gasoline of 1 liter. This can be seen on the answer sheet and transcript marked with code MP1. The steps also showed that SD had found the multiplicative relationship between quantities. This is clarified in the transcript marked with code MP2. SD found that the operation or multiplicative relationship that is suitable to be used to answer the problem is multiplication. SD did not consider that this problem was a proportion. Seen on the answer sheet and transcript marked with code MP3, SD explained that there was no comparison in the problem, because she felt that the problem was not a type of comparison problem. The multiplicative strategy used by SD in this problem is the unit rate strategy, which is a strategy to determine the value of a quantity used to find the value of another quantity. This is shown by the transcript and answer sheet marked with MP1 and MP2 codes.



Translate:

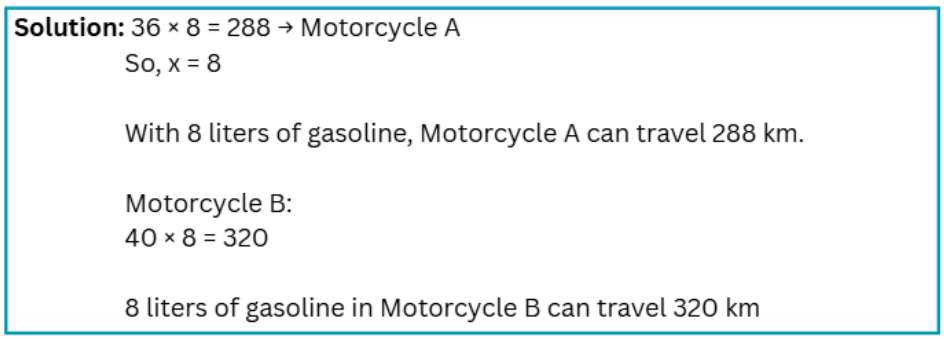


Figure 12. Pieces of SD Answer Sheet on Problem B Related to Making a Solution Plan

P:	*From the answer you wrote, what steps did you take to solve this problem?*	
SD:	*The first step is to find the value of x. Then the value of x is multiplied by 40. So the distance that Motor B can travel with x liters of gasoline is 320 km.*	MP1
P:	*How do you get the value of x? And why do you have to multiply it by 40?*	
SD:	*It was previously known that Motorbike A can travel 288 km with x liters of gasoline, in the previous question I found that Motorbike A can travel 36 km with 1 liter of gasoline. So find the value of x by finding the value that when multiplied by 36 the result is 288. Found 8, so x is equal to 8. Then it is also known that Motorbike B can travel 40 km with 1 liter of gasoline. Just multiply 40 by 8. Found the distance is 320 km.*	MP1, MP2
P:	*Why is the operation used here multiplication? Why not another operation?*	
SD:	*This is my adjustment to the previous question, sis. If you want to find the distance that can be traveled, you have to multiply the distance in 1 liter, by the amount of gasoline, so I use that.*	MP2, MP3
P:	*In your opinion, is this a type of direct proportion or inverse proportion? And why is this type of proportion that you use?*	
SD:	*Just like before, I don't think this is a proportion problem, I think it's like a regular algebra problem.*	MP3
P:	*Why did you use this method? And how did you determine it?*	
SD:	*Because there is no other way.*	MS1

Based on the answer sheet and interview transcript, it can be seen that SD used the method she found from the previous problem. The first step SD did was to find the value of x by dividing the known distance value in the problem, with the distance Motor A can travel per liter, then multiplying it by the distance Motor B can travel per liter to get the answer to the problem. This can be seen on the answer sheet and transcript marked with code MP1. The step also shows that SD has found the multiplicative relationship between quantities. This is clarified in the transcript marked with code MP2. SD found that the operation or multiplicative relationship that is suitable to be used to answer the problem is multiplication. SD did not consider that this problem was a comparison. Seen on the answer sheet and transcript marked with code MP3, SD explained that there was no comparison in the problem, because she felt that the problem was not a type of comparison problem. The multiplicative strategy used by SD in this problem is the unit rate strategy, which is a strategy to determine the value of a quantity used to find the value of another quantity. This is shown by the transcript and answer sheet marked with MP1 and MP2 codes.

Dependent Students in Solving the Problem

The following is the answer sheet and interview transcript of SD in solving MPT related to making a solution plan.

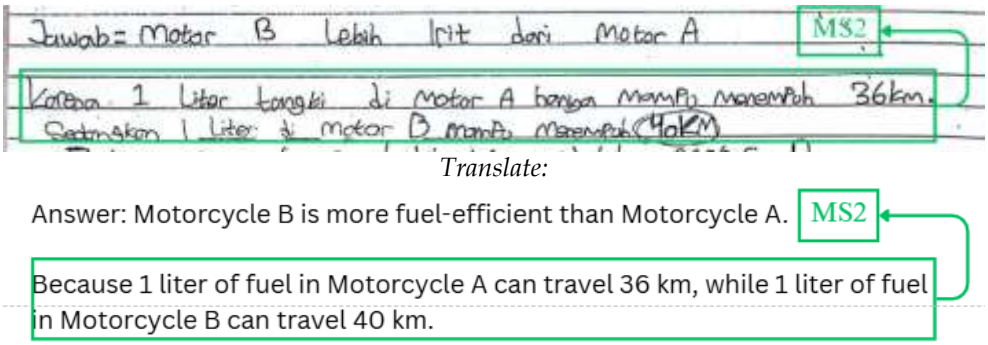


Figure 13. Pieces of SD's Answer Sheet on Problem A Related to Solving the Problem

P: *Why do you think the multiplication you did is correct?*
SD: *Because that way, the results of the operation are correct. And after I saw the results, it made sense.* MR2

Based on the answer sheet marked with code MS2, SD succeeded in executing the multiplicative strategy well. This can be proven by forming the ratio correctly, as shown in the answer sheet with code MR1, so as to get the desired result. The reason for the ratio formation by SD was to consider the value she would get with the ratio. In other words, the ratio is based on the rationality of the relationship between the quantities she found. This is shown by the transcript and answer sheet marked with codes MR1 and MR2.

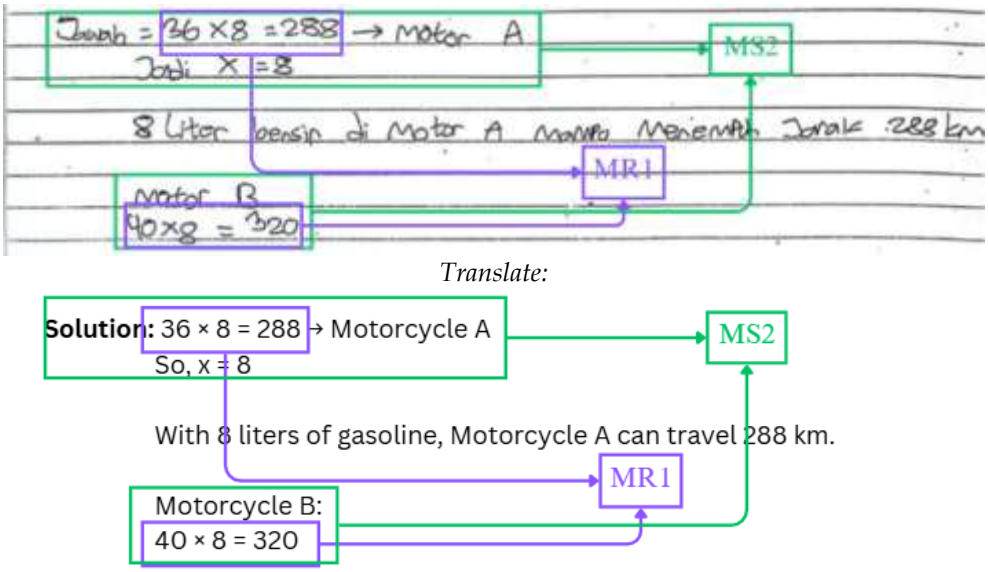


Figure 14. Pieces of SD's Answer Sheet on Problem B Related to Solving the Problem

P: *Why do you think this multiplication is correct? (pointing to the answer sheet with code MR1)*
SD: *Because based on the previous question, if you want to find the distance that can be covered, you have to multiply the distance in 1 liter by the amount of gasoline.* MR2

Based on the answer sheet marked with code MS2, SD succeeded in executing the multiplicative strategy well. This can be proven by forming the ratio correctly, as shown in the answer sheet with code MR1, so as to get the desired result. The reason for the ratio formation by SD was to consider the value she would get with the ratio. In other words, the ratio is based on the rationality of the relationship between the quantities she found. This is shown by the transcript and answer sheet marked with codes MR1 and MR2.

Dependent Students in Looking Back

The following is SD's answer sheet and interview transcript in solving MPT related to looking back.

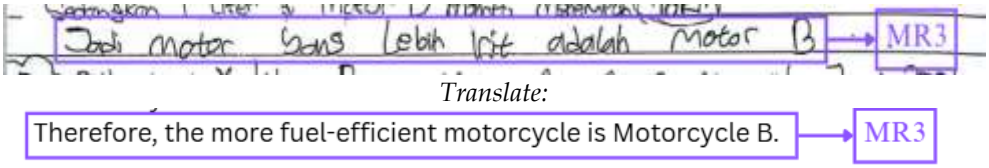


Figure 15. Pieces of SD's Answer Sheet on Problem A Related to Looking Back

P:	*So you think there is no other way?*	
SD:	*Yes, I don't think so.*	MP3
P:	*How do you draw a conclusion from this question?*	
SD:	*Because with 1 liter of gasoline, Motorbike B can go further than Motorbike A, Motorbike B is more fuel efficient.*	MR3

Based on the answer sheet and interview transcript, it can be seen that the strategy used is the only strategy that SD can use. This is confirmed in the transcript marked with MP3 code. In making the conclusion, SD reviewed the information asked in the problem, then connected it with the information that had been obtained. This can be seen in the interview transcript and answer sheet marked with code MR3.

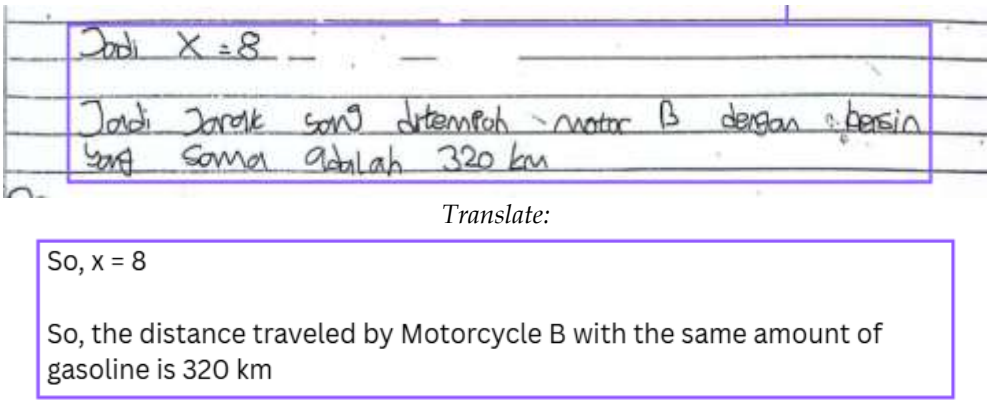


Figure 16. Pieces of SD's Answer Sheet on Problem B Related to Looking Back

P:	*So you think there is no other way?*	
SD:	*Yes, I don't think so.*	MS3
P:	*How do you draw a conclusion from this question?*	
SD:	*The question is how far Motor B can travel with the same gasoline, which is x. Since x has been found to be 8, so the distance Motor B can travel with 8 liters of gasoline is 320 km.*	MR3

Based on the answer sheet and interview transcript, it can be seen that the strategy used is the only strategy that SI can use. This is confirmed in the transcript marked with MP3 code. In making the conclusion, SI reviewed the information asked in the problem, then connected it with the information that had been obtained. This can be seen in the interview transcript and answer sheet marked with code MR3.

Discussion

Based on the analysis that has been done, field independent students can be said to reason proportionally well, because they have fulfilled almost all aspects of proportional reasoning provided. In understanding the problem, field independent students try to

understand the problem first, before determining the information to be used. This shows that field independent students prioritize an analytical approach to understanding the problem. This is in accordance with the characteristics of field independent students who are able to analyze separate objects from their environment, and are able to organize these objects, and adopt an analytical orientation in understanding and processing information, so as to find important parts that can be used to solve problems. Field independent students can determine all the information needed and the more efficient solution steps to work on the problem. Field independent students use their understanding of the problem to identify quantities that change and do not change. Field independent students try to relate the unknown quantity with the information obtained in the problem, as well as the information obtained in the previous problem, namely the distance that can be traveled with 1 liter of gasoline. Field independent students identify the relationship of changes between these quantities by linking changes between quantities to the context of the problem. Field independent students are able to explain that the value of the quantity 'amount of gasoline' affects the value of the quantity 'distance'. Field independent students are able to determine quantities that are interconnected and affect each other. This indicates that field independent students have a good understanding of covariation. In accordance with Lamon's statement (in Walle et al., 2009: 350) that "proportional thinkers understand relationships in which two quantities vary together and are able to see how the variation in one coincides with the variation in another". In making a solution plan, field independent students focus on finding the known and required quantities to answer the problem. In finding the multiplicative relationship between quantities, field independent students consider the use of all quantity relationships, so as to find the multiplicative relationship that they think is in accordance with the context of the problem. This shows that field independent students have their own way to determine the solution steps and find the multiplicative relationship between quantities. In accordance with the characteristics of field independent students, they easily learn unstructured objects, tend to have their own goals and reinforcement, and adopt an impersonal approach in solving problems. Field independent students determine the type of comparison contained in the problem is a valued comparison by paying attention to the direction of change in the multiplicative relationship that they find. Field independent students explain that the comparison used is a value comparison because the amount of gasoline is directly proportional to the distance the motorcycle can travel. In accordance with the statement of Ben-Chaim et al. (2012: 34) that the criteria for a proportional situation are "(1) there must be a multiplicative relationship between the two values, (2) the multiplicative relationship must be constant, either in the same, or opposite direction.". This means that field independent students meet all the criteria for recognizing proportional situations. In determining the multiplicative strategy, field independent students prioritize the easiest strategy and in accordance with the context of the given problem. This shows that field independent students are able to utilize external information in the form of problem context as a means of selecting

multiplicative strategies. In accordance with the characteristics of field independent students, they tend to look for more information outside the content that has been provided. The multiplicative strategy chosen by field independent students to solve the problem is the unit rate, which is the strategy of determining the value of a quantity, then multiplying it by another quantity to find the desired value. This strategy proposed by Cramer & Post (1993) requires the problem to be done coherently by finding the values needed to answer the problem one by one. In this case, the value sought is the distance that can be traveled per liter of both motors. The information is used to find the value of x, then the x value is used to find the value of the distance that Motor B can travel with x liters of gasoline. In solving the problem, field independent students succeeded in executing the multiplicative strategy well in accordance with the solution steps they had previously determined, so they could make the ratio correctly, thus finding the desired answer. The application of multiplicative strategies carried out by field independent students indicates that field independent students have used multiplicative strategies well. In accordance with Lamon's statement (in Walle et al., 2009: 350) that "proportional thinkers develop a wide variety of strategies for solving proportions or comparing ratios". Field independent students provide reasons for the formation of ratios, namely considering the direction of comparison associated with the context of the problem. This reason indicates that field independent students understand the use of ratios. In accordance with Langrall & Swafford (2000: 259), that in proportional reasoning, "students need to recognize situations in which using a ratio is reasonable or appropriate.". In looking back, field independent students do not find other multiplicative strategies that can be used to solve the problem, but provide strategy options that might be used to work on the problem, namely equivalent fractions, which is a strategy of using the concept of multiplication to find fractions that are equivalent to the fractions needed in the problem. In this case, the amount of gasoline and the distance traveled by each motorcycle will be multiplied by a certain number so that the amount of gasoline from each motorcycle becomes the same, then compare which motorcycle is able to travel a longer distance with the same amount of gasoline. This is in accordance with the characteristics of field independent students, which tend to think analytically, so they can solve problems with strategies they develop themselves. In making conclusions, field independent students review the information asked in the problem, then connect it with the information that has been obtained.

Field dependent students cannot be said to reason proportionally well because they have not fulfilled several importan aspects of proportional reasoning. In understanding the problem, field dependent students read and write down all the information first, before understanding the meaning of the problem. This indicates that field dependent students prioritize a global approach in understanding the problem. This is in accordance with the characteristics of field dependent students, which tend to think globally, and accept all structures or information provided. Field dependent students assume that the quantity that must be changed is the quantity written in the problem. The changes between the quantities

are interrelated to find the relationship between the quantities. Field dependent students are able to determine quantities that are interconnected and affect each other. This indicates that field dependent students also have a good understanding of covariation. In accordance with Lamon's statement (in Walle et al., 2009: 350) that "proportional thinkers understand relationships in which two quantities vary together and are able to see how the variation in one coincides with the variation in another". In making a solution plan, field dependent students focus on finding the value of the known and required quantities to answer the problem. In finding a multiplicative relationship between quantities, field dependent students consider changes in quantities, thus finding a multiplicative relationship that they think makes sense. Field dependent students feel that the problem they are working on is not a comparison problem, so they cannot determine the type of comparison. This indicates that field dependent students only remember comparison problems through examples of problems they have learned, without understanding the meaning of the comparison itself. In accordance with the characteristics of field dependent students, it is difficult to learn unstructured objects, and tends to accept lessons that have been arranged, but are unable to rearrange them. The inability to determine the type of comparison indicates that field dependent students have not recognized the proportional situation perfectly. From the criteria of proportional situations proposed by Ben-Chaim et al. (2012: 34), namely "(1) there must be a multiplicative relationship between the two values, (2) the multiplicative relationship must be constant, either in the same, or opposite direction.", field dependent students only meet one of the two criteria, namely only recognizing the multiplicative relationship, without recognizing the direction of comparison. In determining the multiplicative strategy, the field dependent student focuses on the change in quantity, as well as the general strategy he has found before. This shows that field dependent students prefer to use existing procedures, rather than thinking of other procedures that might be used to solve the problem. In accordance with the characteristics of field dependent students, they focus more on the general picture and are passive in adjusting to the influence of the field or context, so they tend to prioritize existing procedures. The dominant multiplicative strategy used by field dependent students to solve problems is the unit rate, which is the strategy of determining the value of a quantity used to find the value of another quantity. In this case, the unit value of the quantity sought by field dependent students is the distance that can be traveled per liter of the two motors (in problem a). The information is used to find the value of x, then used to find the value of the distance Motor B can travel with x liters of gasoline. In solving the problem, the field dependent student managed to execute the multiplicative strategy well according to the solution steps he had previously determined, so that he could make the ratio correctly and find the desired answer. The unit rate strategy of field dependent students is slightly different from field independent students. The unit rate strategy of field dependent students is a little less structured because they use too much 'trial and error' to find a value. Field dependent students prefer to find a value that when multiplied by 36 produces 288, rather than directly dividing 288 by 36.

Overall, the application of multiplicative strategies by field dependent students indicates that field dependent students have used multiplicative strategies well. In accordance with Lamon's statement (in Walle et al., 2009: 350) that "proportional thinkers develop a wide variety of strategies for solving proportions or comparing ratios". Although it can be said to have used the ratio appropriately, the reason for forming the ratio by field dependent students, namely considering the value they will get with the ratio, as well as the ratio previously obtained, has not shown that field dependent students understand the proper use of ratios. This is important because according to Langrall & Swafford (2000: 259), students who reason proportionally are not only able to use multiplicative strategies, but are able to recognize and explain the situation of using ratios in these strategies with appropriate and reasonable reasons. Despite getting the correct answer, students may not be able to be called proportional reasoning well. As stated by Vera & Lloyd (2016) that proportional reasoning also emphasizes the ability to give reasons because many students can answer numerically correct for proportion problems using procedures, but it does not necessarily mean that students use proportional reasoning. This is due to students' inability to give reasons. In looking back, field dependent students did not provide other multiplicative strategy options that might be used to solve the problem. This is confirmed in the transcript marked with code MS3. In making conclusions, field dependent students reviewed the information asked in the problem, then connected it with the information that had been obtained.

The following is the similarities of proportional reasoning of field independent students and field dependent students in solving math problems, in terms of the stages of solving math problems.

Table 2. Similarities of Proportional Reasoning of Independent Students and Dependent Students

Stages	Equation
Understand the problem	Relate changes between quantities to the context of the problem.
Making a Solution Plan	Focuses on finding the known and required quantities to answer the question.
	Considering the use of all quantity relationships, finding multiplicative relationships according to the context of the problem.
	The multiplicative strategy chosen is the unit rate.
Solving the Problem	Successfully executed the multiplicative strategy well in accordance with the completion steps he had previously determined.
	Successfully created the ratio correctly according to the chosen multiplicative strategy and found the desired answer.
Looking Back	Reviewing the information asked in the problem, then connecting it with the information that has been obtained.

The following are the differences in proportional reasoning of field independent and field dependent students in solving math problems.

Table 3. Differences in Proportional Reasoning of Independent and Dependent Students

Stages	*Field Independent*	*Field Dependent*
Understand the problem	Trying to understand the problem first, before determining the information to be used.	Read and write down all the information first, before understanding the meaning of the problem.

Stages	*Field Independent*	*Field Dependent*
	Relate the understanding of the problem to the information provided.	Assumes the quantity to be changed is what is written in the question.
Making a Solution Plan	Noting the direction of change of the multiplicative relationship found.	They felt that the problem they were working on was not a comparison problem, so they could not determine the type of comparison.
	Choosing the strategy that she found easiest and appropriate for the context of the problem.	Focusing on quantity changes, as well as the general strategies he has discovered.
Solving the Problem	Consider the direction of comparison in relation to the context of the problem.	Considering the value he will get with the ratio, as well as the ratio obtained.
Looking Back	Provide an alternative multiplicative strategy that can be used, equivalent fraction.	Did not find another multiplicative strategy that could be used to solve the problem.

CONCLUSION AND SUGGESTIONS

Based on the analysis and discussion described earlier, it can be concluded that at the stage of understanding the problem, both subjects can be said to understand covariation because they fulfill all aspects of understanding covariation, namely identifying information contained in the problem, identifying quantities that change and do not change, and finding a relationship of change between quantities. At the stage of making a solution plan, field independent students can be said to recognize proportional situations because they meet all aspects of recognizing proportional situations, namely finding multiplicative relationships between quantities, and determining the direction of comparison, but field dependent students can be said not to recognize proportional situations because they cannot determine the direction of comparison. Both subjects chose the same strategy, namely unitrate. At the solving the problem stage, both subjects can be said to use the multiplicative strategy because they successfully execute the multiplicative strategy well according to the predetermined solution steps, so that they can make the ratio correctly and find the desired answer, but field dependent students can be said not to understand the use of ratios because they cannot provide reasons for the formation of ratios appropriately. At the looking back stage, field independent students provide another alternative strategy, namely equivalent fraction, while field dependent students do not provide alternative multiplicative strategies that might be used to solve the problem.

This research has several weaknesses, one of which is that the questions given are not yet mathematical problems. This is because the first question given is a bridge to answer the next question, so that students immediately know what to look for first. The advice that researchers can give is to be more careful when creating mathematical problems. Future research must ensure that the questions given are truly mathematical problems. Apart from that, relevant further research can use proportional reasoning indicators in this research because they are made in detail by taking into account the stages of problem solving.

REFERENCES

Allain, A. (2001). *Development of an instrument to measure proportional reasoning among fast-track middle school students*.

Ayan, R., & Isiksal-Bostan, M. (2019). Middle school students' proportional reasoning in real life contexts in the domain of geometry and measurement. *International Journal of Mathematical Education in Science and Technology*, *50*(1), 65–81.

Ball, D. L., Lewis, J., & Thames, M. H. (2008). Chapter 1: Making mathematics work in school. *Journal for Research in Mathematics Education. Monograph*, *14*, 13–201.

Ben-Chaim, D., Keret, Y., & Ilany, B.-S. (2012). *Ratio and proportion: Research and teaching in mathematics teachers' education (Pre- and in-service mathematics teachers of elementary and middle school classes)*. https://doi.org/10.1007/978-94-6091-784-4

Cramer, K., & Post, T. (1993). Proportional Reasoning. *The Mathematics Teacher*, *86*(5), 404–407. http://www.jstor.org/stable/27968390

Dole, S., Clarke, D., Wright, T., & Hilton, G. (2012). Students' proportional reasoning in mathematics and science. *Proceedings of the 36th Conference of the International Group for the Psychology of Mathematics Education*, 195–202.

Fauziyah, F. (2016). Meningkatkan Hasil Belajar Matematika Siswa Kelas XI IPS SMA Tamansiswa Padang dengan Penggunaan Pendekatan Kontekstual Berbasis Tugas yang Menantang (Challenging Task). *Lemma: Letters of Mathematics Education*, *1*(2).

Hidayat, A. F., Amin, S. M., & Fuad, Y. (2017). Profil penalaran proporsional siswa SMP dalam memecahkan masalah matematika berdasarkan gaya kognitif sistematis dan intuitif. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *8*(2), 162–170.

Irpan, S. (2010). Proses Terjadinya Kesalahan dalam Penalaran Proporsional Berdasarkan Kerangka Kerja Asimilasi dan Akomodasi. *Beta: Jurnal Tadris Matematika*, *3*(2), 100–117.

Izzatin, M. (2021). Proportional Reasoning in Mathematics: What and How is the Process? *2nd International Conference on Innovation in Education and Pedagogy (ICIEP 2020)*, 115–119.

Langrall, C. W., & Swafford, J. (2000). Three balloons for two dollars: Developing proportional reasoning. *Mathematics Teaching in the Middle School*, *6*(4), 254–261.

Misnasanti, M., Utami, R. W., & Suwanto, F. R. (2017). Problem based learning to improve proportional reasoning of students in mathematics learning. *AIP Conference Proceedings*, *1868*(1).

NCTM. (2000). *Principles and Standards for School Mathematics: A Guide for Mathematicians*. https://api.semanticscholar.org/CorpusID:2724253

Nelson, G., Hunt, J. H., Martin, K., Patterson, B., & Khounmeuang, A. (2022). Current knowledge and future directions: Proportional reasoning interventions for students with learning disabilities and mathematics difficulties. *Learning Disability Quarterly*, *45*(3), 159–171.

Nugraha, M. G., & Awalliyah, S. (2016). Analisis gaya kognitif field dependent dan field independent terhadap penguasaan konsep fisika siswa kelas VII. *Prosiding Seminar Nasional Fisika (E-Journal)*, *5*, SNF2016-EER.

Polya, G. (2004). *How to solve it: A new aspect of mathematical method* (Vol. 85). Princeton university press.

Rahman, M. T. A., Subarinah, S., & Triutami, T. W. (2023). Kemampuan Penalaran Proporsional ditinjau dari Gaya Belajar pada Siswa. *Journal of Classroom Action Research*, *5*(4), 433–440.

Saputra, C. (2013). Pengaruh Model Pembelajaran Berbasis Masalah (PBM) terhadap Kemampuan Penalaran Proporsional Siswa Sekolah Menengah Pertama. *Jurnal Pendidikan Matematika*, *4*(1), 62–73.

Sobur, K. (2015). Logika dan Penalaran dalam Perspektif Ilmu Pengetahuan. *TAJDID: Jurnal Ilmu Ushuluddin*, *14*(2).

Sumartini, T. S. (2015). Peningkatan kemampuan penalaran matematis siswa melalui pembelajaran berbasis masalah. *Mosharafa*, *4*(1), 1–10.

Suryadi, S. (2017). Analisis Penalaran Proporsional Siswa Kelas VIII Berdasarkan Gaya Kognitif Field Dependent dan Field Independent pada Materi Bangun Ruang. *EKUIVALEN-Pendidikan Matematika, 30 (3)*.

Taufik, A., Nurhayati, N., Prayitno, A. T., Tresnawati, B., & Syafari, R. (2021). Analysis of Mathematical Proportional Reasoning Ability Based on Field Dependent and Field Independent Cognitive Style. *UNISET 2020: Proceedings of the 1st Universitas Kuningan International Conference on Social Science, Environment and Technology, UNiSET 2020, 12 December 2020, Kuningan, West Java, Indonesia*, 274.

Vanluydt, E., Wijns, N., Torbeyns, J., & Van Dooren, W. (2021). Early childhood mathematical development: the association between patterning and proportional reasoning. *Educational Studies in Mathematics*, *107*(1), 93–110.

Vera, F., & Lloyd, P. (2016). Proportional reasoning ability of school leavers aspiring to higher education in South Africa. *Pythagoras*, *37*(1), 1–10.

Walle, J., Karp, K., & Bay-Williams, J. (2009). *Elementary and middle school mathematics: Teaching developmentally*. In https://books.google.co.id/books?id=w_zuAAAAMAAJ.

Wijaya, A. P. (2016). Gaya kognitif field dependent dan tingkat pemahaman konsep matematis antara pembelajaran langsung dan STAD. *Jurnal Derivat: Jurnal Matematika Dan Pendidikan Matematika*, *3*(2), 1–16.

Witkin, H. A. (1971). *A Manual for the Embedded Figures Tests*. Consulting Psychologists Press. https://books.google.co.id/books?id=FYx9AAAAMAAJ

Witkin, H. A. (1973). The role of cognitive style in academic performance and in teacher-student relations 1 2. *ETS Research Bulletin Series*, *1973*(1), i–58.

Yuliani, R., Nurhayati, N., & Alfin, E. (2021). Analisis Kemampuan Penalaran Proporsional Siswa. *Jurnal Bayesian: Jurnal Ilmiah Statistika Dan Ekonometrika*, *1*(1), 24–39.