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Implementation of Missouri Mathematics Project in Reducing Students' Mathematical Errors of Class VII-4 Based on Kastolan Theory

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Abstract

This research is based on the facts that students often made mathematical errors when dealing with mathematical problems. It was implemented in class VII-4 which consists of 28 students with diverse background, academic abilities, interests, and learning style. Data was obtained through observations and interviews with mentor which showed need for reducing students' mathematical errors. The Missouri Mathematics Project (MMP) strategy was implemented to reduce students' mathematical errors through cooperative and individual works steps. The methods that are used in this study is descriptive research with qualitative approach to describe mathematical errors and it is combined with Kastolan theory as the way to analyze those errors. The analysis process used students' results in formative and summative assessments as supporting data in describing students' mathematical errors. The results of individual formative and summative assessments showed a substantial reduction in the rate of mathematical errors among students. On the other hand, students who initially did not achieve the Minimum Passing Score (MPS) on the formative assessment may achieve the MPS on the summative assessment. The implementation of MMP strategy showed improvement in terms of (1) students' understanding about the material, (2) ability to work together, (3) ability to work individually, (4) reducing of students' mathematical errors. Through this process, teacher realize the importance of systematic and holistic learning design so that it not only increases academic abilities but also forms a good character. As a follow-up, it is recommended to use MMP strategy integrated with technologies to further minimize students' mathematical errors.

Keywords: Missouri Mathematics Project, Mathematical Errors, Kastolan Theory, Proportion

1. Introduction

Mathematics is the study of numbers, patterns, and procedures that are used to solve problems related with numbers and patterns in real life or other fields. It is widely used in many aspects, such as trade, carpentry, measuring distances, calculating the area of region, and even calculating population figures. Mathematics comes as a communication tool to solve human's problems

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(Siregar & Dewi, 2022). Hayati & Jannah (2024) also stated that mathematics can help students in facing several problems or challenges in real-life context. Besides, by learning mathematics students not only learn to memorize or use all the formulas, but to increase their critical thinking ability. Therefore, mathematics cannot be separated from human life since it can be found in many things. However, in learning Mathematics there are chances for students to make errors. In this research there are three errors that are usually made by students, those are conceptual errors, procedural errors, and technical errors. That is why those errors must be reduced so that students can learn Mathematics well. Missouri Mathematics Project can be used as a strategy to help them in reducing those errors because they are given many opportunities to work with many mathematical problems individually and cooperatively.

There are many students who struggle with learning mathematics. Some of them frequently fail to observe and acknowledge how mathematics is used in real life or other fields (Pratama et al., 2022). That is why students consider mathematics as a scary monster and does not have correlation with their life. On the other hand, students sometimes make several errors in solving mathematical problems. The research conducted by Siregar (2019) shows that there are four common types of mathematical errors made by students when working with mathematical problems, which include conceptual errors, calculation (technical) errors, writing errors, and procedural errors. If those errors are left unsolved, it will affect students' advanced mathematics learning. Analysis of those errors is needed in order to identify what things are done by students that are actually incorrect and to know where students made errors (Hasibuan et al., 2022).

There are some factors that cause students to make errors in solving mathematical problems. Nasrudin in Hakim et al. (2021) stated that each type of mathematical errors has their own factors. The factors causing conceptual errors are (1) students do not understand what the questions mean, (2) students are wrong in choosing a formula, and (3) students cannot apply the formulas. The factors causing procedural errors are (1) students do not follow the correct way in solving the questions, (2) students are not trained in solving mathematical problems, and (3) students are not able to solve the questions until the simple step. The factors causing technical errors are (1) students are less careful in doing the questions, (2) students do not recheck their answer, and (3) students' study less and teachers have less motivation. For writing errors, Siregar (2019) in her research explain that students sometimes forgot to write the step in complete way or in good order. For example, they forgot to write the units of the answer and they are not able to use mathematical symbols in the right way. In relation with Kastolan theory, this theory only divided mathematical errors in three kinds of errors since these three categories encompass the entire fundamental essence of the subject matter and the activities involved in solving mathematical problems

An observation of a class VII-4 at a private school in Tangerang confirmed that students made all of mathematical errors in solving mathematical problems. Based on summative result in the topic of Inequalities, some of the students got score under the Minimum Passing Score (MPS) because they have made mistakes in concept of Inequalities, procedure in solving Inequalities problems in real life, and they were careless in calculating the final result. This is also supported by questionnaire given by teacher to students which shows that students made all three types of errors.

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To help address this problems, one strategy that can be used is Missouri Mathematics Project (MMP). MMP is a strategy designed to help teachers to improve the effectiveness of classroom learning by using various exercises or assignments with the aim of enhancing students' learning outcomes (Listiani et al., 2023). The research conducted by Setyorini et al. (2022) showed that MMP strategy is able to increase the result of students' learning because it can reduce students' mathematical errors in solving questions. This is also supported by the research conducted by Ervinasari & Astuti (2023) that MMP strategy can increase students' understanding of mathematical concepts, thereby students are not make the same errors in doing the questions because they have understood the right concepts. Thus, this research also comes to strengthen the results by providing strong proofs. This research sees how mathematical errors are manifested in students work and compares each error in each assessment. MMP strategy is used in this context as a strategy to helps students in reducing those errors so that their score increases. These things make this research different from another research because there is comparison of each error in all assessments and also comparison in students' scores.

As a learning strategy, MMP has its own syntaxes. There are five syntaxes in MMP, those are introduction, development, cooperative work, individual work, and assignments (Listiani et al., 2023). In introduction step, teachers give apperceptions about what students have learned on previous meeting and then introductory to what students will learn on the meeting. This will help students to recall the concepts they have learned and see the connection between previous concept and the new concept that they will learn. Development step becomes an opportunity for teacher to develop the concepts so that students are able to understand that concept before dealing with mathematical problems. Cooperative and individual work become steps for students to face all mathematical problems related to the concepts they have learned on the meeting, thereby students can understand the concept well. Teachers help students who have difficulties and monitor every mathematical error that occurs. In the last step, students are given assignments to train and strengthen their understanding about the concepts after knowing their mathematical errors.

In implementing this MMP strategy to reduce students' mathematical errors, Kastolan theory is used to describe and analyze those errors. Kastolan theory is a method that can be used to analyze students' mathematical errors when solving mathematical problem in a form of story (Ndek et al., 2022). Khanifah and Nusantara in Ndek et al. (2022) explain that based on Kastolan theory there are three types of mathematical errors, those are conceptual errors, procedural errors, technical errors. Sahriah in Fitriyah et al. (2020) explain definition of those errors: conceptual errors are errors in using formulas or definitions in answering questions, procedural errors are errors in steps when solving questions, and technical errors are errors in calculation. In this study, MMP strategy and Kastolan theory is used to reduce students' mathematical errors in the concept of Proportion. In this context, conceptual errors are seen on how students use the concept of direct or inverse proportion to solve problems, procedural errors are seen on how students operate or work with mathematical manipulation, and conceptual errors are seen on how students write the results or using the proper signs.

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Proportion is a concept in Mathematics that is used to show equality between two ratios or quantities (Fadilla & Siswono, 2022). There are two kinds of proportion, those are direct proportion and inverse proportion. Proportion becomes the fundamental concept that underlies several complex concepts in Mathematics, such as algebra and geometry. In geometry, proportion governs the harmony of geometric shape's structure, thereby revealing the beauty of that shape (Hassan & Dafrina, 2018). Besides, proportion is widely used in many contexts. For instance, in agriculture, direct proportion is used to calculate the area of farmland, and in animal husbandry, inverse proportion is used to calculate the supply and demand for nutrients (Nainggolan & Noverica, 2025). Through learning proportion, students are able to understand the concept of proportion and its application in several real-life situations. Students not only see proportion as something that is too abstract, but as concept that is contextual and applicable. Therefore, the understanding about proportion is crucial for students. Students are prone to making mistakes when studying the topic of proportions because there are two types of proportions: direct and inverse. This means students must be careful to determine when to use each type of proportion and how to calculate it.

Based on the context that has been explained, this research is focused on the implementation of Missouri Mathematics Project in reducing students' mathematical errors of class VII-4 and Kastolan theory in describing and analyzing those errors. This study aims to see how MMP strategy can be used to reduce students' mathematical errors and increase their learning result. As a follow-up, it is recommended to use MMP strategy integrated with technologies to further minimize students' mathematical errors.

2. Methods

The method that is used in this research is descriptive research with qualitative approach. It is research that tries to describes events and occurrences systematically according to the conditions existing within a population. It also involves a process of conceptualization and results in the formation of classification schemes (Zellatifanny & Mudjiyanto, 2018). Thus, this research describes the errors made by students in solving problems in Mathematics on the concept of Proportion. This study was conducted to describe the MMP strategy in reducing students' mathematical errors systematically with the research object being the students in class VII-4 at a private school in Tangerang for the academic year of 2025/2026 with 28 students consisting of 12 male students and 16 female students with diverse ability level. The MMP strategy is used to reduce those errors and it is implemented in seven meetings.

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Table 1.
Topics, duration, activities, and role of teachers or students in each meeting

Meeting	Topic	Activities	Role
1	Direct Proportion	Teacher explains the concept of direct proportion and gives several examples. Students work in groups to solve questions.	Teacher: material giver, facilitator Students: active listeners, working in groups
2	Review and Exercise of Direct Proportion	Teacher reviews the concept of direct proportion. Students do the worksheet individually.	Teacher: facilitator Students: doing the worksheet individually
3	Formative Direct Proportion	Students do the Formative Direct Proportion	Teacher: supervisor Students: doing the formative individually
4	Inverse Proportion	Teacher explains the concept of direct proportion and gives several examples. Students work in groups to solve questions, after that doing worksheet individually.	Teacher: material giver, facilitator Students: active listeners, working in groups
5	Review and Formative Inverse Proportion	Teacher reviews the concept of inverse proportion. Students do the Formative Inverse Proportion	Teacher: facilitator, supervisor Students: doing the formative individually
6	Preparation for Summative	Teacher reviews the concept of direct and inverse proportion, and how to distinguish whether a problem is direct or inverse proportion.	Teacher: facilitator Students: active listeners
7	Summative Proportion	Student do Summative Proportion.	Teacher: supervisor Students: doing the summative individually

Instruments that are used to collect data in this study is learning assessment, which include formative and summative assessments. Formative assessment is made in essay form, while summative assessments are made in essay form and true-false questions. All assessments are made in such way in order to know students' ability in doing the assessments and errors that are made by them. Validation of instruments was done by mathematics teacher before be used in assessments. There are indicators in identifying each error. Those indicators can be seen in Table 2.

Table 2.
Indicator for each error

Type of Errors	Indicator of Errors
Conceptual Errors	• Unable to interpret questions or use a terms, concept, and principle. • Unable to choose formula of direct and inverse proportion. • Unable to use formula of direct and inverse proportion.
Procedural Errors	• Inconsistency in the steps taken to solve the assigned problems. • Unable to solve questions to the simplest form.

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Technical Errors	• Made mistakes in the calculation. • Made mistakes in carrying over numbers or operations from one step to the next step.

Resource: Ulfa & Kartini (2021)

The data analysis techniques that is used in this research is Kastolan theory. Lebriansari (2025) stated that this theory can be used as a tool to understand the causes of mathematical errors made by students. Before the analysis process, three students are selected as representatives for three levels of students' results: higher (81 – 100), medium (70 – 80), and lower (under 70). This selection was based on their score in Summative Inequalities they got before. This selection was intended to capture variations in the types and characteristics of mathematical errors across different achievement levels, allowing for a deeper exploration of students' errors patterns and their underlying causes. The finding was not intended to be generalized to all students within each achievement category. Instead, the analysis sought to provide rich insights into how mathematical errors mathematical errors are manifested across varying levels of students' achievement.

The analysis process consists of data reduction, data presentation, and drawing conclusions. The data obtained in this research are in the form of students' answer sheets, which will be reduced. Reducing in this context means students' answer sheets will be simplified and be grouped as one type of error based on Kastolan theory. The next step is presenting the data, which is the result of the reduction in the form of descriptions of students' work. Then, the final step is drawing conclusions from the data based on the second step. To ensure that the results of this research are valid, discussions with mentor always be done. A recheck of the errors classification results was also conducted to avoid errors in grouping and analyzing students' mathematical errors.

3. Result and Discussion

3.1. Results

3.1.1. Implementation of Missouri Mathematics Project (MMP) in Reducing Students' Mathematical Errors

As explained in the previous section, Missouri Mathematics Project (MMP) is a method aimed at assisting educators in boosting the effectiveness of classroom instruction through different activities or tasks to improve students' learning results. There are five syntaxes in MMP, those are introduction, development, cooperative works, individual works, and assignments. This strategy was implemented when students learned about the concept of Proportion. Before they learned this concept, they have learned about the concept of Inequalities and this strategy had not implemented. The Minimum Passing Score (MPS) for all assessments is 70. The result of their summative assessment in Inequalities can be seen in Table 3.

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Table 3.
The results of the Inequalities summative assessment in class VII-4

Score	Frequency	Percentage
< 70	14	50%
70 - 100	14	50%
Total	28	

Based on Table 3, half of students got scores above the MPS, but half of them also got scores under the MPS. This occurs because students who got score under the MPS in class VII-4 made mathematical errors in solving their summative in terms of concepts, procedures, and technical aspects.

In order to reduce their mathematical errors, MMP strategy was implemented in learning when they learned about the concept of Proportion. The implementation of this strategy was conducted based on its syntaxes. In the beginning of each meeting, teacher gives apperception and using interesting introduction to the concepts they will learn. By doing this, students can easily understand the concept of proportion. This also can spark students' interest in learning the concept. After that, in syntaxes cooperative work and individual work, the teacher observes how students solve the questions. In these steps the teacher also points out on students' errors, whether it is conceptual, procedural, or technical errors. Then, students try to correct their answers. If it is individual work, they correct it individually. If it is cooperative work, they correct it in groups.

Figure 1
Interesting introduction slide of the concept of direct proportion (left) and inverse proportion (right)



Figure 1 shows interesting introduction given by teacher to help students understand the concept of direct proportion, inverse proportion, and differences between them. After that, teacher gives further explanation about direct and inverse proportion in development step.

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Figure 2
Development step slide of the concept of direct proportion (left) and inverse proportion (right)

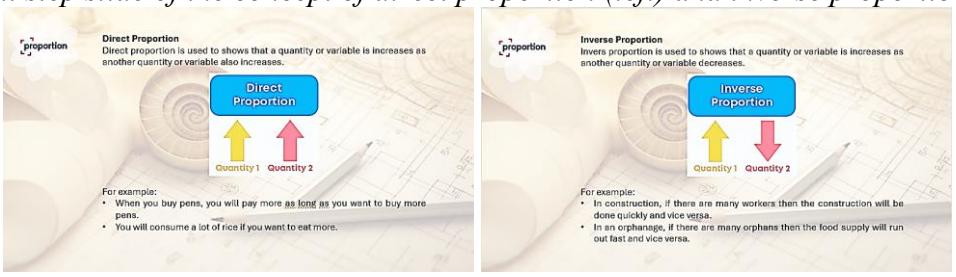
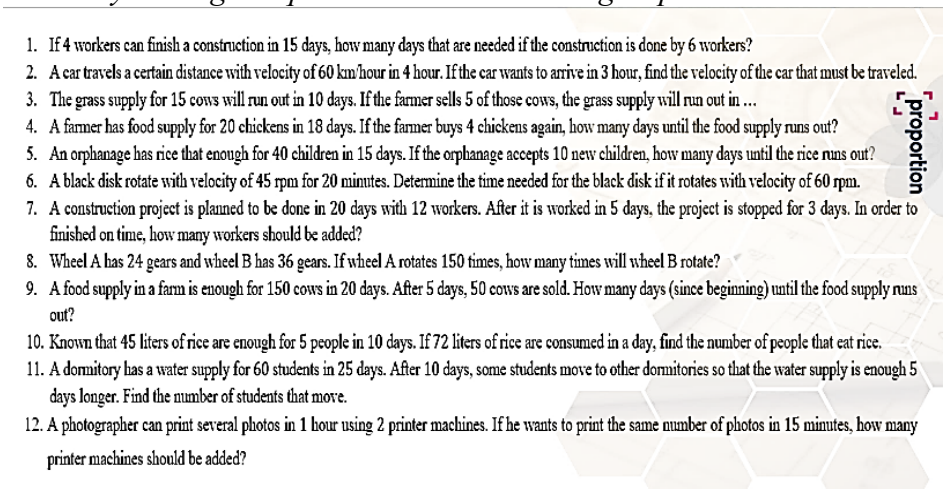


Figure 2 shows how the development step is conducted. In giving more explanation about direct and inverse proportion, teacher gives them definition, an illustration, and some examples of both proportions. By doing this, teacher helps students to understand the concept of direct and inverse proportion well. The next step is cooperative and individual works. Cooperative works are designed to encourage students to work in groups, thereby they can help each other if there are mathematical errors. Teacher also monitors all of those errors made by students. Meanwhile, individual works are designed to help students to understand more about the concept of direct proportion and inverse proportion by solving the given worksheet individually. Those worksheets were made with guided steps so that students can understand the correct way to solve the questions. An example of cooperative works can be seen in Figure 3. Each group must solve two questions on the slide.

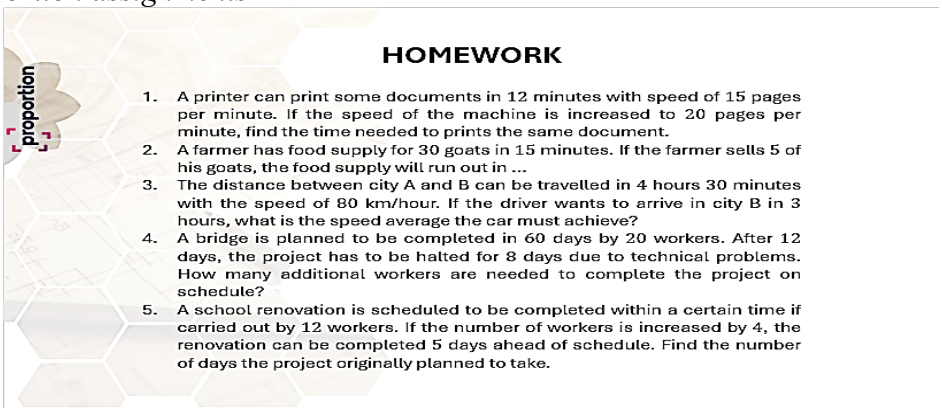
Figure 3
Cooperative works by solving the questions on the slide in group



The last step is assignments. At the end of the class, teacher gives assignments to students related with the concept they have learned in class. Assignments be an instrument for students to increase their understanding to what they have learned recently. Figure 4 shows an example of assignments of students related with inverse proportion.

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Figure 4
Inverse proportion assignments



While implementing this strategy, teacher conducted formative assessments for both direct and inverse proportion. At the end of Proportion material, teacher conducted summative assessment. The result of those assessments can be seen in Table 4.

Table 4.
The results of formative and summative assessments in Proportion material

Score	Summative Inequalities		Formative 1 Proportion		Summative Proportion	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
< 70	3	10.71%	4	14.29%	0	0%
70 - 100	25	89.29%	24	85.71%	28	100%
Total	28		28		28	

Based on Table 4, there is a noticeable increasing from summative Inequalities to formative and summative Proportion. This result shows a reduction in students' mathematical errors in class VII-4. It can be concluded that the implementation of MMP can reduce students' mathematical errors. Through cooperative and individual works, students are able to know their errors and then they try not to make the same errors.

3.1.2. Analysis of Students' Mathematical Errors Based on Kastolan Theory

Based on explanation in the previous part, the MMP strategy can reduce students' mathematical errors. Analysis of these errors can be conducted using Kastolan theory. According to this theory, there are three types of mathematical errors: conceptual errors, procedural errors, and technical errors. These three errors are analyzed to determine why students made them.

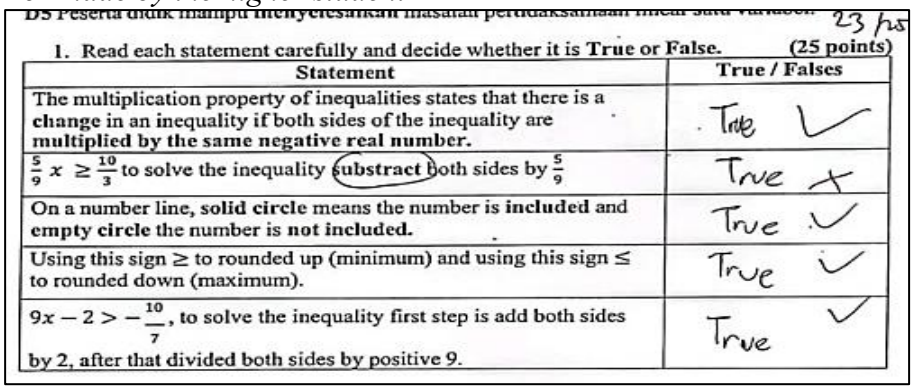
In this research, three students are selected to represent three levels of students' results: higher, medium, and lower. There are also three assessments that are used to analyze their errors: summative Inequalities, formative Direct Proportion, and summative Proportion. Those assessments are chosen because they show how students made mistakes before the strategy was implemented, during the strategy was implemented in their learning, and after the strategy was implemented.

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In summative Inequalities, the higher student got scores 94. This result shows that the higher student has good understanding of Inequalities. But the student still made slight mathematical errors. There are two types of errors made by the student: conceptual error and technical error.

Figure 5

Conceptual error made by the higher student



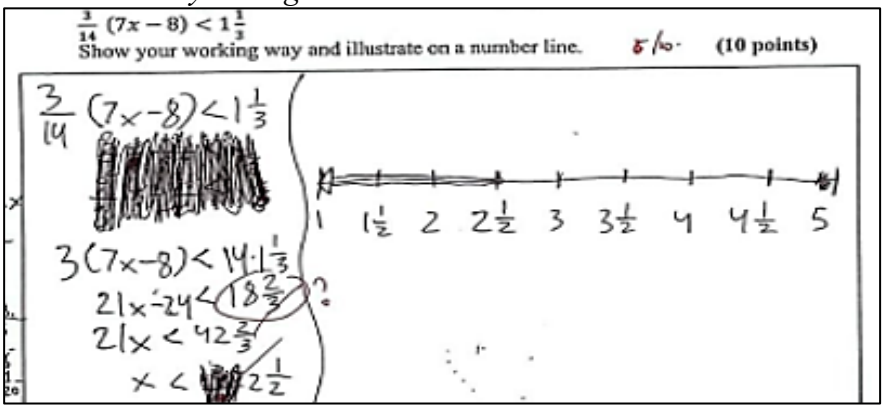
1. Read each statement carefully and decide whether it is **True** or **False.** (25 points)

Statement	True / Falses
The multiplication property of inequalities states that there is a **change** in an inequality if both sides of the inequality are **multiplied by the same negative real number.**	True ✓
$\frac{5}{9}x \geq \frac{10}{3}$ to solve the inequality **substract** both sides by $\frac{5}{9}$	True ✗
On a number line, **solid circle** means the number is **included** and **empty circle** the number is **not included.**	True ✓
Using this sign ≥ to rounded up (minimum) and using this sign ≤ to rounded down (maximum).	True ✓
$9x - 2 > -\frac{10}{7}$, to solve the inequality first step is add both sides by 2, after that divided both sides by positive 9.	True ✓

Figure 5 shows conceptual error made by the higher student in true-false questions. The statement is "$\frac{5}{9}x \geq \frac{10}{3}$ *to solve the inequality* ***subtract*** *both sides by* $\frac{5}{9}$" and the correct answer for this statement is *False* since to solve the inequality the first step is multiply both sides by $\frac{9}{5}$, not subtract both sides by $\frac{5}{9}$. But the higher student wrote that the statement is *True*. This error occurs because the higher student did not read the question carefully.

Figure 6

Slight technical error made by the higher student

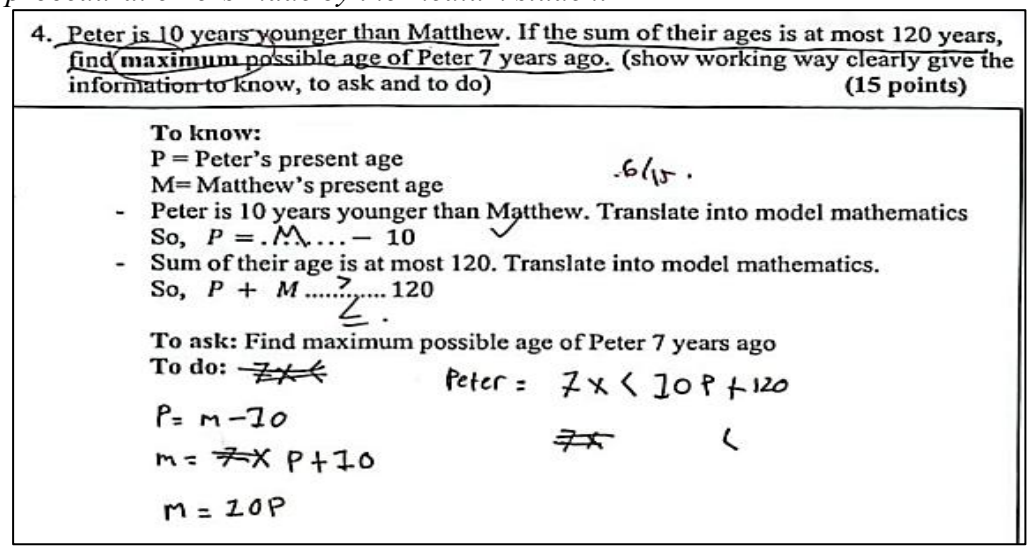


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Figure 6 shows slight technical error made by the higher student when trying to find the value of x. The inequality is $21x < 42\frac{2}{3}$. To find the value of x, the first step is changing the mix number to improper fraction so that $42\frac{2}{3} = \frac{128}{3}$, and then it is divided by 21, thereby the value of x is $x < \frac{128}{63}$ or $x < 2\frac{2}{63}$. But the higher student got $2\frac{1}{2}$ as the result and this is wrong. This error can be made by the student because the student was not careful in calculation.

For the medium student, the student got scores 75. This result shows that the medium student has enough understanding of Inequalities. But the student still made some mathematical errors. Type of errors made by the student is procedural errors.

Figure 7
The first procedural errors made by the medium student


4. Peter is 10 years younger than Matthew. If the sum of their ages is at most 120 years, find maximum possible age of Peter 7 years ago. (show working way clearly give the information to know, to ask and to do) (15 points)

To know:
P = Peter's present age
M= Matthew's present age
- Peter is 10 years younger than Matthew. Translate into model mathematics
So, P = M ... – 10
- Sum of their age is at most 120. Translate into model mathematics.
So, P + M 120

To ask: Find maximum possible age of Peter 7 years ago
To do:

P= m –10
m = 7x P+10
m = 10P

Peter = 7x < 10P + 120

Figure 7 shows the first procedural errors made by the medium student. The question asked the student to determine the age of P. To find the age of P the student must fill the blank part first to get some information. The student got that P = M – 10 and P + M ≤ 120. The next step is substituting the value of P with M – 10. But the student wrote $7x < 10P + 120$. This does not even match with the information. There is no variable x, but the student suddenly uses it. This error occurs because the student did not understand how to use that information to solve the question and the next step should be done to answer the question.

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Figure 8

The second procedure errors made by the medium student

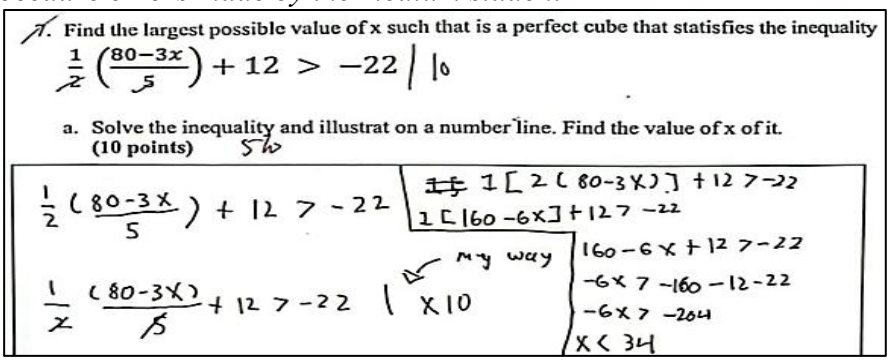


Figure 8 shows the second procedure errors made by the medium student when trying to find the value of x. The inequality is $\frac{1}{2}\left(\frac{80-3x}{5}\right)+12>-22$. The first step is eliminating the fraction on the left side by multiplying both sides by 10 so that it will become $80 - 3x + 120 > -220$. But the student did wrong algebra operation because the student did not multiply 10 to all algebraic forms so that the inequality became $1[2(80 - 3x)] + 12 > -22$. This error occurs because the student was to focus on eliminating the fraction on the left side, thereby the student forgot to multiply all algebraic forms with 10.

For the lower student, the student got scores 50. This result shows that the lower student needs improvement in learning Inequalities. The student still made significant mathematical errors. There are two types of errors made by the student: conceptual error and procedural errors.

Figure 9

Conceptual error made by the lower student

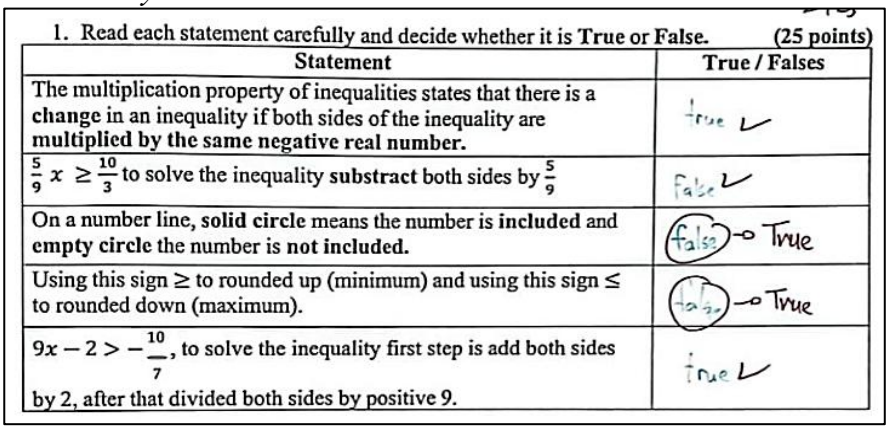


Figure 9 shows conceptual error made by the lower student in true-false questions. There are two statements in which the lower student made errors. The first statement is "*On a number line,* ***solid***

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circle *means the number is* ***included*** *and* ***empty circle*** *the number is* ***not included.***" The correct answer is *True*, but the student wrote that the answer is *False*. The second statement is "*Using this sign ≥ to rounded up (minimum) and using this sign ≤ to rounded down (maximum).*" The correct answer is *True* because the symbol "≥" means *at least* or *minimum* and the symbol "≤" means *at most* or *maximum*, but the student wrote that the statement is *False*. This error occurs because the student was unable to distinguish between solid circle and empty circle, and also between the symbol "≥" and "≤".

Figure 10

The first procedural errors made by the lower student

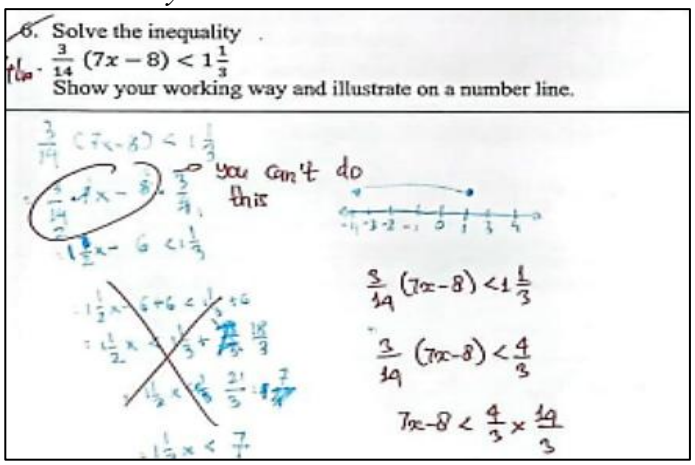


Figure 10 shows the first procedural errors made by the lower student when trying to find the value of x. The inequality is $\frac{3}{14}(7x-8) < 1\frac{1}{3}$. Procedures in solving this inequality is change $1\frac{1}{3}$ to improper fraction and then multiply both sides by $\frac{14}{3}$ so that the inequality becomes $7x - 8 < \frac{56}{9}$. But the student forgot the bracket and thought that $\frac{3}{14}$ was only multiplied by $7x$ and 8 was multiplied with $\frac{3}{4}$.

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Figure 11
The second procedural errors made by the lower student

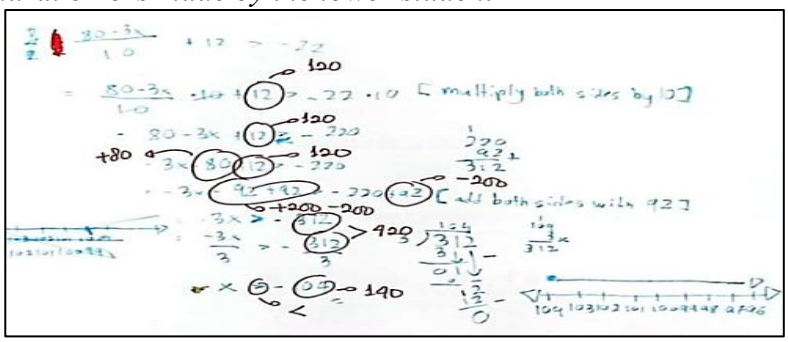
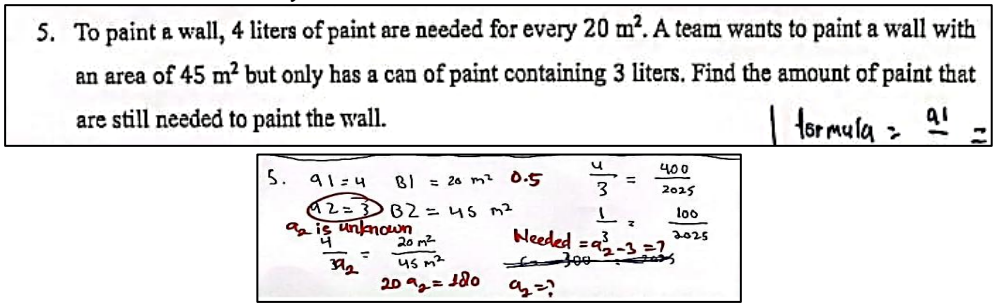


Figure 11 shows the second procedural errors made by the lower student when trying to find the value of *x*, too. The inequality is $\frac{1}{2}\left(\frac{80-3x}{5}\right)+12>-22$. The first step is eliminating the fraction on the left side by multiplying both sides by 10. But the student was not multiplied all algebraic forms with 10 so that the inequality became $80 - 3x + 12 > -220$. This error occurs because the student was to focus on eliminating the fraction on the left side, thereby the student forgot to multiply all algebraic forms with 10.

In formative Direct Proportion, the higher student got scores 100. This result shows that the higher student has perfect understanding of Direct Proportion. There is no mathematical error the student made. The student remembers the concepts well, uses procedures in the right way, and be careful in calculating the result.

For the medium student, the student got scores 92. This result shows an improvement than before. This also shows that there is a reducing in mathematical errors the medium student made. Although there is an improvement, the medium student still made slight mathematical errors. The types of errors the student made is technical errors.

Figure 12
The first technical errors made by the medium student



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Figure 12 shows the first technical errors made by the medium student. The student treated paint as variable a and time as variable b. From the question known $a_1 = 4$, $b_1 = 20$, and $b_2 = 45$. The question asks the student to find the amount of paint that are still needed to paint the wall if there are already 3 liters of paint available so that the student has to find the value of a_2 first. But the medium student was misled by thinking that 3 liters was the value of a_2. The process in doing this question is correct, but the inputted value is wrong. This error occurs because the student directly uses all the value given by the question without reading the question carefully.

Figure 13

The second technical errors made by the medium student

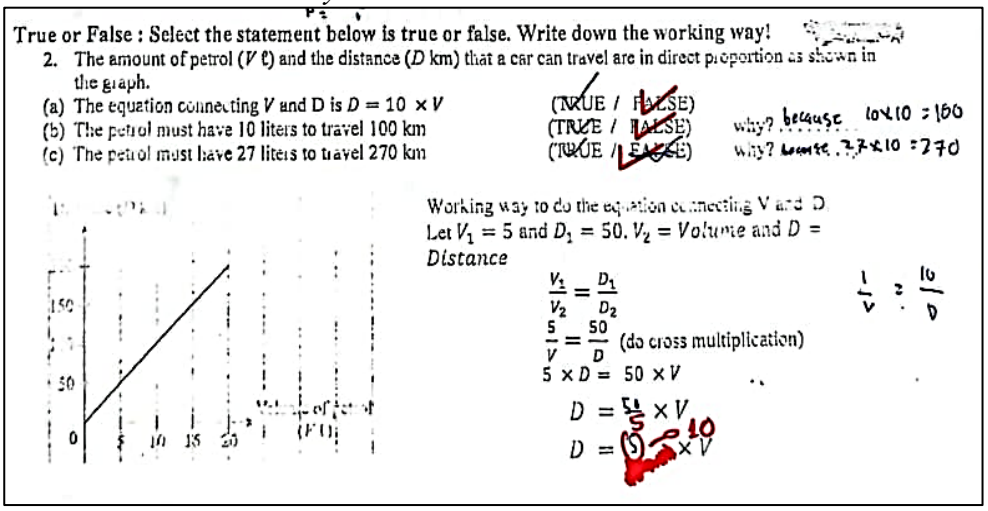


Figure 13 shows the second technical errors made by the medium student when trying to find the relation between volume (V) and distance (D). The student wrote that $D = 50 \times V$. The correct answer is $D = 10 \times V$, where 10 is obtained by dividing 50 by 5. This error occurs because the medium student was not careful in calculating the results.

For the lower student, the student got scores 57. This result shows an improvement than before. This also shows that there is a reducing in mathematical errors the lower student made. Although there is an improvement, the lower student still made some mathematical errors. There are two types of errors made by the student: procedural error and slight technical error.

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Figure 14
Procedural error made by the lower student

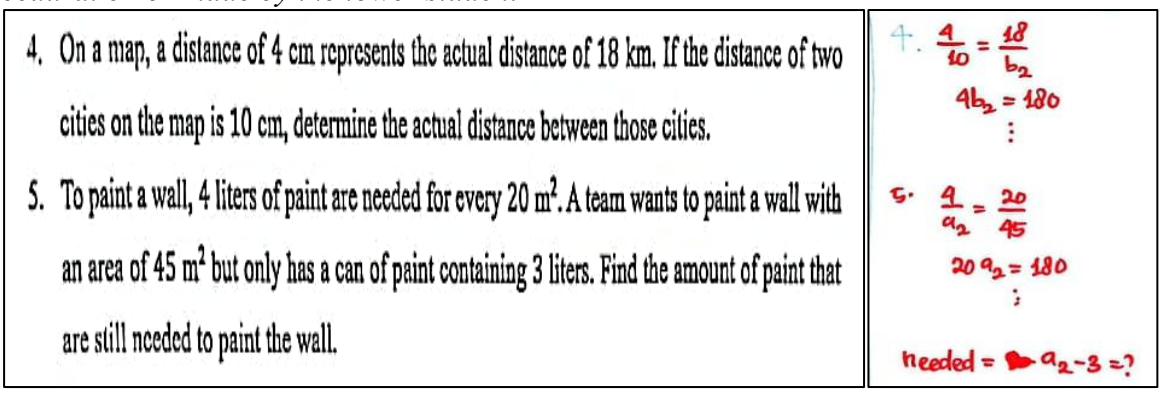


Figure 14 shows procedural error made by the lower student. The student did not know the procedures to solve question 4 and 5. This error occurs because the student could not understand the questions and how to use all given information.

Figure 15
The first technical errors made by the lower student

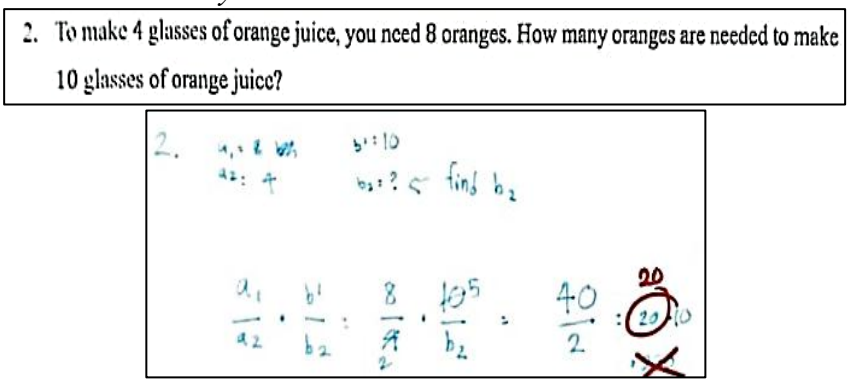


Figure 15 shows slight technical error made by the lower student. The student treated the number of oranges as variable a and the number of glasses as variable b. From the question known that $a_1 = 8$, $a_2 = 4$, and $b_2 = 10$. But the lower student was misled by thinking that b_2 was the unknown variable. This results an incorrect calculation. This error occurs because the student did not read the question carefully.

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Figure 16
The second technical errors made by the lower student

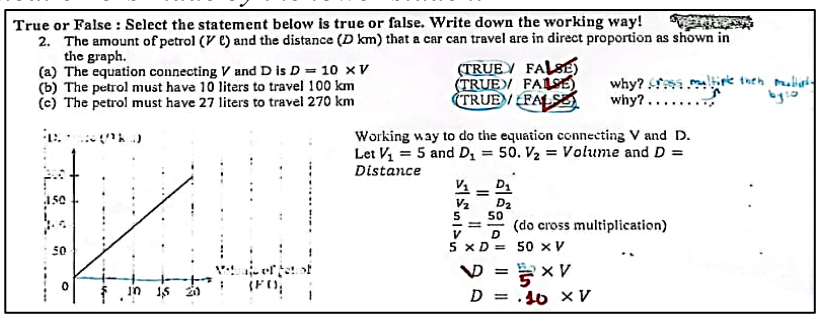


Figure 16 shows the second technical errors made by the lower student when trying to find the relation between volume (V) and distance (D). The student wrote that D = 50 × V. The correct answer is D = 10 × V, where 10 is obtained by dividing 50 by 5. This error occurs because the lower student was not careful in calculating the results.

In summative Proportion, the higher student got scores 100. This result shows that the higher student has perfect understanding of Direct Proportion and Inverse Proportion. There is no mathematical error the student made. The student remembers the concepts well, uses procedures in the right way, and be careful in calculating the result.

For the medium student, the student got scores 96. This result shows that the medium student has improved well in learning Proportion. But the student still made slight mathematical errors. There are two types of errors made by the student: slight conceptual error and slight technical error.

Figure 17
Slight conceptual error made by the medium student

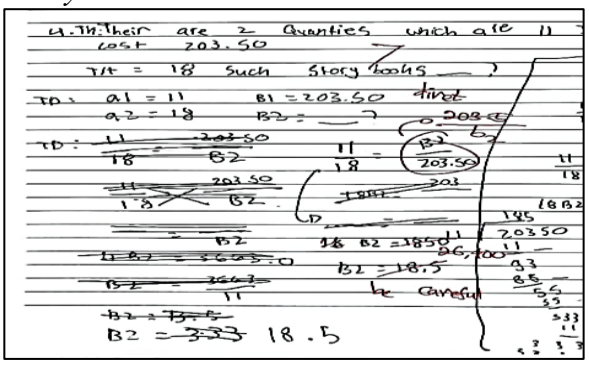


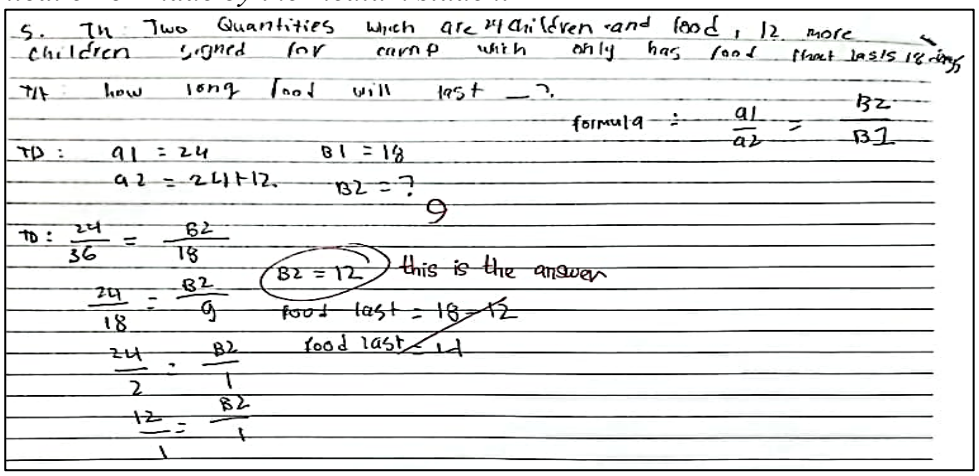
Figure 17 shows slight conceptual error made by the medium student. In this question, student is asked to find the price of 18 books if know that the price for 11 books is $203.50. This question uses the concept Direct Proportion. But the medium student used the concept of Inverse Proportion because the student saw that the next two questions also use the same concept. This made the result wrong even though the calculation is correct.

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The medium student also made slight technical error when trying to wrote the answer for question number 5. The question stated that food for 24 children is enough for 18 days and asked the student to find how long the same amount of food will last if the number of children increases by 12. The correct answer is 12 days, but the student subtracted 18 days from the information in the question by 12 days as the answer. This error occurs because the student assume that the question asked to find the difference in days. Figure 18 shows the slight technical error made by the medium student.

Figure 18

Slight technical error made by the medium student



For the lower student, the student got scores 72. This result shows that the lower student has improved well in learning Proportion, thereby the student could pass the MPS. But the student still made slight mathematical errors. There are two types of errors made by the student: procedural error and slight technical error.

Figure 19

Procedural error made by the lower student

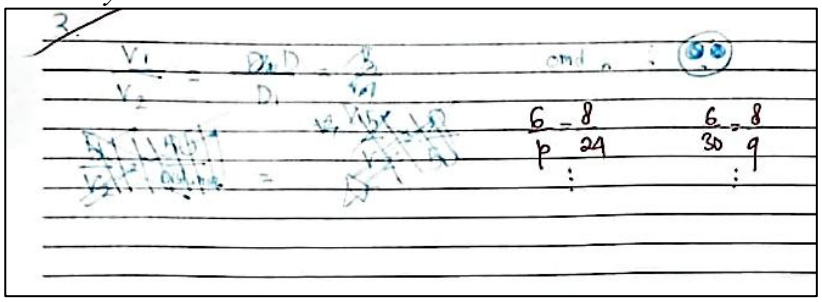


Figure 19 shows procedural error made by the lower student. This error occurs because the student did not know the procedures in to find the value of *p* and *q*. That is why the student did not write down any steps for this question. There were only a few scribbled calculations so that the student lost points on this question.

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Figure 20
Slight technical error made by the lower student

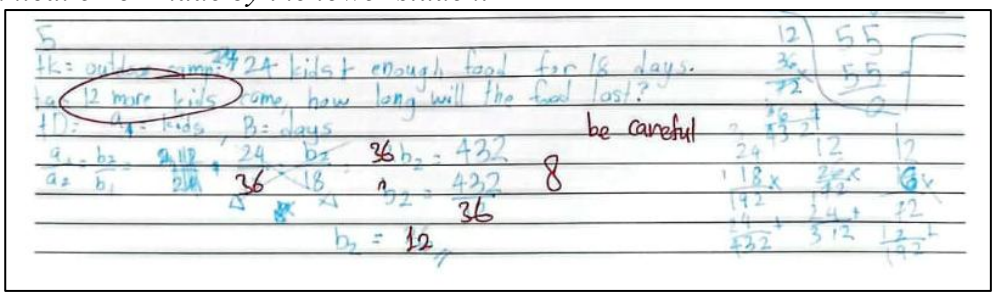


figure 20 shows slight technical error made by the lower student. In this question known that food for 24 children is enough for 18 days and asked the student to find how long the same amount of food will last if the number of children increases by 12. The lower student treated the number of children as variable *a* and days as variable *b*. From the question it follows that $a_1 = 24$, $a_2 = 36$, and $b_1 = 18$. But the student assumed that $a_2 = 12$ because the question stated that the number of children increased by 12. This is what caused the calculation to be incorrect. This error occurs because the student did not read the question carefully and directly used all the values.

3.2. Discussion

This study uses the Missouri Mathematics Project (MMP) to reduce students' mathematical errors and analyze those errors using Kastolan theory. There are three assessments that are used to see mathematical errors made by them, those are summative Inequality, formative Direct Proportion, and summative Proportion. Three students are selected to represent three levels of students' results: higher, medium, and lower. Before the MMP strategy was implemented (in summative Inequality), all students made mathematical errors. The higher student made conceptual error and slight technical error, thereby the student got scores 94. The medium student made some procedural errors, thereby the student got scores 75. While the lower student made conceptual errors and many procedural errors, thereby the student got scores 50.

During the implementation of the MMP strategy (in formative Direct Proportion), all students show an improvement in their results. Cooperative and individual works helps students to see those errors clearly. The higher student did not make any kind of errors, thereby the student got scores 100. The student remembers the concepts well, uses procedures in the right way, and be careful in calculating the result. The medium student still made slight technical errors, thereby the student got scores 92. This result increases than the result of summative Inequality before. The lower student also still made some procedural errors and slight technical errors, thereby the student got score 57. Although this score is still under the MPS (which is 70), this show an improvement in the lower student's result during the MMP strategy was implemented.

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After the implementation of the MMP strategy (in summative Proportion), all students show an improvement because they all pass the MPS. The higher student did not make any kind of errors, thereby the student got scores 100. The student remembers the concepts well, uses procedures in the right way, and be careful in calculating the result. The medium student still made slight conceptual errors and slight technical errors, thereby the student got scores 96. This result increases than the result of formative Direct Proportion before. The lower student shows an improvement because the student got score 72 so that the student passed the MPS. The lower student still made procedural errors and slight technical error.

Based on explanation above, it is seen that the MMP shows positive indication in reducing students' mathematical errors in class VII-4. This research supports previous research which shows that MMP can be used to reduce students' mathematical errors. The research conducted by Nababan (2026) gives a results that the implementation of this strategy can helps students in reducing their errors makes by them to recheck again their results. This is also supported by the research conducted by Bertutu et al. (2022), where class who did not use the MMP strategy made more errors in solving mathematical problems than the class that did this strategy. This reduction in students' mathematical errors affects to increase in students' ability to solve mathematical problems. This is in line with the research conducted by Harianda & Junedi (2021) that the MMP strategy can increase students' ability to solve mathematical problems. The MMP strategy gives positive impacts on mathematical conceptual skills, making learning more active and meaningful by cooperative and individual works.

4. Conclusion

This study aims to see how the implementation of Missouri Mathematics Project (MMP) can reduce students' mathematical errors. Based on assessments and analysis of results of summative Proportion by comparing it with results of formative Direct Proportion and summative Inequality, it can be concluded that the implementation of the MMP strategy is proven to minimize or reduce students' mathematical errors. This is supported by increasing in students' results before the strategy was implemented (in summative Inequality), during the strategy was implemented (in formative Direct Proportion), and after the strategy was implemented (in summative Proportion). All students passed the MPS, which is 70 in summative Proportion. This is also supported by cooperative and individual works, which further sharpened students' ability to solve problems related to the material taught. Analysis of students' mathematical errors is essential to enable teachers in identifying students' weaknesses in solving mathematical problems, thereby teachers can provide intensive guidance to reduce those errors. However, this study involved only 28 students as subjects. This study also has limitation because a detailed analysis of each students' mathematical errors pattern is not available. Therefore, further research with a larger sample size is needed to make the conclusions that MMP can reduce mathematical errors more valid and a detailed analysis of each students' mathematical errors pattern must be provided.

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