Studies in Learning and Teaching (SiLeT)
Homepage: https://scie-journal.com/index.php/SiLeT
Email: silet@scie-journal.com

p-ISSN: 2722-399X; e-ISSN: 2722-1857
SiLeT, Vol. 4, No. 1, April 2023
Page 157-169
©2023 SiLeT

Students' Learning Trajectory in Solving Fraction Problems: Cases of Boy and Girl Students in Junior High School

***M Rizal[1], T Y E Siswono[2], Nurdin[3], T Bitara[1]**
[1]Department of Mathematics, FKIP Universitas Tadulako Palu, Indonesia
[2]Department of Mathematics, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya, Indonesia
[3]Department of Mathematics, FKIP UNIMEN Enrekang, Sulawesi Selatan, Indonesia

Article Info

Article history:

Received March 22, 2023
Revised May 1, 2023
Accepted May 5, 2023
Available Online May 6, 2023

Keywords:

Learning trajectory
Fractions
Problem solving
Sex

ABSTRACT

This study aims to describe the learning trajectories of male and female students in solving fraction problems. The research subjects consisted of a male student and a female student who had the same mathematical ability. Learning trajectory data for both subjects were taken through fractional problem solving tests and in-depth interviews. Observations focused on the four stages of problem solving strategies, namely understand the problem, divide a plan, carry out the plan, and look back. Data analysis begins with examining all data, reducing data, grouping data, categorizing, coding, and finally checking data through time triangulation. The results of the study show that in understanding the problem, boys identify goals and information to solve the problem to state its completeness, and girls identify information to solve the problem to state its completeness. In making plans, girls complete in detail and involve many concepts, while boys only have one concept, so girls' learning trajectories are longer. While carrying out the plan, the two solve problems according to the plan. Looking back, girls used more than one method alternative while boys only used one alternative.

https://doi.org/10.46627/silet

INTRODUCTION

Indonesia's education reform is not only focused to improving educational facilities and infrastructure, but also on improving learning strategies by prioritizing student-oriented learning. Student-oriented learning requires students to be able to find and construct their knowledge (Caputi & Garrido, 2015; Ijirana & Supriadi, 2018). To provide knowledge to students, a teacher needs to know the students' thinking processes including the learning trajectories that students have. learning trajectory can provide an overview to teachers about students' thinking processes in learning. Therefore the teacher needs to know this and make it the basis for planning a lesson, so that the material presented can be well received because it is in accordance with the level of thinking of students. Learning planning based on this learning trajectory allows teachers to build children's thinking naturally in achieving learning goals. Clement & Sarama (2020) stated "learning trajectories allow teachers to build the thinking of children as it develops naturally. So, all the goals and activities are within the developmental capacities of children. Finally, activities provide the learning for school success. Through learning trajectories, teachers can develop student ways of thinking so that they can provide appropriate learning activities to achieve learning objectives. Emphson (2011) stated "provisional creation of researchers attempting to understand students' learning and to represent it in a way that is useful for teachers, curriculum designers, and test makers. Learning trajectory can be used by teachers, curriculum developers and assessment developers. Rofiki (2018) and Wijaya & Doorman (2021) stated that knowing students' learning trajectory can assist educators in designing instructional model/strategy in

response to students' mathematical thought process. The same thing was stated by Clements and Sarama (2004), namely "Thus, learning trajectories can facilitate developmentally appropriate teaching and learning for all children" which means that knowledge of student learning trajectories will assist teachers in facilitating learning according to the development of each student.

Learning trajectory can be known through the process of solving problems. This process may differ due to gender. Men and women have a tendency to use different problem-solving strategies. Helwig et al. (2001) and Rizal et al. (2013) stated that mathematical abilities, accuracy, and skills in arithmetic were also influenced by differences in gender. Carpenter & Moser (2020) and Ganley & Lubienski (2016) stated "that boys tend to use newer problem-solving strategies, while girls are more likely to follow procedures taught at school". This means that male students tend to use unusual problem-solving strategies, namely strategies that are unique and not tied to routine procedures. Meanwhile, female students tend to follow the problem solving procedures taught at school. This illustrates that male students tend to look for their own strategies compared to female students and this can be done by students who already have the basic provisions from the previous level of education. Difference strategy in solving problems indicates that there is difference in the learning trajectory of both. Therefore, this study took boy and girl subjects in junior high school.

Learning trajectory can be observed properly if the problem solved involves many concepts, because the sequence of mental activity stages can be observed from the association between one concept and another in achieving the goals. This illustrates that learning trajectories can be traced when carrying out activities in linking between concepts when solving problems. Chen (2014) and Chen (2016) stated that learning trajectory can provide an overview of mental activity in achieving goals when solving problems.

The learning trajectory in this study uses fractional problems, because apart from involving many interrelated concepts, this material is also the basic material that is very much needed in studying further mathematics, as stated by Misquitta (2011), Fennell & Karp (2017), Namkung & Fuchs (2019), and Singh et al. (2021) namely, "proficiency with fractions is an important foundation for learning more advanced mathematics".

As a basic material that students need to be master, the teacher is expected to teach it well so that the material presented can be well received by students. One of the things that teachers need to know to be able to teach well is students' learning trajectory. If know this then teacher has an overview of the concepts that students have so that they can create a framework to plan effective learning according to the students' abilities. In addition, teacher will also be able to develop knowledge to learning based on the students' learning trajectory, so that students have basic knowledge to learn more mathematics. Knowledge of students' learning trajectory can also be used as a basis for improve the student's thinking stages in solving problems so that the work carried out is clearer, simpler and more efficient.

Based on the description above, this study reveals the learning trajectory of junior high school students in solving fractional problems based on sex differences.

RESEARCH METHOD

This study examined students' learning trajectory in solving fractional problems in terms of sex differences. The subjects of this study were boy students (S1) and girl student (S2) who had the same mathematical ability.

The learning trajectory data of both subjects was taken through fractional problem solving tests and in-depth interviews. Observations focused on each stage of Polya's problem-solving strategy (Rizal & Lefrida, 2018) which consisted of four stages, namely understand the problem, devise a plan, carry out the plan, and look back. The data analysis used data analysis techniques by Moleong (2018) and Palandu & Rizal (2022) namely examining all data, reducing data, grouping data, categorizing, coding, and checking data through time triangulation.

RESULTS AND DISCUSSION

Result

The data credibility check was conducted by time triangulation, which is giving two equivalent fractional problem solving tests (M1 and M2) followed by in-depth interviews at different times. The results of the examination showed that the learning trajectory data of both subjects in solving M1 and M2 was credible. Therefore, the analysis and display in this section is only the learning trajectory data of both subjects in solving M1. The M1 in question is as follows.

> Mr. Ahmad will share his plot of land to his three children on the condition the older child must obtain a larger plot. Mr. Ahmad's children starting from the eldest are Hendra, Ahsan, and Rian. The total land area of the plot is 1.200 m^2 with the area of each plot as follows.
> Plot A covers 22% part of the total area.
> Plot B covers an area of $\frac{11}{25}$ part of the total area.
> Plot C is 0,34 part of the total area.
> If Hendra wants to give half of his plot of land area to his two brothers equally wide, then what percentage of land area belongs to each of them?

Figure 1. Problem solving test (M1)

S1 and S2 in understand the problem

S1 learning trajectory data in understanding M1 taken by in-depth interviews is presented in Table 1 as follows.

Table 1. S1's interview results in understanding M1

R/S1	Interview Sentence	Interview Code
R :	What do you understand about this question?	RM1-009
S1 :	The question asked about this question is what percentage of the land area belongs to each child.	S1M1-010
R :	Okay.	RM1-011
S1 :	The thing that is known from the question is that Mr. Ahmad will share his plot land to his three children.	S1M1-012
R :	Yes	RM1-013
S1 :	Hendra is the first child, Ahsan is the second child, and Rian is the third child.	S1M1-014
R :	Yes	RM1-015
S1 :	The condition of the land to be divided is that older children must obtain a larger plot of land.	S1M1-016
R :	What does that mean?	RM1-017
S1 :	So, the first child's plot is larger than the second child's plot, the second child's plot is larger than the third child's plot.	S1M1-018
R :	Anything else do you understand?	RM1-019
S1 :	Land area is 1.200m^2, area of Plot A is 22% of the total area, area of Plot B is $\frac{11}{25}$ part of the total area, the area of Plot C is 0,34 part of the total area.	S1M1-020
R :	Anything else do you understand?	RM1-025
S1 :	The first child will give half of his plot to his brothers equally.	S1M1-026
R :	Okay, anything else do you understand?	RM1-033
S1 :	That is it, so it just needs to be done.	S1M1-034
P :	Is the information are complete to solve the question?	RM1-037
S1 :	Yes.	S1M1-038

S2 learning trajectory data in understanding M1 taken by in-depth interviews are presented in Table 2 as follows.

Table 2. S2's interview results in understanding M1

R/S2	Interview Sentence	Interview Code
R :	What do you understand about this question?	RM1-009
S2 :	Mr. Ahmad will share his plot of land to his three children. Older children should get a larger plot.	S2M1-010
R :	Yes, and then?	RM1-013
S2 :	The total land area is $1{,}200m^2$, the area of Plot A is 22% of the total area, the area of Plot B is $\frac{11}{25}$ part of the total area and the area of Plot C is 0,34 part of the total area.	S2M1-014
R :	Yes, and then?	RM1-015
S2 :	Quiet then says "The first child will give half of his plot to his brothers equally large". Then quiet again.	S2M1-016
R :	Anything else do you understand?	RM1-019
S2 :	There is, that is the question asked.	S2M1-020
R :	What's being asked?	RM1-021
S2 :	Percentage of the land area owned by each child.	S2M1-022
R :	Okay, and then?	RM1-025
S2 :	Next work.	S2M1-026
R :	Is the information are enough to work the question?	RM1-027
S2 :	Quiet and then says "Yes it is enough".	S2M1-028

The results of the study of in-depth interview data about learning trajectory in understanding M1 show that S1 starts from identifying what is asked or wanted from M1 (S1M-010). After knowing what is being asked, then carefully identifying the available information one by one the relationship between the thing being asked and the available information (S1M-012 to S1M-034). After having an overview of the relationship between the question and the available information, finally stated that the information was enough to complete M1 (S1M1-034 to S1M-038). In other cases S2 in understanding M1, she starts from identifying one by one the available information (S2M1-010 to S2M1-014). After that, identify what is asked or wanted from M1 (PM1-015 to S2M1-022). To get answers the question, they are silent for a moment to think by linking the known information and the question, until finally stating that the available information was enough to complete M1 (S2M1-028).

S1 and S2 in devise a plan

S1 learning trajectory data when planning to solve of M1 taken by in-depth interviews are presented in Table 3 as follows.

Table 3. S1's interview results in devising a plan of M1

R/S1	Interview Sentence	Interview Code
R :	Okay, what do you plan to solve this question?	RM1-039
S1 :	First, look for plot belonging to each child.	S1M1-040
R :	How to find it?	RM1-041
S1 :	Fraction 22%, $\frac{11}{25}$, and 0,34 are created equal.	S1M1-042
R :	Made the same?	RM1-043
S1 :	All three are converted to fractions of one hundredth so that the order of the area of the three plots is known. The most spacious plot is for the first child, the plot with the second area is for the second child, and the plot with the third area is for the third child	S1M1-044
R :	If the plot belonging to the three children has been obtained next how?	RM1-045
S1 :	The first child's plot was divided in half so that half of it was divided into two.	S1M1-046
R :	After that?	RM1-047
S1 :	The first child's plot is reduced by half, while the second child's plot and the third child increase. After that will be directly obtained a percentage of the land area owned by each child.	S1M1-048
R :	Get a percentage right away?	RM1-049
S1 :	Yes, because the plan was that the whole fraction was converted into the hundredth of all, percent it means fractions of a hundredth	S1M1-050

https://doi.org/10.46627/silet.v4i1.212

S2 learning trajectory data when planning to solve of M1 taken by in-depth interviews are presented in Table 4 as follows.

Table 4. S2's interview results in devising a plan of M1

R/S2	Interview Sentence	Interview Code
R :	Okay, what do you plan to solve this question?	RM1-029
S2 :	First, look for plot belonging to each child.	S2M1-030
R :	How to find it?	RM1-031
S2 :	Sorted the area of the three plots so that it is known the order of the area of the three plots.	S2M1-032
R :	How do I sort it?	RM1-033
S2 :	First find the area of each plot by multiplying it by 1,200 m^2	S2M1-034
R :	Why?	RM1-035
S2 :	In order to know the area of each plot to be sorted. The plot with the first order of area is for the first child, the plot with the second order of area is for the second child, and the plot with the third order of area is for the third child	S2M1-036
R :	After that?	RM1-037
S2 :	The plot belonging to the first child is divided in half to get a half, the half is divided in half again. It means that the land area of the first child decreases, while the land area of the second child and third child increases.	S2M1-038
R :	After that?	RM1-039
S2 :	Percentage the area.	S2M1-040
R :	And then?	RM1-041
S2 :	Got the answer.	S2M1-042

Based on the analysis of the results of the interview above, it is known that S1's learning trajectory in devising a plan of M1, first find out the area of each plot (PM1-039 to S1M1-042), then find out the area of each child's plot (S1M1-044 to PM1-045), then find out the area of the first child's plot because half of it will be given to his brothers equally (PM1-045 to S1M1-046). Therefore the S2's learning trajectory, she plan to start by finding out the area of each child's plot (S2M1-030 to S2M1-032), then find out the area of each plot (S2M1-034 to S2M1-036), then find out the area of the first child's plot because half of it will be given to his brothers equally (PM1-037 to S2M1-038).

The description provides an illustration that the learning trajectory of S1 and S2 in solving the problem of M1 that although both are at the same level of mathematical ability, but S1 (boy) has a shorter plan because it only involves some information, compared to S2 (girl) involves all the information to devise a plan.

S1 and S2 in carry out the plan

The results of S1 and S2 in carrying out the plan of M1 are as follows.

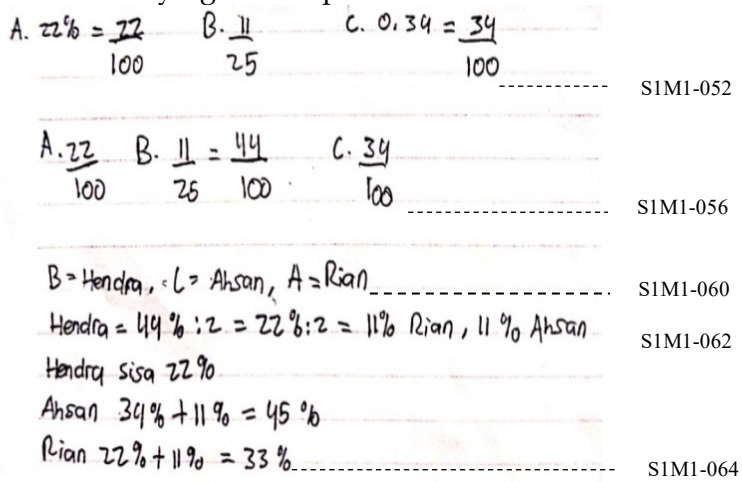


Figure 2. S1's work of M1

https://doi.org/10.46627/silet.v4i1.212

The results of reduction to the data of S1 interview results in implementing the M1 completion plan are presented in Table 5 as follows.

Table 5. S1's interview results in carrying out of M1

R/S1	Interview Sentence	Interview Code
R :	Okay, let's do it.	RM1-051
S1 :	(*While writing the completion*) The area of plot A is 22% $= \frac{22}{100}$, the area of plot B is $\frac{11}{25}$, and the area of plot C is 0,34 $= \frac{34}{100}$.	S1M1-052
R :	Why it is like that?	RM1-053
S1 :	Because percent is one hundredth, so 22% $= \frac{22}{100}$, if 0,34 $= \frac{34}{100}$ because there are two numbers behind the comma then it becomes a hundredth.	S1M1-054
R :	After that?	RM1-055
S1 :	(*While writing down the completion*) The area of plot A is $\frac{22}{100}$, the area of plot B is $\frac{11}{25} = \frac{44}{100}$, the area of plot C is $\frac{34}{100}$.	S1M1-056
R :	Why is the extent of Plot B so $\frac{44}{100}$?	RM1-057
S1 :	Numerators and denominators multiplied by 4 to be hundreds.	S1M1-058
R :	After that?	RM1-059
S1 :	Since it's already a fraction of a hundredth of all, then it's sorted. (*While writing down the completion*) Plot B belongs to Hendra, Plot C belongs to Ahsan, Plot A belongs to Rian.	S1M1-060
R :	After that?	RM1-061
S1 :	(*While writing down the completion*) Hendra's land area is 44% ÷ 2 = 22% ÷ 2 = 11%, 11% for Rian and 11% also for Ahsan.	S1M1-062
R :	After that?	RM1-063
S1 :	(*While writing down the completion*) The remaining of Hendra's area is 22% because 44% − 22% = 22%, Ahsan's area becomes 34% + 11% = 45%, and Rian's land area becomes 22% + 11% = 33%.	S1M1-064
R :	So what percentage of land area of each child?	RM1-065
S1 :	Hendra is 22%, Ahsan is 45%, Rian is 33%.	S1M1-066

The results of S2's work in carrying out the plan of M1.

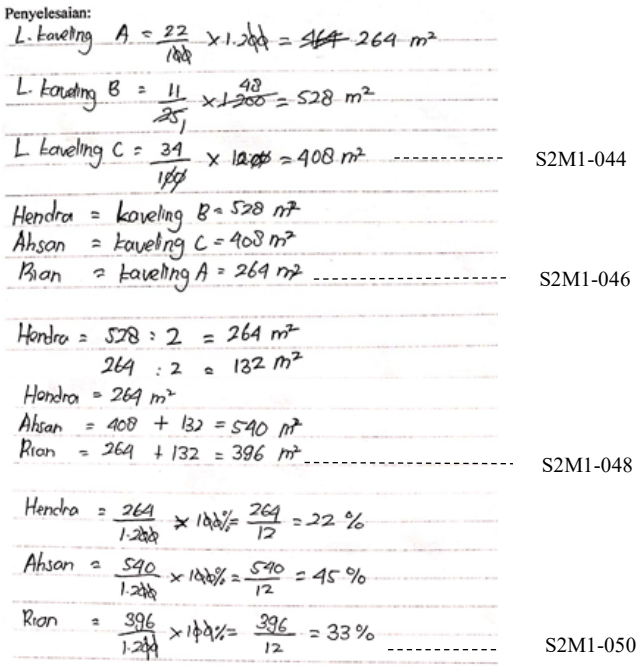


Figure 3. S2's work of M1

https://doi.org/10.46627/silet.v4i1.212

The results of reduction to the data from S2 interview in carrying out the plan of M1 are presented in Table 6 as follows.

Table 6. S2's interview results in carrying out of M1

R/S1	Interview Sentence	Interview Code
R :	Okay, try to do it!	PM1-043
S1 :	(*While writing the solution*) The area of plot A is $22\% = \frac{22}{100} \times 1.200 = 22 \times 12 = 464$ so $264\ m^2$. The area of plot B is $\frac{11}{25} \times 1.200 = 11 \times 48 = 528\ m^2$. The area of plot C is $0{,}34 = \frac{34}{100} \times 1.200 = 34 \times 12 = 408\ m^2$	S2M1-044
R :	After that?	PM1-045
S1 :	(*While writing the solution*) Hendra's plot is land B which has an area of $528\ m^2$, Ahsan's plot is land C which has an area of $408\ m^2$, Rian's plot is land A which has an area of $264\ m^2$	S2M1-046
R :	And then?	PM1-047
S1 :	(*While writing the solution*) Hendra's plot is divided by two that is $528 \div 2 = 264\ m^2$, and divided by two again that is $264 + 132 = 396\ m^2$. It means that Hendra's plot remains $264\ m^2$ because it is reduced by half, Ahsan's $408 + 132 = 540\ m^2$ because it is added from Hendra's, Rian's $264 + 132 = 396\ m^2$ because it is added also from Hendra's.	S2M1-048
R :	After that?	PM1-049
S1 :	(*While writing the solution*) Hendra's $\frac{264}{1.200} \times 100\% = \frac{264}{12} = 22\%$. Owned by Ahsan $\frac{540}{1.200} \times 100\% = \frac{540}{12} = 45\%$. Rian's $\frac{396}{1.200} \times 100\% = \frac{396}{12} = 33\%$.	S2M1-050
R :	So, what percentage of the land area they each own?	PM1-051
S1 :	Hendra is 22%, Ahsan is 45%, Rian is 33%.	S2M1-052

The results of the study of the data show that the completion plan prepared by S1 and S2 are in line with their implementation. This can be seen from the similarity of the plans previously disclosed with their implementation. The process of implementing the plans carried out by S1 is shorter and directly directed at the goals of M1, namely the percentage of land area of each child. Therefore, since the beginning S1 has changed the form of fractions to fractions of a hundredth (percent), then S1 only needs to do the division, subtraction, and addition of fractions to get percentage of land area owned by each child. In contrast to S2 who chooses to take a longer path, namely by multiplying fractions by integers. The result of multiplication between fractions and integers produces then S2 division, subtraction, and addition of integers. The thing that M1 wants or asked for a percentage, therefore S2 must then convert the whole number to a percent again.

The differences in thinking activities that S1 and S2 in carrying out the plan of M1 show that even though both are at the same level of mathematical ability, but S1 which is a boy student has a shorter completion than S2 who is a girl student.

S1 and S2 in look back

The results of reduction to the data from S1 interview in looking back of M1 are presented in Table 7 as follows.

Table 7. S1's interview results in looking back of M1

R/S1	Interview Sentence	Interview Code
R :	Are you sure with your answer?	RM1-067
S1 :	(*While calculating mentally*) $22\% + 45\% + 33\% = 100\%$. Yes, I am sure.	S1M1-068
R :	Why are you sure?	RM1-069
S1 :	Because the percentage if the total is 100%.	S1M1-070
R :	How do you sum up?	RM1-071
S1 :	I count the shadows.	S1M1-072
R :	So, that's the answer?	RM1-073
S1 :	Yes	S1M1-074

https://doi.org/10.46627/silet.v4i1.212

The results of S2's scribbles in looking back of M1 are as follows.

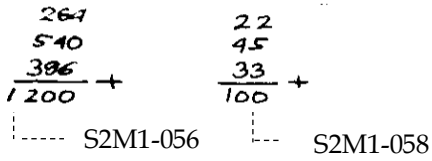


Figure 4. S2's scribbles of M1

The results of reduction to the data from S2 interview in looking back of M1 are presented in Table 8 as follows.

Table 8. S2's interview results in looking back of M1

R/S2	Interview Sentence	Interview Code
R :	Are you sure with your answer?	RM1-053
S2 :	Wait, I will count it first.	S2M1-054
R :	What are you counting?	RM1-055
S2 :	(*While counting on scribbled paper*) $264 + 540 + 396 = 1.200$, this land area Hendra, Ahsan, with Rian if summed equal to the area of the entire plot.	S2M1-056
R :	Is it true?	RM1-057
S2 :	(*While counting on scribbled paper*) $22\% + 45\% + 33\% = 100\%$, this is also a total of 100%	S2M1-058
R :	So, that's the answer?	RM1-059
S2 :	Yes, because the result of the 1.200 is the same as the area of the entire land. The percentage is also 100%	S2M1-060

The results of the study of the data show that both S1 and S2 used other methods or strategies in looking back of M1. S1 checks by adding the percentage of land area of all children mentally and it turns out that the number is 100%, so that S1 was sure of the correctness of answer, while S2 checks by adding the land area of all children in the scribble paper which turns out to be 1200 m^2 . Not only that, S2 continued the examination by adding the percentage of land area of all children in the scribble paper which turned out to be 100%. Because total of land area same as the information stated in the question and because the percentage of land area is 100%, then S2 sure that the answer was correct.

Based on the description, it can be concluded that there is a difference between S1 and S2 in looking back of M1. S1 only uses one examination strategies to check the correctness of the answer, while S2 uses two examinations strategies. Another difference was seen by their count. S1 does the calculation mentally, while S2 does the calculation not mentally namely by writing it on the scribble paper.

S1 and S2 learning trajectory schemes

Here is S1's learning trajectory scheme in solving M1. The scheme presented use symbols, including A, B, C, and D which successively show the subject's thinking activity at the stage of understand the problem, devise a plan, carry out the plan, to looking back. The first digit in the index indicates the subject, while the second digit in the index indicates the order of the subject's thinking activity.

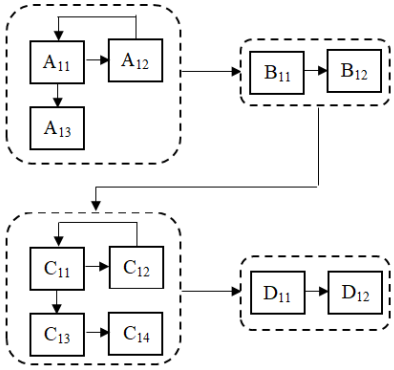


Figure 5. S1's learning trajectory scheme

https://doi.org/10.46627/silet.v4i1.212

The meaning of the code used in the scheme is detailed in Table 9 as follows.

Table 9. The meaning of S1's scheme code

Code	Meaning of the Code
A_{11}	Identify what's being asked.
A_{12}	Identify one by one known information.
A_{13}	Identify the completeness of the information needed to complete the M1.
B_{14}	Plan to use the conversion of fractional shapes into fractions of a hundredth (percent) to obtain the plot belonging to each child.
B_{12}	Plan the use of calculated operations such as division, subtraction, and addition of fractions to obtain a percentage of the land area owned by each child after the first child gives half of the area of his plot to his two brothers.
C_{11}	Converting fractional shapes into fractions of a hundredth (percent) to acquire each child's plot.
C_{12}	Dividing fractions to obtain the part that the first child wants to give to his two brothers.
C_{13}	Subtract fractions to obtain the share that the first child still has.
C_{14}	Perform fractional summation to obtain the share of the second child and the third child after being added to the gift of the first child.
D_{11}	Calculate the total percentage of land area of each child mentally.
D_{12}	Believe the truth of the answer because the total percentage of land area of all children is 100%.

S2's learning trajectory scheme in solving M1 is presented as follows.

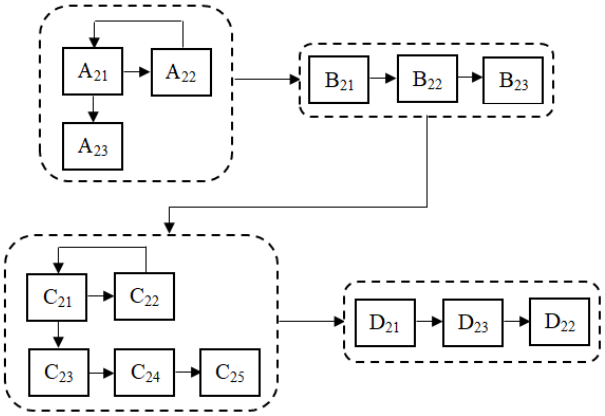


Figure 6. Learning trajectory scheme

The meaning of the code used in the scheme is detailed in Table 10 as follows.

Table 10. Meaning of S2 learning trajectory scheme codes in solving M1

Code	Meaning of the Code
A_{21}	Identify one by one known information.
A_{22}	Identify what's being asked.
A_{23}	Identify the completeness of the information needed to complete the M1.
B_{21}	Plan the use of fraction multiplication operations with integers to obtain each child's plot.
B_{22}	Plan the use of counting operations such as division, subtraction, and addition of integers to acquire the area of land owned by each child after the first child gives half of the area of his plot to his two brothers.
B_{23}	Plan to use integer to percent conversion to obtain a percentage of each child's land area.
C_{21}	Multiply fractions by integers to obtain each child's plot.
C_{22}	Dividing integers to obtain the area of land that the first child wants to give to the second child and third child.
C_{23}	Subtracting integers to acquire the area of land that the first child still owns.
C_{24}	Add integers to obtain the land area owned by the second child and the third child after supplementing with the gift of the first child.
C_{25}	Convert integers to percent to obtain a percentage of each child's land area.

Discussion

Learning trajectory subject in solving problems as follows:

1. Learning trajectory S1 and S2 in understanding problems

The learning trajectory of the male subject (S1) in understanding the problem (M1) starts from identifying the things that are asked or desired from M1. After knowing what is being asked, then identifying the available information one by one carefully and imagining the relationship between the things being asked and the information available. After having an overview of the relationship between the thing being asked and the information provided, finally stating that this information is sufficient to be able to complete M1. This description illustrates that S1 first finds out what is in question from the problem, then finds out the adequacy of the available information to solve the problem.

It's different from the learning trajectory for women subjects (S2) in understanding the problem (M1), they start from identifying the available information one by one. After that, identify the things that are asked or desired from M1. To get answers to the things being asked, they paused for a moment to think by associating the known information with the things being asked, until they finally stated that the information provided was sufficient to complete M1. This description illustrates that S2 first finds out the information available from the problem, then identifies what is asked or desired from M1.

2. Learning trajectory S1 and S2 in developing problem solving plans

Learning trajectory of male subjects (S1) in planning problem solving (M1), first find out the area of each plot, then find out the area of each child's plot, then find out the area of the plot for the first child because half of it will be given to two people so many siblings. In contrast to the master's learning trajectory, they make a problem-solving plan starting with finding out the area of each child's plot, then finding out the area of each plot, then finding out the area of the first child's plot because half of it will be given equally to two younger siblings. This description illustrates that the S1 and S2 learning trajectories in solving M1 problems, that even though both are at the same level of mathematical ability, S1 (male) has shorter planning because it only involves some information, compared to S2 (female) involving all information to develop a settlement plan. This is in line with the statement that boy students are able to see information that is interconnected to devise problem solving strategies or methods, while girl students more complete and orderly thinking patterns. This difference is in line with the statement put forward by Hardy et al. (2015) that male students are able to see interconnected information to develop appropriate strategies or problem-solving methods, while female students have a more complete and orderly pattern of thinking. The same thing was expressed by Firmasari et al. (2019) that male students are weak in understanding basic concepts, while women always follow the examples of answers given.

3. Learning trajectory S1 and S2 in implementing the plan

Problem solving for both male (S1) and female (S2) subjects carried out according to plan. Learning Trajectory for Male Subjects (S1) in carrying out plans is shorter and directs to the goal or desired thing from the problem (M1), namely the percentage of land area of each child. Therefore, since the beginning S1 has changed the form of fractions to hundredths fractions (percent), so that S1 only needs to divide, subtract, and add fractions to obtain the percentage of land area owned by each child. In contrast to the female subject (S2) who chose to take a longer path, namely by multiplying fractions by integers. The result of multiplying fractions by integers is an integer, so S2 then performs division, subtraction, and addition of integers. The thing that M1 wants or asks for is a percentage, therefore S2 then has to change the whole number again to a percent.

Differences in the thinking activities that S1 and S2 go through in carrying out the M1 completion plan show that even though both are at the same level of mathematical ability, S1 who is a male student has a shorter completion than S2 who is a female student. This difference is in line with the statement put forward by Kessel and Linn (1996) that compared to men, women

tend not to be able to use simpler ways to solve problems quickly. The same thing was also stated by Gallagher et al. (2000) that men tend to be more flexible in implementing problem solving strategies than women.

4. Learning trajectory S1 and S2 in re-examining

The Learning Trajectory of the male subject (S1) in checking his work again by mentally adding up the percentage of the land area of all children and it turns out that the number is 100%, so that S1 is sure of the correct answer. On the other hand, the female subject (S2) checked by adding up the land area of all the children on the scribbled paper which turned out to be 1200 m^2. It didn't stop there, S2 continued the examination by adding up the percentage of the land area of all the children on the scribbled paper which turned out to be 100%. Because the total area of all land is the same as the information stated in the question and because the total percentage of land area is 100%, then S2 is sure of the correct answer

Based on this description, it can be concluded that there are differences between S1 and S2 in re-examining M1. S1 simply uses one checking strategy to check the correctness of the answer, while S2 uses two checking strategies. Another difference is seen in the way the two of them calculate. S1 does the calculations mentally, while S2 does the calculations not mentally, namely by writing them on scribbled paper. This indicates that women are more conscientious than men, as stated by Krutetskii (1976), Wulansari & Rosyidi (2013), and Adi et al. (2017) that women are superior to men in terms of accuracy, rigor, rigor and thoroughness of thinking. However, male subjects are more dominant in using their spatial abilities than female gendered subjects by Musdalifah et al. (2015) and Subrahmanyam & Greenfield (1994).

CONCLUSION

Based on the results and discussion it can be concluded that the learning trajectory: (1) in understand the problem, boy students first identified the goals, then identified the information that was known one by one, until finally stated that the information was complete to be solved, while the girl student first identify the information that was known one by one, then identify the thing being asked, until finally stated that the information of the question was completed. (2) At the stage of devise a plan, girl student made a completion plan by involving many concepts, while male student only involve one concept. (3) At the stage of carry out the plan, they solve the problem according to the plan that has been devise, because the planning of girl student involves more concepts and the solution was longer. (4) At the look back stage, boy student only used one alternative examination, while girl student used two alternative examinations. The differences in each stage of problem solving showed that the learning trajectory of boy in solving fractional problems was shorter than girl's learning trajectory.

ACKNOWLEDGEMENTS

This research can be completed thanks to the support of various parties, for that the researcher would like to thank: (1) Mathematics Education Study Program,Universitas Tadulako, Indonesia which has facilitated this research, (2) Middle School (SMP) Madani Palu, which has given permission to conduct research.

REFERENCES

Caputi, V., & Garrido, A. (2015). Student-oriented planning of e-learning contents for Moodle. *Journal of Network and Computer Applications*, *53*, 115-127.

Ijirana, I., & Supriadi, S. (2018). Metacognitive skill profiles of chemistry education students in solving problem at low ability level. *Jurnal Pendidikan IPA Indonesia*, *7*(2), 239-245

Rofiki, I. (2018). Investigating students' learning trajectory: a case on triangle. *Journal of Physics: Conference Series, 1088*(1), 012021. IOP Publishing.

Wijaya, A., & Doorman, M. (2021). A learning trajectory for probability: a case of game-based learning. *Journal on Mathematics Education*, *12*(1), 1-16.

Clements, D. H., & Sarama, J. (2020). *Learning and teaching early math: The learning trajectories approach*. Routledge.

Emphson, S.B. (2011). On idea learning trajectories promises and piftfalss. *The Mathematics Enthuasis, 8*, 571-596.

Clements, D. H. dan Sarama, J. (2004). Learning trajectories in mathematics education. *Mathematical Thinking and Learning, 6*(2), 81-89.

Rizal, M., Lukito, A., & Siswono, T. Y. E. (2013). Proses berpikir siswa SD dalam melakukan estimasi masalah berhitung berdasarkan jenis kelamin. *Jurnal Ilmu Pendidikan*, *18*(1).

Helwig, R., Anderson, L., & Tindal, G. (2001). Influence of elementary student gender on teachers' perceptions of mathematics achievement. *The Journal of Educational Research*, *95*(2), 93-102.

Chen, C. Y. (2014). A hypothetical learning trajectory of arguing statements about geometric figures.

Chen, C. Y. (2016). A hypothetical learning trajectory of arguing statemants about geometric figures.

Misquitta, R. (2011). A review of the literature: Fraction instruction for struggling learners in mathematics. *Learning Disabilities Research & Practice*, *26*(2), 109-119.

Fennell, F., & Karp, K. (2017). Fraction sense: Foundational understandings. *Journal of learning disabilities*, *50*(6), 648-650.

Namkung, J., & Fuchs, L. (2019). Remediating difficulty with fractions for students with mathematics learning difficulties. *Learning Disabilities: A Multidisciplinary Journal*, *24*(2), 36-48.

Singh, P., Hoon, T. S., Nasir, N. A. M., Han, C. T., Rasid, S. M., & Hoong, J. B. Z. (2021). Obstacles faced by students in making sense of fractions. *The European Journal of Social & Behavioural Sciences*.

Ganley, C., & Lubienski, S. (2016). Current research on gender differences in math. *Teaching Children Mathematics*.

Carpenter, T. P., & Moser, J. M. (2020). The development of addition and subtraction problem-solving skills. *Addition and subtraction,* 9-24. Routledge.

Rizal, M., & Lefrida, R. (2018). Profile of calculus problem solving of mathematics education students. *First Indonesian Communication Forum of Teacher Training and Education Faculty Leaders International Conference on Education 2017 (ICE 2017)*, 247-251. Atlantis Press.

Moleong, L. J. (2018). *Metode penelitian kualitatif*. Remaja Rosdakarya.

Palandu, A., & Rizal, M. (2022). Profil number sense siswa SMP dalam memecahkan masalah matematika berdasarkan jenis kelamin. *Jurnal Elektronik Pendidikan Matematika Tadulako*, *9*(3), 295-308.

Hardy, M. R., Hudiono, B., & Rajiin, M. (2015). Pengaruh gender dan strategi pembelajaran terhadap kemampuan pemecahan masalah matematis siswa. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa, 4*(9).

Firmasari, S., Sulaiman, H., Hartono, W., & Noto, M. S. (2019). Rigorous mathematical thinking based on gender in the real analysis course. *Journal of Physics: Conference Series, 1157*(4), 042106. IOP Publishing.

Kessel, C., & Linn, M. C. (1996). Grades or scores: Predicting future college mathematics peformance. *Educational Measurement: Issues and Practice*, *15*(4), 10-14.

Gallagher, A. M., De Lisi, R., Holst, P. C., McGillicuddy-De Lisi, A. V., Morely, M., & Cahalan, C. (2000). Gender differences in advanced mathematical problem solving. *Journal of experimental child psychology*, *75*(3), 165-190.

Krutetskii, V. A. (1976). *The psychology of mathematics abilities in school children*. The University of Chicago Press.

Wulansari, A., & Rosyidi, A. H. (2013). Profil pengetahuan konseptual siswa SMP di jenjang proses kognitif menganalisis pada materi segi empat berdasarkan jenis kelamin. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *4*(2), 174-181.

Adi, A. W., Triyanto, T., & Pramesti, G. (2017). Penerapan model pembelajaran student teams achievment division dengan pendekatan open ended untuk meningkatkan tingkat berpikir

kreatif dan hasil belajar siswa. *Jurnal Pendidikan Matematika dan Matematika SOLUSI*, *1*(4), 61-80.

Musdalifah A, Nurdin A, Alimuddin. (2015). Profil kemampuan spasial dalam menyelesaikan masalah geometri siswa yang memiliki kecerdasan logis matematis tinggi ditinjau dari perbedaan gender (studi kasus di kelas XI SMAN 17 Makassar). *Jurnal Daya Matematis*, *3*(1).

Subrahmanyam, K., & Greenfield, P. M. (1994). Effect of video game practice on spatial skills in girls and boys. *Journal of applied developmental psychology*, *15*(1), 13-32.

Author (s):

* Muh Rizal (Corresponding Author)
Department of Mathematics,
FKIP Universitas Tadulako Palu, Indonesia
Email: muh62.rizal@gmail.com

Tatag Yuli Eko Siswono
Department of Mathematics, Faculty of Mathematics and Natural Science,
Universitas Negeri Surabaya,
Jl. Ketintang, Surabaya 60231, Indonesia
Email: tatagsiswono@unesa.ac.id

Nurdin
Department of Mathematics,
FKIP UNIMEN Enrekang, Sulawesi Selatan, Indonesia
Email: -

Tria Bitara
Department of Mathematics,
FKIP Universitas Tadulako Palu, Indonesia
Email: -