

# The Use of Collaborative Problem Solving on Mathematical Representation in Solving One Variable Linear Equation Problem in Junior High School

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Article submitted: 01-03-2023, revised: 20-07-2023, published: 31-07-2023

## Abstrak

Penelitian ini bertujuan untuk melihat dan mendeskripsikan kemampuan representasi matematis siswa pada materi Persamaan Linier Satu Variabel (PLSV) setelah diterapkan model *Collaborative Problem Solving* (CPS). Metode penelitian yang digunakan adalah deskriptif dengan analisis data secara kuantitatif dan kualitatif sesuai dengan indikator representasi matematis. Penelitian ini dilaksanakan di SMP Negeri 6 Indralaya Utara di kelas VII.1 dengan melibatkan sebanyak 16 siswa sebagai subjeknya. Pengumpulan data dilakukan dengan memberikan tes tertulis berupa soal uraian dan hasil wawancara dengan siswa. Teknik analisis data yang digunakan meliputi memeriksa tes uraian merujuk pada indikator representasi matematis yaitu visual, simbolik dan verbal. Data yang telah terkumpul kemudian dianalisis berdasarkan pedoman penskoran yang merujuk pada indikator representasi matematis. Hasil analisis data selanjutnya dikelompokkan menjadi tiga kategori yaitu tinggi, sedang, dan rendah. Berdasarkan hasil analisis data didapatkan bahwa kemampuan representasi matematis siswa pada materi persamaan linier satu variabel setelah diterapkannya model CPS berada dikategori sedang dengan nilai rata-rata sebesar 59,687 dan skor rata-rata untuk indikator representasi visual yaitu sebesar 71,093, representasi simbolik 60,156, dan verbal 35,937.

Kata Kunci: Collaborative Problem Solving; Kemampuan Representasi Matematis; PLSV.

## Abstract

This study aimed to look at and describe students' mathematical representation abilities in the One Variable Linear Equation (PLSV) material after applying the Collaborative Problem Solving (CPS) model. The research method used was descriptive with quantitative and qualitative data analysis according to the indicators of mathematical representation. This research was conducted at SMP Negeri 6 Indralaya Utara in class VII.1 involving 16 students as participants. Data collection was carried out by giving written tests in the form of description questions and the results of interviews with students. The data analysis technique used included examining the description test referring to indicators of mathematical representation, namely visual, symbolic and verbal. The data were then analyzed based on scoring guidelines that refer to indicators of mathematical representation. The results of the data analysis were later categorized into three categories, namely high, medium, and low. Based on the results of data analysis, it was found that students' mathematical representation abilities in the material of one-variable linear equations after the implementation of the CPS model were in the moderate category with an average score of 59.687 and an average score for visual representation indicators that was 71.093, symbolic representation 60.156, and verbal 35.937.

Keywords: Collaborative Problem Solving; Mathematical Representation Ability; PLSV.

## I. INTRODUCTION

Representation is an important ability in learning mathematics (Hidayat & Lestari, 2022; Rahmayani, Susanto, & Suwito, 2023). Based on the objectives of mathematics learning in the 2013 curriculum stated in the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 58 of 2014, namely students are able to understand mathematical concepts, with one of the indicators of achieving their abilities in presenting concepts in various forms of mathematical representations such as mathematical models, tables, graphs, diagrams, sketches, drawings, or other methods. According to Sa'diyah et al., (2020), representation is the ability to express ideas in order to obtain solutions to the problems experienced. Mathematical representation ability is the student's ability to bring up mathematical ideas (meaning, problems, explanations, and so on) in order to present the results in various ways which are the results of student thinking to find problem solving (Huda et al., 2019; Ulfa & Sundayana, 2022). It is one of the most important components to improve students' thinking skills and students are required to improve their mathematical representation skills (Marliani & Puspitasari, 2022) because they have to find the connection within the mathematical material learned and present the ideas through various ways Selviani et al., (2017). From the

explanation, it can be concluded that mathematical representation ability is interpreting or communicating students on mathematical problems towards objects, sketches, charts, graphs, symbols, and words or written text as a solution to mathematical problems (Salamah, Susiaty, & Ardiawan, 2022; Muniri & Erika, 2022; Pebrianti & Puspitasari, 2023).

Based on the previous studies at SMPN 6 Indralaya Utara analyzing the results of the students' work in solving problems containing mathematical representation indicators, it revealed that students' representation skills in answering these problems were quite low. From the observations, the reasons regarding the issue were that students considered it was difficult to identify important information in the problem into written text or mathematical sentences, lack of understanding of students' concepts of a material, and teachers did not provide opportunities for students to solve problems with various kinds of representations. This was supported by Herdiman et al. (2018) that students' mathematical representation skills were less developed because teachers generally only explained the material, and presented the solution steps so that students tend to only imitate the steps given by the teacher. Annajmi et al. (2019) added that most teachers did not guide students to be able to represent other forms. In a previous study, it was found that students

were unable to answer questions using words. The students only made a picture without giving any explanation. In addition, there were also students who could not answer problems by making mathematical models from other representations given (Damayanti & Afriansyah, 2018; Arfah & Basuki, 2022).

Based on the issues, it is necessary to develop mathematical representation skills. The Collaborative Problem Solving model was chosen as one of strategies to develop the skills made by the researchers to address the issue (Albab, Saputro, & Nursyahidah, 2017). Through this model, according to Nahdi, (2017) an alternative learning strategy could be utilized to improve students' mathematical representation skills.

According to Assaibin et al., (2021) a learning model began with the presentation of problems to students that would be solved individually and in groups, which stimulated when presenting ideas related to mathematical problems and students were expected to find solutions to the problems presented. Studies on the application of the CPS learning model has previously been conducted by Setiawan et al., (2019) which reveals an excellent CPS learning model to improve students' mathematical representation abilities, especially in terms of verbal and visual representation abilities.

The CPS model is a problem-based model of learning. One of the materials in mathematics learning that was closely

related to everyday life was Linear Equations One Variable (PLSV) (Sari & Afriansyah, 2022). In fact, students were struggling to solve problems related to PLSV. One of the main reasons was that students were not able to convert story problems into mathematical models. In line with what Sulastri et al. (2017) they revealed the students also lacked mastery of PLSV supporting material. Panduwinata et al. (2019) added that students were struggling in PLSV material due to several things such as lack of mastery of supporting material for algebraic form operations and converting problems in story form.

This article discussed the use of students' representation ability in solving PLSV problems after the implementation of the Collaborative Problem Solving model at SMP Negeri 6 Indralaya Utara. The purpose of this writing was to describe the use of CPS on students' mathematical representation ability in solving PLSV problems. Teachers were expected to make this study as a reference to use mathematical representation skills, especially in PLSV material.

## II. METHOD

This study was descriptive research with quantitative and qualitative data analysis in accordance with mathematical representation indicators. The selection of this method was adjusted to the purposes of the study that were previously determined, namely, to see and describe

the mathematical representation abilities of students after implementing the Collaborative Problem-Solving model on PLSV material at SMP Negeri 6 Indralaya Utara. The indicators of mathematical representation ability in this study according to Mudzakir (2006), namely (1) presenting images to explain problems and facilitate solutions, (2) making equations or mathematical models of problems or information given, and (3) writing down the steps of solving mathematical problems in words. The participants of this study were students of class VII.1 as many as 16 students.

This study was conducted in the odd semester of the 2022/2023 school year. The instruments were written tests and interview guidelines. Written tests and interviews were used as the data collection techniques. The test was provided to see the extent of the students' representation skills. It consisted of 2 descriptive questions related to PLSV material. Meanwhile, the interview was conducted after the test to explore further information about the problem-solving process. The implementation of the study was carried out in 2 meetings to apply the CPS model in the class, 1 meeting to conduct written tests and 1 meeting to interview. Furthermore, the test results obtained were analyzed based on the scoring guidelines that had been made and referred to the mathematical representation indicators. The test results

were then categorized into three categories, namely, high, medium, and low. The following is a table of categories of students' mathematical representation abilities.

Table 1.  
Category of Mathematical Representation Ability

Category	Students' score interval
High	$71 \leq a < 100$
Medium	$36 \leq a < 71$
Low	$0 \leq a < 36$

(Rahmatika et al., 2022)


### III. RESULTS AND DISCUSSION

This study was conducted in three meetings with two meetings for the learning process using the CPS model and the third meeting a written test was conducted to measure students' mathematical representation skills. Learning activities at the first and second meetings used LKPD. In solving the problems in the LKPD, the students were guided by the researchers. The problems in the LKPD deal with everyday life. After the learning activities were completed, the researchers provided 2 questions related to mathematical representation ability. The problems given to students were problems related to PLSV material. Each problem aimed to measure students' mathematical representation ability. Each problem represented one indicator of the type of representation, namely symbolic representation, visual representation, and verbal representation. The following is the

problem given to measure students' mathematical representation ability.

1) Sebuah jembatan yang berada di dekat rumah Raju memiliki panjang 370 m. Di dekat rumah Dwi juga terdapat sebuah jembatan. Jembatan di dekat rumah Raju memiliki panjang 12 m lebih panjang dari dua kali panjang jembatan di dekat rumah Dwi. Berapakah panjang dari jembatan dekat rumah Dwi ?

2) Perhatikan gambar di bawah ini!



Keliling atap rumah di atas adalah 48 meter. Jika panjang sisi alas transpesium pada atap rumah lebih 12 meter dari panjang sisi atas transpesium. Tentukan :

a) Berapa panjang sisi alas dan sisi atas pada atap rumah tersebut?

b) Benarkah luas dari bagian atas atap tersebut adalah  $14\sqrt{96}^2$  ? Apabila  $t = \sqrt{96}$ , berikan penjelasanmu!

Figure 1. Questions to measure students' mathematical representation ability

The description of the students' work for each problem was then described as follows. First, the ability of visual representation, namely problem 1, was used to determine the ability of visual representation. Based on the problem given, here are the students' answers:

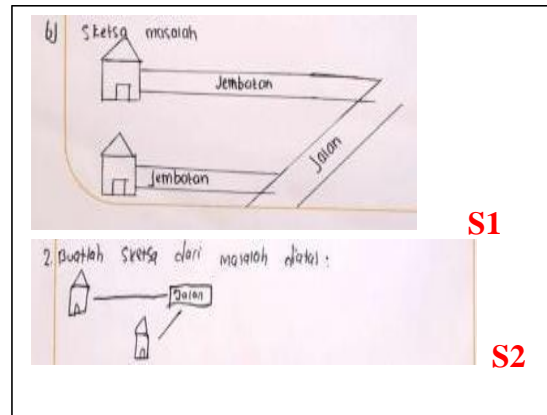


Figure 2. The second student's answer to question 1 (visual)

Referring to Figure 2, it illustrated that students were able to answer the problem completely and accurately so that student 1 had used visual representation to answer question 1. Student 2 had also answered the problem by using visual representation even though it was incomplete. In problem 1, student 2 was able to sketch the problem despite incomplete information. Based on the results of the interview, student 2 misunderstood the problems given. Meanwhile, student 3 did not write anything on his answer sheet in answering question 1.

The following is an excerpt from an interview with student 2:

P : "why didn't you write all the description on the sketch?"

S2 : "I'm afraid I was distracted during the tes."

P : "So, this sketchy house, the one that is far from the road is Raju's, and near one is Dwi's. Isn't it? "

S2 : "Yes, that's what my sketch meant to say."

Based on the results of the interview, it was discovered that student 2's mistake in determining the sketch was due to lack of focus or lack of accuracy. Nevertheless, student 2 had been able to draw the sketch correctly.

The following is an excerpt from an interview with student 3:

P : "Did you understand question 1?"

S3 : "(quiet). I don't understand."

P : "Can you read the meaning of the problem in the question? What does it ask?"

S3 : "How long is the bridge near Dwi's house?"

P : "What is the picture probably like?"

S3 : "Hmm... I have no idea"

Based on the results of the interview, it was found that student 3 did not understand the meaning of problem 1 so that student 3 could not answer the problem.

Problem 2a was also used to determine the ability of visual representation. Based on the problems given, the following are student answers:

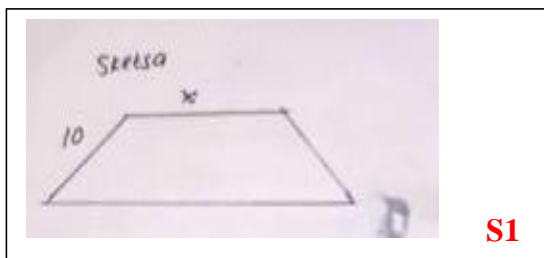


Figure 3. A student's answer on question 2a (visual)

Based on Figure 3, it illustrated that the students were able to answer the problem correctly so that student 1 had used visual representation to answer question 1.

Student 2 did not use visual representation because a picture was presented in the problem, this was based on the results of the interview with student 2. Meanwhile, student 3 did not write anything on his answer sheet in answering question 2a.

The following is an excerpt of an interview with student 2:

P : "Why didn't you draw a picture for question 2a?"

S2 : "because it has been presented in the question, so I didn't have to draw it."

P : "Did you know the picture provided in the picture?"

S2 : "Yes I did. The roof is a trapezoid"

Based on the results of the interview, it was discovered that student 2 did not make a picture because the picture was presented in the problem. Nevertheless, student 2 was able to know the shape of the roof of the house was a trapezoidal flat shape.

The following is an excerpt of an interview with student 3:

P : "What does question 2a ask about?"

S3 : "How long are the base and top sides of the roof?"

P : "What is the picture like?"

S3 : "Trapezoid, but I'm confused whether I should draw the picture or not."

Based on the results of the interview above, it was found that student 3 understood what the question asked but he was unsure whether to make a drawing or not.

Symbolic representation ability, problem 1, was used to determine the ability of symbolic representation. Based on the problem given, here are the students' answers:

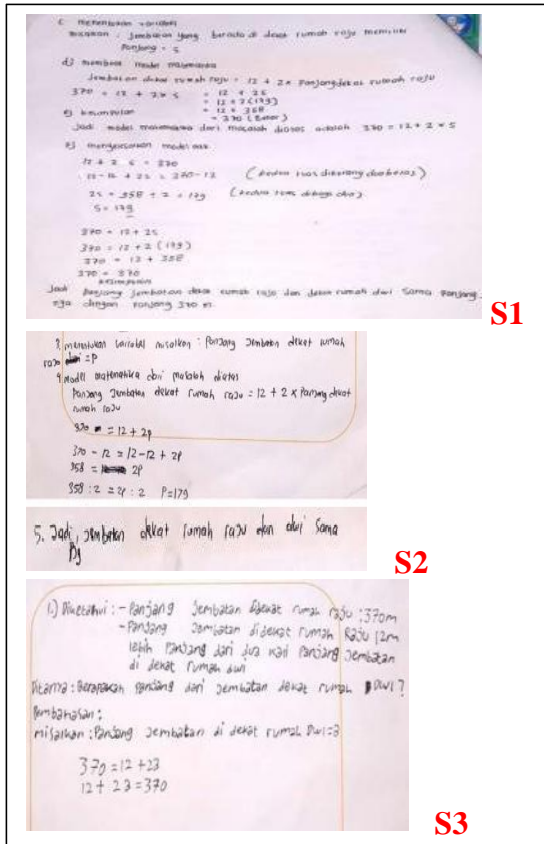


Figure 4. The third student's answer to question 1 (symbolic)

Based on Figure 4, it was revealed that student 1 and student 2 could solve the problem using symbolic representation completely and correctly. It was illustrated from the answers of student 1 and student 2 who wrote the equation, performed algebraic operations, and chose the PLSV solution method correctly. On the other hand, student 3 answered the problem less precisely.

The following is an excerpt of an interview with student 3:

- P : "What does 'a' symbol you've made refer to?"  
 S3 : "It refers to the length of the bridge next to Dwi's house."  
 P : "Not the bridge near Raju's?"  
 S3 : "(quiet)"  
 P : "Why didn't you finish the equation?"  
 S3 : "I'm doubtful and I forgot how to finish it. So, I stopped at this stage"

Based on the results of the interview, it was discovered that student 3 had not fully understood the PLSV solution method well and was confused to determine the next step in solving the problem.

Problem 2a was also used to determine the ability of symbolic representation. Based on the problem given, here are the students' answers:

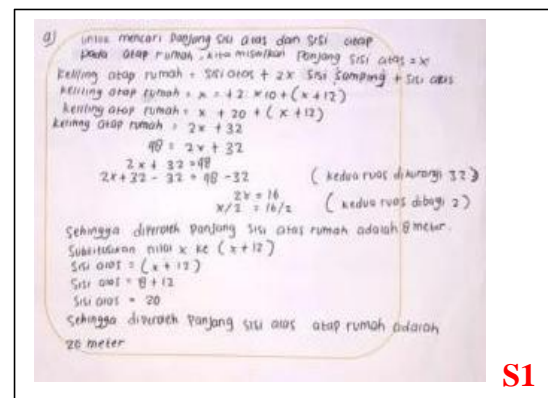


Figure 5. The student's answers on question 2 (symbolic)

Based on Figure 5, It was found that student 1 and student 2 could solve the problem by using symbolic representation completely and correctly. This was demonstrated from the answers of

student 1 and student 2 who wrote the equation, performed algebraic operations, and chose the PLSV solution method correctly. Meanwhile, student 3 answered the problem less precisely.

The following is an excerpt of the interview with student 3:

P : "Why didn't you finish the equation?"  
 S3 : "I'm doubtful and I forgot how to solve algebraic operation. So, I stopped at this stage to solve question 2a"

Based on the results of the interview above, it was found that student 3 had not fully understood the method of solving PLSV and algebraic operations well and was confused to determine the next step in solving the problem.

Verbal representation ability. Specifically, question 2b was used to determine verbal representation ability. Based on the problem given, the following are the students' answers.

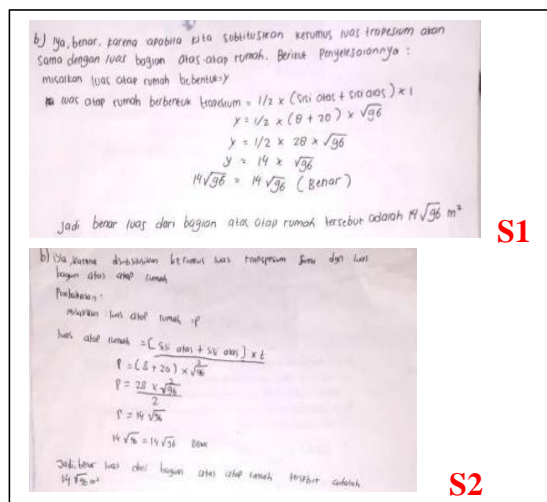


Figure 6. The students' answers on question 2b (verbal)

Based on Figure 6, student 1 was able to answer the question correctly, as well as student 2. While student 3 did not write any answers on his answer paper.

The following is an excerpt from the interview with student 3:

P : "Did you understand what question 2b ask?"  
 S3 : "(Quiet). I didn't"  
 P : "What does it ask?"  
 S3 : "Is it correct that the area of the roof is  $14\sqrt{96}$ "  
 P : "Could you give some statements or opinion?"  
 S3 : "I couldn't"

Based on the results of the interview above, it was discovered that student 3 did not understand the problem well and was confused in determining what information was needed in answering question 2b.

From the explanation related to the results of students' written tests in solving the description test questions given. Table 2 shows the occurrence of students' mathematical representations as follows.

Table 2. Occurrence of Mathematical Representation Indicators

Participants	Mathematical representation indicators			
	Visual	Symbolic	Symbolic	Visual
Items	1	1	1	1
A1 (T)	√	√	√	√
A2 (S)	√	-	√	√
A3 (R)	-	-	√	√

Note:

√ : appear  
 - : not appear



T : high  
S : medium  
R : low

Furthermore, the results of the calculation of each student's written test score were then divided into three categories. The following Figure 7 shows the categories of students' mathematical representation ability.

Rentang Nilai Siswa	Kategori Kemampuan Representasi Matematis	Frekuensi	Persentase
$71 \leq \text{nilai} < 100$	Tinggi	4	25%
$36 \leq \text{nilai} < 71$	Sedang	7	43,75%
$0 \leq \text{nilai} < 36$	Rendah	5	31,25%
Jumlah		16	100%
Skor Rata-rata		59,687	

Figure 7. Categories of Mathematical Representation Ability

Figure 7 shows that the highest frequency of the mathematical representation ability category was in the medium category of 7 students with a percentage of 43.75%. While for the high category there were 4 students with a percentage of 25% and for the low category there were 5 students with a percentage of 31.25%. The table above also shows that the mathematical representation ability of students on the material of linear equations of one variable class VII.1 was in the medium category with an average value of 51.12.

Then, the written test results were analyzed according to the students' mathematical representation indicators consisting of three indicators which were calculated as the average score as shown in Table 3 below.

Table 3.  
Occurrence of Student Mathematical Representation Indicators

Type of representation	Indicators	average score
Visual	presenting a picture to describe the problem and facilitate the solution	71,093
Symbolic	Providing mathematical equation or model from the given problem or information	60,156
Verbal	Writing the steps to solve the mathematical problems in written form	35,937

Table 3 implied that the highest average score was in the type of visual representation with an indicator of completing drawings to explain the problem and facilitate the solution obtained an average score of 71.093, then the type of symbolic representation with an indicator of making equations or mathematical models of the problem or information given obtained an average score of 60.156, and for the type of verbal representation with an indicator of writing the steps of solving mathematical problems in words obtained an average score of 35.937.

From the results of the data analysis and data description, the study concluded that the mathematical representation ability of students in class VII.1 SMP Negeri 6 Indralaya Utara in solving problems on

the material of linear equations of one variable in the medium category with an average score of 59.687. The visual representation indicator was the indicator that had the highest occurrence of 71.093. Visual representation ability with a good enough category where students answer problems by making pictures. Seen in questions number 1 and 2a students were asked to make pictures of the problems given. High and medium ability students were able to provide drawings or sketches. For low ability students, there were some obstacles in solving problems using drawings or sketches such as obstacles in translating problem number 1 to make a drawing and problem number 2a to make a drawing of a trapezoid that had actually been displayed in the question, this required the students to be more careful in reading the question. When creating visual representations, it is important to focus more on the concept of the desired image. Because the students could convey ideas by interpreting them in images, real objects, or symbolic objects (Mastuti et al., 2017). Furthermore, the occurrences of symbolic indicators showed an average score of 60.156. Symbolic representation ability was categorized as fairly good where students answered problems by making mathematical symbols or expressions. Judging from questions number 1 and 2a, students were instructed to determine the symbol and value of a variable using previously learned

concepts. In fact, to construct symbolic representations in this PLSV material, students must be able to convey ideas such as making symbols on algebraic concepts. Based on the opinion of Mastuti et al. (2017) that ideas were formed after students understood the material, so that students could describe it symbolically, visually, or with real objects. Instead of that, to make the right symbolic representation, students must be more careful when handling problems (Hijriani et al., 2018).

The last indicator was the verbal representation indicator, namely solving problems using words or written text in the low category with an average score of 35.937. In answering problem 2b, students must first solve problem 2a correctly and precisely because 2b was related to problem 2a. It was the reason why the students' mathematical representation skills were in the low category. In line with Fuad's, (2016) states that students' knowledge of the problem could produce verbal representations or words, such as recognizing and writing what is known and what is required in the given problem. Based on the results of written tests and interviews, it showed that students' responses would have been wrong if they had not understood the problem nor used information properly when answering questions. Based on the research of Hijriani et al., (2018) which stated that careless students did not carefully make

symbolic representations and verbal representations appropriately.

#### IV. CONCLUSION

Based on the analysis and research results, it could be concluded that the utilization of mathematical representation skills of students in class VII. 1 SMPN 6 Indralaya Utara in solving problems on PLSV material after applying the Collaborative Problem Solving (CPS) learning model was in the medium category. This was due to the lack of understanding of students' concepts of prerequisite material. For better results, further studies should prepare a more coherent lesson plan so that the students understand the concept of PLSV better. In addition, further research is expected to explore the factors that influence the results of the study using the Collaborative Problem Solving (CPS) learning model such as mastery of student prerequisite material, LKPD used, and others as needed.

#### ACKNOWLEDGMENT

Thanks to the students of class VII.1 SMP Negeri 6 Indralaya Utara who had been willing to become the participant of the study and those who participated in this study.

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