International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 12 December 2024
DOI: 10.47191/ijcsrr/V7-i12-35, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Analysis of Students' Mathematical Connection Ability of Two-Variable Linear Equation System Material with *Card Sorting Activity (CSA)*

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ABSTRACT: This study aims to describe students' mathematical connection ability on the material of two-variable linear equation system with card sorting activity (CSA). This research was conducted in 2 subjects, namely at SMP IS and SMK SH Malang City in March to April 2020. The subjects used in this study were VIII grade students of SMP IS and X grade students of SMK SH. The subjects of this study were 9 people, 5 students at SMP IS and 4 students at SMK SH. Data collection techniques in this study are tests and non-tests where the test here students are given a connection ability question card as many as 20 question cards in which there are indicators of the connection itself, then for non-tests in the form of interviews with students and observations.

KEYWORDS: *Card Sorting Activity*, Linear Equation System Two Variables, Mathematical Connection.

INTRODUCTION

Mathematical connection is a benchmark of the acquisition of mathematical knowledge achieved by students. Lasmanawati [1] explains that through mathematical connections students' knowledge of mathematics will grow. Mathematical connections will have a positive impact on the development of mathematics itself. The ability to understand mathematical concepts is important for learning at school [2]. Mathematical connections can help students in understanding the concepts of learning mathematics at school. The mathematical connection ability of junior high school students is low [3]. This is because students have difficulty in solving problems with mathematical concepts. This is also evidenced based on the results of observations of researchers during field experience practices that students have not been able to solve problems. Students still have difficulty solving story problems. The development of mathematical ideas is a part of human activities and is then realized and expanded so that it becomes a science which is then used to facilitate humans in solving a problem [4].

The development of technology and communication can make it easier for everyone to easily interact with others without face-toface or direct contact. Learning is also inseparable from technology which is interrelated with one another [5]. Learning independence is a condition of students who have the will to learn, ensure learning goals and learning strategies, and evaluate or self-awareness in the student's own learning activities [5].

Technology is an important tool for developing mathematical connection skills [6]. Mathematical *software* such as *Geogebra* has a contribution to the mathematical connections built by students. One of the learning approaches that is based on real situations, incorporating students actively to direct their own mathematical abilities is group discussion. This can develop their mathematical connection skills through the model *eliciting activities* learning approach [7].

From a constructivist point of view, one's mathematical connections can be considered as a way or bridge to construct new knowledge or prior knowledge is used to build or strengthen links between mathematical ideas, concepts, flows, or representations in mental networks [8]. Oral problems in mathematics are a category of mathematical problems that are prepared to assist students in applying abstract mathematical ideas to real-world situations [9]. The ability of continuity between ideas or guidelines in mathematics plays a very important role in learning mathematical connections. With this ability, students can understand mathematical concepts in mathematical connections in general and more deeply. Based on the explanation above, it can be said that mathematical connection is an ability of the subject to use the continuity of ideas in mathematics and apply mathematical ideas in conditions outside of mathematics. Mathematical connection is one aspect of mathematical ability that must be pursued by a student through mathematics learning activities or activities. Therefore, by knowing mathematical relationships, students will also better understand or explore mathematics and also give them better mathematical strength or insight.

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So, through this mathematical connection students learn to make comparisons and develop their knowledge using insights in a particular context to test an abstract thing in another context.

RESEARCH METHOD

This type of research is descriptive research with a qualitative approach that reveals the meaning behind the symptoms that occur in the research subject. This research describes students' mathematical connections on the material of the system of linear equations of two variables with *Card Sorting Activity (CSA)*.

The things that researchers do when research are as follows:

1. Prepare equipment and equipment needed during the research, in the form of test questions, paper glue, scissors, manila paper, and student mathematical connection cards as many as 20 cards for each student.
2. Preparing student conditions before research, such as arranging student seating, preparing stationery, problem cards, scissors, manila paper, and paper glue.
3. Providing mathematical connection cards, glue, scissors, manila paper, and test questions as many as 20 cards per individual.
4. Observing and documenting the activities or activities carried out by students during the card preparation stage and solving the problems on the cards.
5. Conducting interviews with students related to the results of the preparation of cards that they relate or connect.

According to Creswell [10], qualitative research has several characteristics

1. Exploring the problem and developing a detailed understanding of the main problem.
2. The literature review has a small role, but justifies the problem.
3. Stating general and broad research objectives and questions in accordance with the experience of the research subject.
4. Collect data based on the words of a small number of individuals so as to obtain the views of the research subjects.
5. Analyze the data for descriptions and themes using text analysis and interpret more meaning from the findings.
6. Writing reports using flexible criteria, emergent structure criteria, and evaluative criteria and involving subjective reflexivity and researcher bias.

This study aims to describe the mathematical connection ability of students on the material of the system of linear equations of two variables. This research was conducted in 2 subjects, namely at SMP IS and SMK SH Malang City in March to April 2020.

RESULT AND DISCUSSION

This study aims to describe students' mathematical connection skills on the material of the system of linear equations of two variables with *Card Sorting Activity* (CSA). This research was conducted in two schools, namely SMP IS and SMK SH. All schools are located in Malang City. The research subjects at SMP IS were 5 students in class VIII while at SMK SH were 4 students in class X. The reason for selecting the subjects at SMP IS was the VIII grade students.

The reason for selecting subjects in grade VIII junior high school is because in the grade VIII mathematics curriculum in Permendikbud No. 68 of 2013 concerning the junior high school curriculum there are basic competencies regarding the TwoVariable Linear Equation System, more details are shown in table 1 as follows.

Table 1. Core Competencies and Basic Competencies of Grade VIII Mathematics on SPLDV

Core Competencies	Core Competencies
KI 3: Understand and apply knowledge (factual, conceptual, and procedural) based on his curiosity about science, technology, arts, culture related to visible phenomena and events	3.1 Determine the value of linear equations of two variables in real contexts

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KI 4: Processing, presenting, and reasoning in the concrete domain (using, parsing, assembling, modifying, and making) and abstract domain(writing, reading, calculating, drawing, and composing) in accordance with what is learned at school and other similar sources in the point of view/theory	3.2 Create and solve mathematical models of real problems related to linear equations of two variables

In line with this, at the SMK level there is also SPLDV material in class X. This is shown in table 2. This is shown in table 2 as follows.

Table 2. Core Competencies and Basic Competencies of Grade X Mathematics about SPLDV.

Core Competencies	Core Competencies
KI 3: Understand, apply, analyze factual, conceptual, procedural knowledge based on his curiosity about science, technology, arts, culture, and humanities with insights into humanity, nationality, state, and civilization related to the causes of phenomena and events, and apply procedural knowledge to specific fields of study in accordance with his talents and interests to solve problems.	3.3 Describe the concept of a system of linear equations of two and three variables and linear inequality of two variables and be able to apply various effective strategies in determining the solution set and checking the correctness of the answer in solving mathematical problems.
KI 4: Processing, reasoning, and presenting in the concrete and abstract domains related to the development of what is learned at school independently, and able to use methods according to scientific principles.	4.3 Make mathematical models in the form of SPLDV, SPLTV, and SPtLDV from real and mathematical situations, and determine the answer and analyze the model as well as the answer Use SPLDV, SPLTV and system of linear inequalities of two variables (SPtLDV) to present contextual problems and explain the meaning of each quantity orally and in writing.

The things that researchers do during research are as follows:

1. Prepare equipment and equipment needed during the research, in the form of test questions, paper glue, scissors, manila paper, and 20 student mathematical connection cards for each student.
2. Preparing student conditions before research, such as arranging student seating, preparing stationery, problem cards, scissors, manila paper, and paper glue.
3. Providing mathematical connection cards, glue, scissors, manila paper, and test questions as many as 20 cards per individual.
4. Observing and documenting the activities or activities carried out by students during the card preparation stage and solving the problems on the cards.

Conducting interviews with students related to the results of the preparation of cards that they relate or connect.

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A. Low Partial Mathematical Connection

This mathematical connection occurs in students in IS junior high school. The criteria that occur in this type of mathematical connection are as follows:

Students are said to produce low partial mathematical connections, because students are only able to connect the connection cards that are given and have not reached the stage of working on problems, but they only read the things that appear on the whole card and then connect them according to the knowledge they have or the knowledge they have learned before.

In general, students are categorized as having *low partial mathematical connection* ability with the following indicators:

a. Students are able to connect 2-4 groups of mathematical connection card categories based on the category or topic of the problem. However, students cannot connect all cards.
b. Students have not been able to solve the problem.

Student Z connects cards 17 and 18, because the cards are both looking for equations. So that student Z considers these two cards to have the same topic, namely about the material of the system of linear equations of two variables. Student Z has not yet reached the stage of solving the problems on these cards. But he only read the things listed on the card and then arranged the cards that were related to each other. Here is one picture of the card arrangement made by student Z.

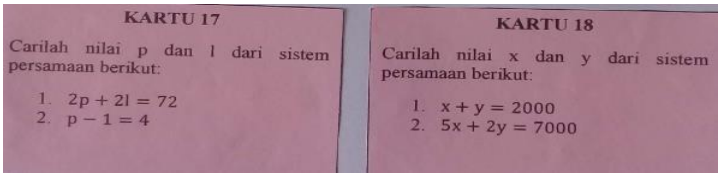

Figure 1. Results of Student Z's Card Compilation

Student Z connects cards 9 and 20, because the cards both draw graphs. So that student Z has not yet reached the stage to solve the problems on these cards. But he only reads the things on the card and then arranges the cards that are interrelated and gives reasons for the cards he connects. The following shows the results of the work and the arrangement of the cards made by student Z.

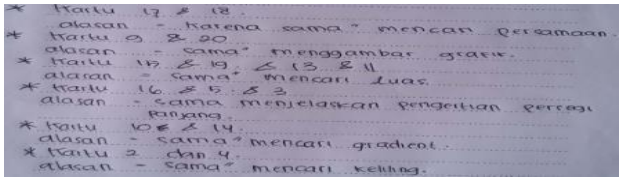

Figure 2. Results of Student Z's Work

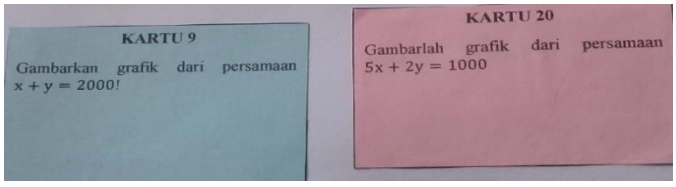

Figure 3. Results of Student Z's Card Compilation

Student Z connects cards 15, 19, 13, and 11, because the cards are both looking for area. So that student Z considers all of these cards to have the same topic, namely about rectangles.

The area of a rectangle (A) that has sizes a and b is

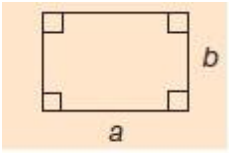

Figure 4. Rectangle Musser et al, [11]

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So that student Z has not yet reached the stage to solve the problems on the cards. But he only reads the things on the card and then arranges the cards that are related to each other. Here is one picture of the card arrangement made by student Z.

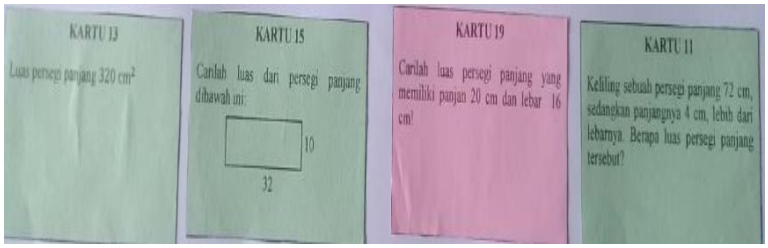

Figure 5. Results of Student Z's Card Compilation

Student Z connects cards 16, 5, and 3, because the cards both explain the meaning of rectangles. So that student Z considers all of these cards to have the same topic, namely about rectangles.
A rectangle is a rectangular flat shape whose four corners are right-angled and whose sides are equal in length.

Figure 6. Rectangle Koberlein, [12]

So that this Z student comes to the stage of arranging cards that are related to each other. Here is one picture of the card arrangement made by student Z.

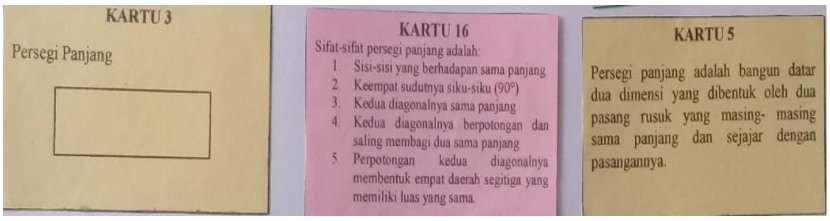

Figure 4.7 Results of Student Z's Card Compilation

Student Z connects cards 10 and 14, because the cards are both looking for gradient. So that student Z considers these two cards to have the same topic, namely about the equation of a straight line. So that student Z has not yet reached the stage to solve the problems on these cards. But he only read the things on the card and then he arranged the cards that were related to each other. Here is one picture of the card arrangement made by student Z.

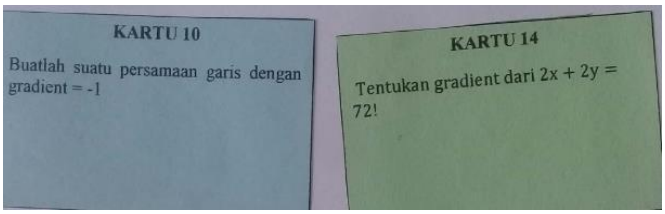

Figure 4.8 Compilation Result of Student Card Z

Student Z connects cards 2 and 4, because the cards are both looking for perimeter. So that student Z considers these two cards to have the same topic, namely about rectangles. So that student Z has not yet reached the stage to solve the problems on the card. But he only reads the things listed on the card and then arranges the cards that are related to each other. Here is one picture of the card arrangement made by student Z.

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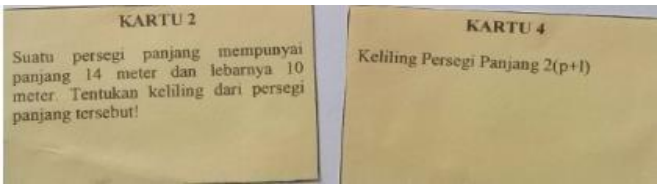

Figure 9. Compilation Result of Student Card Z

When doing card arrangement activities, student Z tries to recall the SPLDV material that he has learned. Student Z reopens his notebook and looks for ways to solve by elimination. He recalls the knowledge that has been recorded in his memory. Student Z's activity in recalling the SPLDV material he had learned is shown in Figure10. as follows.

Figure 10. Student Card Compilation Activity Z

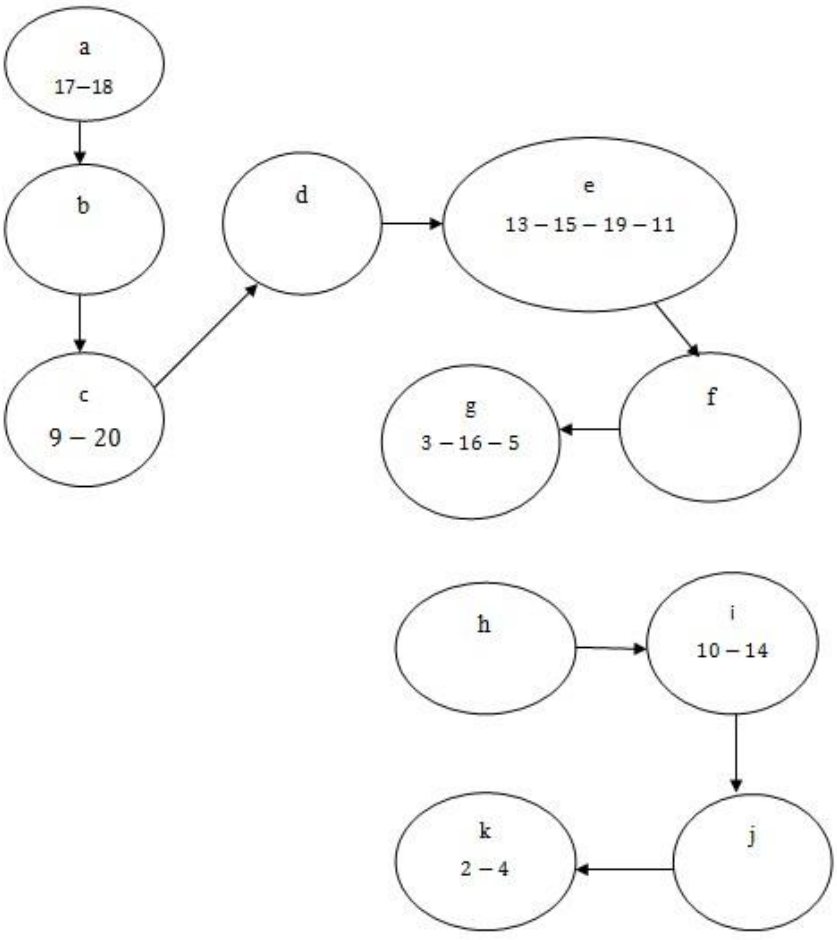

Diagram 1. Mathematical Connection Process of Students Z, A, E, and K

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Table 3. Description of Mathematical Connection Chart of Students Z, A, E, and K

No.	Description
a	Students connect cards 17 and 18, because the two cards are both looking for equations in the material of the system of linear equations of two variables (SPLDV).
b	Students call on memory from prior knowledge of graphs
c	Students connect cards 9 and 20 as a result of memory recall of prior knowledge.
d	Students begin to observe in depth to connect the next card related to finding the area of a rectangle.
e	Students connect cards 13, 15, 19, and 11 from their in-depth observations.
f	Furthermore, students continue to observe and recall the memory of knowledge about the definition of a rectangle.
g	Students connect cards 3, 16, and 5 as a result of observing and recalling the material they learned before.
h	Students still remember the material they learned before in depth about gradient.
i	Then students connect cards 10 and 14, because it is the result of knowledge about the material they learned before.
j	In this way, students remember more deeply about the material they learned, namely finding the circumference.
k	Then the student connects cards 2 and 4, which is the result of the student's deeper thinking.

B. Medium Partial Mathematical Connection

Moderate partial mathematical connection, this occurred when student N worked on the problem on question card 1 using the rectangle formula. While the method used to solve the problem on problem card 1 is the elimination and substitution method on the material of the system of linear equations of two variables (SPLDV). So in this case student N considers that problem card 1 in solving the problem uses rectangular material, so he works on the problem on card 1 without using the method of elimination and substitution in the material (SPLDV).

In general, students are categorized as having *medium partial mathematical connection* ability with the following indicators:

a. Students are able to connect 2-8 per group of mathematical connection card topics. However, students have not been able to connect all cards.
b. Students are able to solve the problem, but the solutions made are not precise.

For student N, it is different from student Z who has not reached the problem solving stage. Meanwhile, student N reached the stage of writing problem solving.

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For example, as in the problem card 1 which is looking for the length of the rectangle. Student N writes down what is known from card 1 using the rectangle formula and starts working on card 1. 2 (p + l) So the process of working on the problem on card 1 is by reading and understanding the contents of the problem and until he works on the problem that he thinks he can do.
The following work results from student N are shown in Figure 11. below:

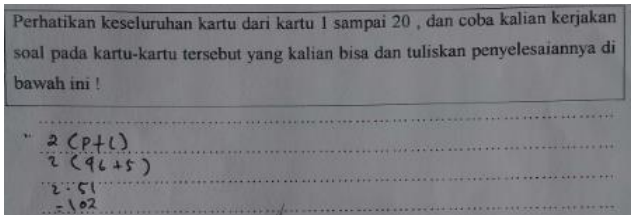

Figure 11. Student N's Work Result from Problem Card 1

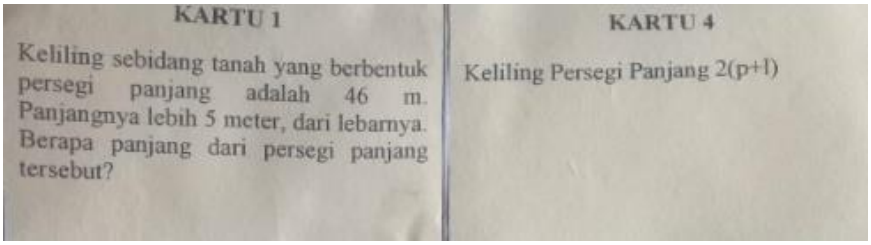

Figure 12. Results of Student Card Compilation N

Student N connects cards 5, 3, 15, 13, 16, 2, 11, 17, because in the card the questions are related to rectangles. So that student N considers all of these cards to have the same topic, namely about rectangles. So that student N has not yet reached the stage to solve the problems on these cards. But he only reads the things on the card and then arranges the cards that are related to each other.
The following shows student N's work and the corresponding card arrangement made by student N.

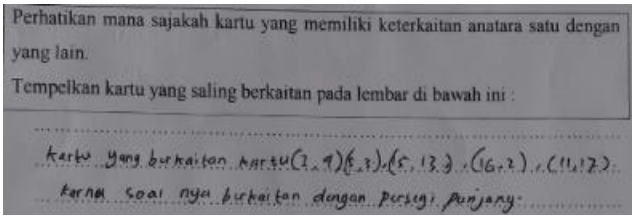

Figure 13. Student N's work

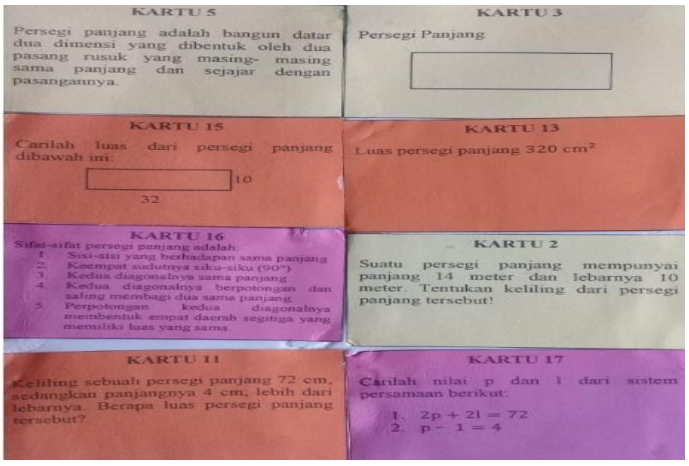

Figure 14. Results of Student Card Compilation N

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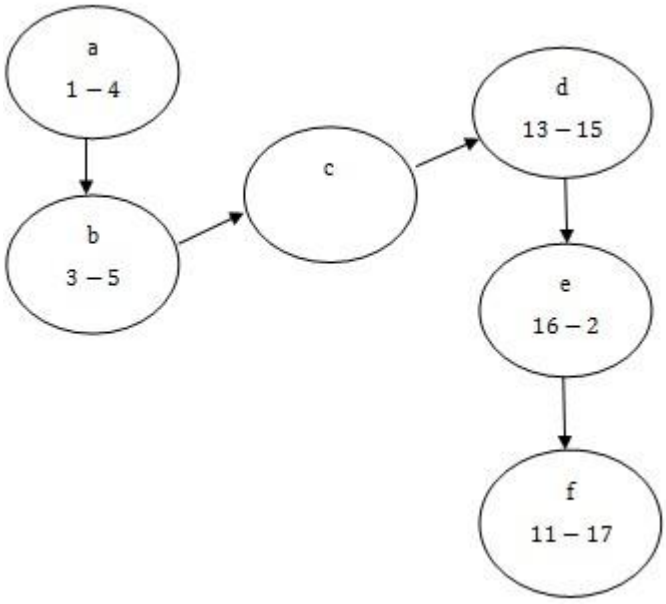

Diagram 2. Mathematical Connection Process of Student N

Table 4. Description of Students' Mathematical Connection Chart N

No.	Description
a	Students connect cards 1 and 4, as they relate to the rectangle material.
b	Then the student observes the next card and tries to remember the material he learned before the rectangle, then he associates the connection cards, namely cards 3 and 5.
c	Students begin to look more deeply at the connection problem cards, to connect the next card related to the rectangle material.
d	Students connect cards 13 and 5 because it is the result of student thinking or deeper student observation.
e	Students connect the 16 and 2 cards because it is the result of their in-depth thinking about rectangle material.
f	Students connect cards 11 and 17 because these two cards all contain questions related to rectangles.

C. *High Partial Mathematical Connection*

This mathematical connection occurs in students at SMK SH. The criteria that occur in this type of mathematical connection are as follows:

High partial mathematical connection, occurred when SMK SH students were able to think logically in connecting all the problem cards and solving several problems on the connection problem cards provided by the researcher. As in problem card 15 which is looking for the area of a rectangle, and SMK SH students solve precisely and clearly according to the knowledge previously learned

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about rectangular material. Then the next card is on the problem card 2 which looks for the perimeter of the rectangle and SMK SH students write the solution precisely and clearly according to the material of the perimeter of the rectangle, and the next problem card that SMK SH students write the solution is card 18 which finds the value of x and y in the material of the system of linear equations of two variables (SPLDV) using the elimination method.

In general, students are categorized as having *high partial mathematical connection* ability with the following indicators:

a. Students are able to connect 2-7 per group of mathematical connection cards.
b. Students are able to solve problems on mathematical connection cards that have been grouped appropriately.

For MT students, it is different from students A, E, K, Z, and N who have not yet reached the problem solving stage, but only up to giving reasons for the cards. Meanwhile, this MT student reached the stage of writing problem solving and linking problem cards that he thought could work on the problems on the card, and the number of problem cards written by MT students was cards 13 and 15, 2 and 4, 6 and 18. So, as shown in the test question sheet in activity III point 3, it appears that the reason MT students link cards 13 and 15 is because he considers cards 13 and 15 to be the formula for rectangular area.

For example, in question cards 13 and 15, what is being looked for is the area of the rectangle. MT students write what is known from the question cards 13 and 15 by multiplying the length and width of the rectangle. So the process of MT students working on the problems on cards 13 and 15 is by reading the test questions and understanding the contents of the questions and until he starts working on problems that he thinks he can do until he finds the final result of these problems. The following work results from MT students are shown in Figure 15. below:

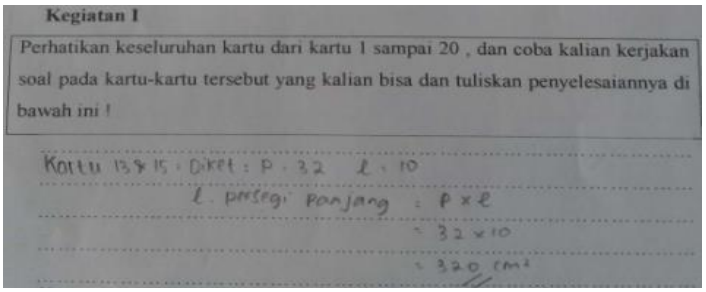

Figure 15. Student work MT part 1 of question cards 13 and 15

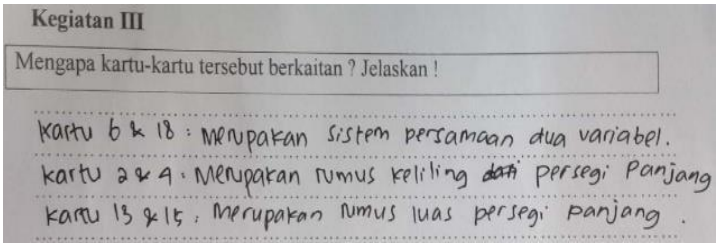

Figure 16. Student MT's reasoning for linking cards 13 and 15

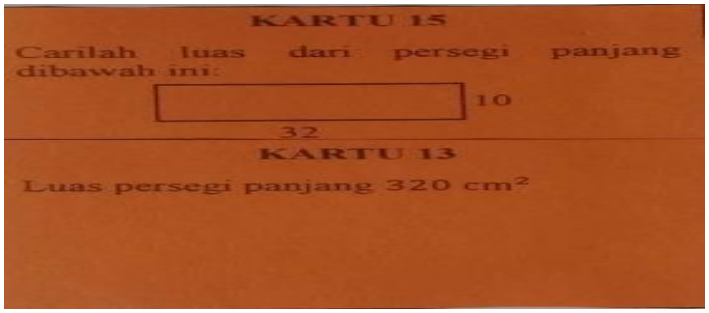

Figure 17. Results of MT Student Card Compilation

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For MT students, it is different from students A, E, K, and Z, who have not yet reached the problem solving stage but only up to giving reasons for the cards they associate. While this MT student reached the stage of writing problem solving and linking the cards that he considered could do the problems on the card and the number of problem cards written by MT students, namely there were cards 2 and 4.

For example, in question cards 2 and 4, what is being looked for in question card 2 is the perimeter of a rectangle, while in question card 4 the formula for the perimeter of a rectangle appears. So the process of MT students working on the problems on cards 2 and 4 is by reading the test questions and understanding the contents of the questions. Then MT students wrote down what was known from the question card 2, then he wrote the formula for the perimeter of the rectangle shown on card 4, and then he multiplied the length and width of the rectangle and until he arrived at determining the final result of card 2 using the formula on card 4.

The following work results from MT students are shown in Figure 18. below:

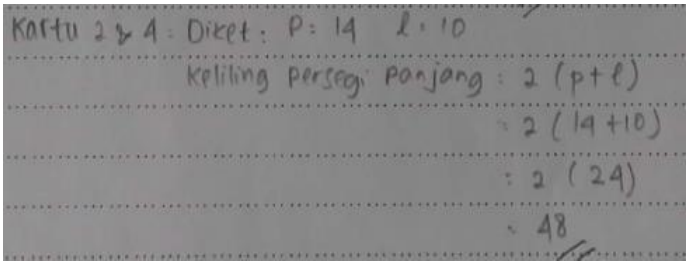

Figure 18. Student work MT part 2 of question cards 2 and 4

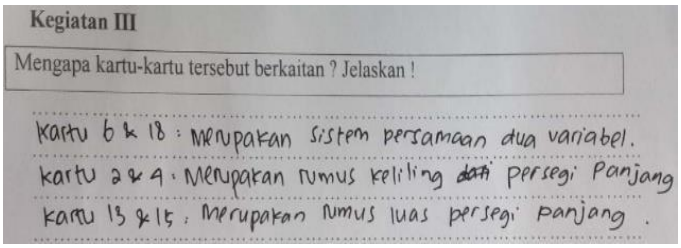

Figure 19. MT students' reasoning for linking cards 13 and 15

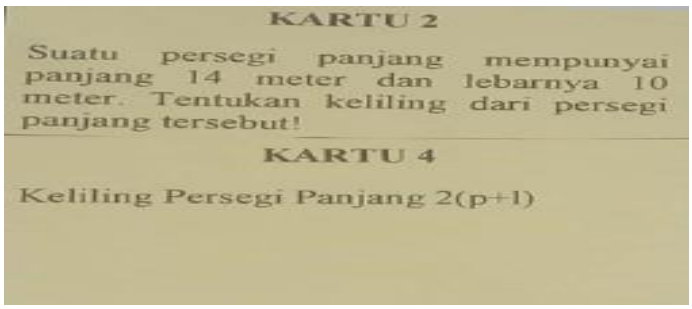

Figure 20. Results of MT Student Card Compilation

For MT students, it is different from students A, E, K, and Z who have not yet reached the problem solving stage but only up to giving reasons for the cards they linked.

Meanwhile, MT students reached the stage of writing problem solutions and associated several cards that he thought could solve the problems on the card, and some of the problem cards were also written by MT students, namely, there were cards 6 and 18. So, as in the test question sheet in activity III point 1, the reason MT students associated cards 6 and 18 was because he considered the cards to be the same topic in the material of the system of linear equations of two variables.

For example, in card questions 6 and 18, what is being looked for on card 6 is the price of 1 pencil, while on card 18 is finding the x and y values of an equation. So the process of MT students working on the problems on cards 6 and 18 is by reading the test

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 12 December 2024
DOI: 10.47191/ijcsrr/V7-i12-35, Impact Factor: 7.943
IJCSRR @ 2024
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questions and understanding the contents of the problem, then MT students write down what is known from the questions on cards 6 and 8, then they make equations from cards 6 and 8 by eliminating the two equations by multiplying, subtracting, and dividing until they get the final result of card questions 6 and 18, namely the price of 1 pencil on the card is Rp. 1000 and the x and y values on card 18 are 1000 each.

The following work results from MT students are shown in Figure 21. below:

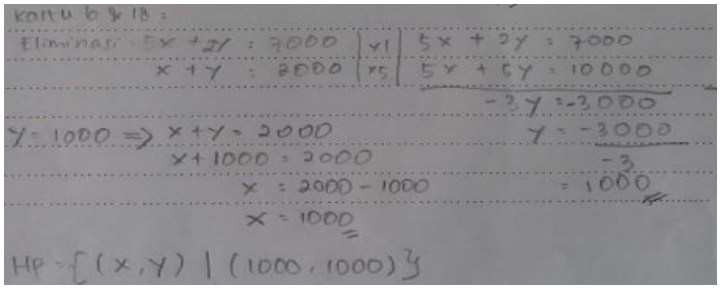

Figure 21. Student work MT part 3 of question cards 6 and 18

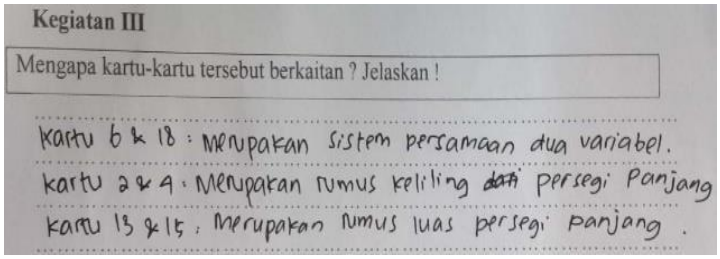

Figure 22. MT students' reasoning for linking cards 6 and 18

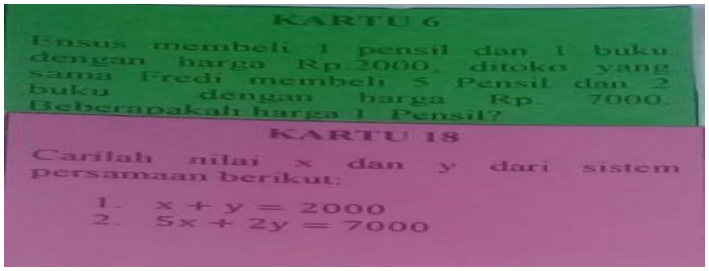

Figure 23. Results of MT Student Card Compilation

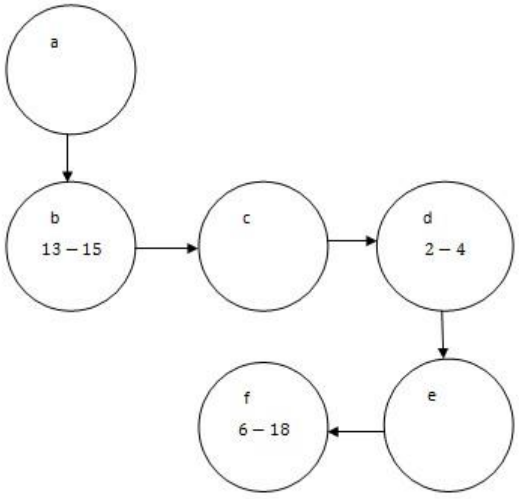

Diagram 3. Mathematical Connection Process of MT Students

International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 12 December 2024
DOI: 10.47191/ijcsrr/V7-i12-35, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Table 6. Description of Mathematical Connection Chart of Students MT, APA, IL, and A.WNP

No.	Description
a	The student looks at all the connection problem cards and starts to connect some of the cards that he understands the content of the cards, and starts to remember the material he learned before about rectangles.
b	The student connects cards 13 and 15 and works on the problems that appear on the cards, which is the result of his deep thinking or observation.
c	Students observe deeply to connect the next card and work on the problems that they are able to do by remembering the material or memory that they learned before about the formula for the perimeter of a rectangle.
d	The student connects cards 2 and 4 and works on the problems in the cards, which is the result of his in-depth thinking.
e	Students recall the material they learned previously in more depth about the system of linear equations of two variables.
f	Students connect and work on the problems shown in cards 6 and 18, which are the result of deeper thinking.

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International Journal of Current Science Research and Review
ISSN: 2581-8341
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DOI: 10.47191/ijcsrr/V7-i12-35, Impact Factor: 7.943
IJCSRR @ 2024
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Cite this Article: Damayanti N.W., Kaka D. (2024). Analysis of Students' Mathematical Connection Ability of Two-Variable Linear Equation System Material with Card Sorting Activity (CSA). International Journal of Current Science Research and Review, 7(12), 8963-8976, DOI: https://doi.org/10.47191/ijcsrr/V7-i12-35