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Analyzing students' mathematical connection ability on linear inequality system in two-variable

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Abstract

In this research, we wanted to analyze the student's mathematical connection abilities on the inequality system of two variables material by using a descriptive qualitative approach. Class X MIPA 1 SMA Negeri 2 Bantul was made the subject of this research. The instruments used in this research are tests and interview guidelines. The form of data collection is by giving written descriptions of 3 questions with unstructured interviews. Based on the results of the analysis, it was found that the mathematical connection abilities of students of class X MIPA 1 SMA N 2 Bantul on the material of the inequality system of two variables were in the "good enough" category. Through the results of the interview, it was confirmed that the low mathematical connection ability was caused by several mistakes that were often made by students, such as conceptual errors, computational skills errors, and language interpretation errors.

Keywords: mathematical connection, linear inequality system in two variables, descriptive qualitative

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INTRODUCTION

Mathematics is one of the fields of study that must be studied and has an important role for students and in the development of other scientific fields (Jihad, Asep, 2012). Through learning mathematics, it is expected that students can develop logical thinking skills, reasoning abilities, understanding of a problem, and train their accuracy (Arikunto, 2013). In line with this, Permendikbud No. 22 of 2016 also stated that the objectives of school mathematics learning include: (1) understanding the concepts and connections between concepts and their use in problem-solving; (2) developing mathematical reasoning, (3) solving problems through appropriate problem-solving procedures, (4) communicating ideas (Kemdikbud, 2016).

One of the learning objectives of mathematics listed in Permendikbud No. 58 of 2014, namely for students can explain the relationship between concepts and use concepts and algorithms, flexible, accurate, efficient, and precise in problem-solving. Indicators explain the relationship between concepts as a form of mathematical connection ability. Mathematical connection ability is the ability to connect mathematical concepts/rules in one field of study or with other fields of study or with its application to the real world (Latipah & Afriansyah, 2018; Romiyansah, et al., 2020).

It is important for teachers to teach students about mathematical connection skills from an early age so that students are able to understand the meaning of mathematics not only used in performing certain arithmetic operations (Apriyono, 2018; Budiyarti, Dwijayanti, & ..., 2021). It also aims to form students' perceptions that mathematics is a unified whole so that the material is interrelated with one another. In addition, the ability to connect mathematically also directs students to view mathematics as part of life (Agusta, E. S, 2017; Nurliza et al., 2022).

Mathematical connection is an important ability because it helps students to understand concepts and helps improve their understanding of concepts with other disciplines in terms of

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the reciprocal relationship between mathematical concepts (Widiyawati et al., 2020). In addition, mathematical connection skills also play an important role for students in helping students understand the various forms of mathematical models and their solutions. In detail, it is stated that students are said to have mathematical connection abilities if they can fulfill three indicators of mathematical connections, including connections between topics in mathematics, connections between mathematics and other fields of science, and mathematical connections with students' real lives (Romli, 2016).

The results of the researcher's interview with the teacher in charge of compulsory mathematics in class X MIPA 1 SMA N 2 Bantul, it was found that students had many difficulties in formulating daily problems into their mathematical form. In addition, students also still have difficulty in determining what formula to use when faced with questions related to everyday problems. Researchers saw that students had difficulty in relating concepts that had previously been mastered by students with new concepts to be studied. This is reinforced by the opinion of Hidayati & Roesdiana (2019) that, so far, mathematics learning taught in schools is generally independent or separate from other subjects. The student's difficulties are elements of mathematical connection ability. So, from the results of the interview, it shows that the mathematical connection abilities of students in class X MIPA 1 SMA Negeri 2 Bantul are still not optimal.

Based on the description that has been described above, it is necessary to analyze students' mathematical connection abilities in learning mathematics. Therefore, the researcher conducted a study to analyze the mathematical connection ability of students of class X MIPA 1 at SMA N 2 Bantul on the material of the system of inequalities of two variables. The updates that the authors present in this study are found in the research subjects taken as well as in the material taken as test material.

RESEARCH METHOD

This research is qualitative and descriptive. This study aims to analyze students' mathematical connection skills in the material of the inequality system of two variables obtained in class X in the odd semester. This research was conducted in early February 2022 online through the Google Form application. The subjects in this study were taken randomly, and a sample of 27 students of class X MIPA 1 at SMA N 2 Bantul was obtained.

This research went through three stages, namely: (1) the preparation phase, (2) the implementation phase, and (3) the evaluation phase. The data collection procedures applied in this study were through tests and interviews. The test conducted to obtain data in this study aims to obtain qualitative data regarding the students' mathematical connection abilities on the problem of the inequality of two variables. The instrument used in this qualitative research is in the form of a mathematical connection ability test question in the form of a description of 3 questions. It was also strengthened by conducting interviews with six students in class X MIPA 1. The interview method applied was using an unstructured interview method concerning indicators of mathematical connection ability. The indicator of mathematical connection ability used in this study is a modified indicator of the (NCTM, 2000). These indicators can be seen in Table 1.

Table 1. Mathematical Connection Ability Indicator

No	Mathematical Connection Ability Indicator
1	Connections between topics in mathematics
2	Connections of mathematics with other disciplines
3	Connections of mathematics with students' daily lives

Modified from (NCTM, 2000)

The scoring of the mathematical connection ability is used in the form of a rubric for assessing the developed mathematical connection ability (Suhandri, Nufus, & Nurdin, 2017). For more details, it can be seen in Table 2.

Table 2. Mathematical Connection Ability Test Weighting Table

Score	Description
5	Using the right concept, using the right terms and notation, implementing the algorithm correctly and completely
4	Using concepts correctly, using almost correct terms and notations, executing the algorithm completely, and in general, the calculations are correct, but there are still errors.
3	Using concepts incorrectly in the mathematical process of problems, identifying important elements, but many erroneous ideas, making some calculation errors
2	Using concepts incorrectly in the mathematical process of problems, using inappropriate tools and solving strategies, and making many calculation errors.
1	Understanding concepts and not doing calculations
0	No answer information

Modified from (Suhandri, 2017)

Next, regarding the categorization of students' mathematical connection abilities, referring to the modified results (Wardina & Sudihartinih, 2019), which are presented in Table 3.

Table 3. Categorization of Students' Mathematical Connection Ability (MC)

Percentage	Category
$85 \leq MC \leq 100$	Very Good
$70 \leq MC < 85$	Good
$55 \leq MC < 70$	Good Enough
$40 \leq MC < 55$	Less
$0 \leq MC < 40$	Very Less

Modified by (Wardina & Sudihartinih, 2019)

RESULTS AND DISCUSSION

The results obtained from this study were in the form of student answer scores consisting of 27 students based on the reference guidelines for scoring students' mathematical connection ability tests in table 2. The results of the data analysis showed that students' mathematical connection abilities were categorized into five categories, namely: very good, good, good enough, less, and very less. The categorization is described in Table 4.

Table 4. Category and Percentage

Category	Total Students	Percentage
Very Good	0	0,00%
Good	6	22,22%
Good Enough	10	37,04%
Less	10	37,04%
Very Less	1	3,70%

Based on Table 4, shows that based on the mathematical connection ability test of students in class X MIPA 1, 1 student is in the very less category if the percentage is 3.70%. The mathematical connection ability of students who are in the less category is 10 students, and the percentage is 37.04%. The mathematical connection ability of students who are in the good enough category is 10 students, and the percentage is 37.04%. The mathematical connection ability of students who are in the good category is 6 students, and the percentage is 22.22%. As for the very good category, there were no students who managed to enter that category. In other words, the percentage was 0.00%. The researchers then carried out an analysis of the results of students' answers based on the mathematical connection ability test by referring to the indicators of mathematical connection ability according to the modified NCTM, namely: connections between topics in mathematics, connections between mathematics and other disciplines, and connections between mathematics and students' daily lives. (NCTM, 2000).. The average test results of the mathematical connection ability indicators of class X MIPA 1 students can be seen in Table 5 below.

Table 5. Percentage of each Mathematical Connection Ability Indicator

Mathematical Connection Ability Indicator	Percentage	Category
Connections between topics in mathematics	67,41%	Good Enough
Connections of mathematics with other disciplines	40,74%	Less
Connections of mathematics with students' daily lives	71,85%	Good

Based on Table 5 the percentage of each indicator of the mathematical connection ability test of students in class X MIPA 1 shows that the percentage of students who can connect between topics in mathematics is 67.41% and is in the good enough category. The percentage of students who can connect mathematics with other disciplines is 40.74% and is in the less category. Finally, the percentage of students who can connect mathematical concepts with daily life is 71.85% and is in the Good category.

Furthermore, the results of the analysis per category on students' mathematical connection abilities can be presented as follows.

Very Good Category

Based on the results of the mathematical connection ability test, which has a very good category, there are 0 students, with a percentage of 0.00%. In other words, the research subject students did not find students who had mathematical connection skills in the very good category.

If the author needs another sub-subsection, it can be written in an italic sentence case. Moreover, we encourage the author to present figures and tables. Tables and figures are presented centered, as shown in Figure 1 and cited in the manuscript. The dotted line is only a guide to putting the figure in the correct position. After it is a good fit, make it borderless.

Good Category

Based on the test results, students who have a good category are 6 students, with the percentage who have a good category being 22.22%. The following is an example of the completion of one of the students, namely S-3, who obtained a good category on the mathematical connection ability test.

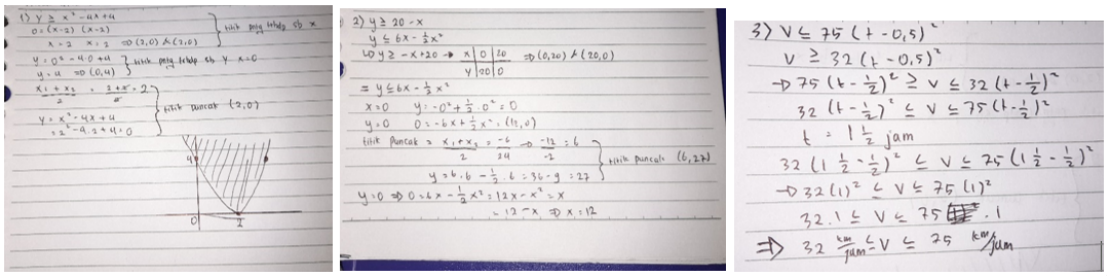

Figure 1. Example of completion of S-3 students with good category

Based on Figure 1 shows students in question number 1, namely: indicators of connecting between topics in mathematics, students can analyze well the concept of quadratic functions taught in grade 9 SMP and associated with the concept of quadratic inequality. S-3 students on problem number 2, namely: indicators of the connection of mathematics with other sciences, students can formulate questions into mathematical form (known and asked) by linking mathematical concepts in the relationship between income and production costs but are unable to make conclusions for solutions The solution is in the form of a linear-squared inequality graph. This is supported by research conducted by (Utami, 2019) with similar error analysis results. Through interviews with S-3 data obtained, those students were not very careful in reading the questions, so students only took the steps of preparing a graph of a quadratic-linear function by not taking a picture of the solution. As for question number 3, doctoral students can relate the concept of a two-variable inequality system in determining the vehicle speed range properly. Students who are in the good category can use concepts correctly, use almost correct terms and notations, carry out complete algorithms, and in general, the calculations are correct. Therefore, it can be stated that the doctoral students overall are in a good category (70 ≤ MC < 85).

Good Enough Category

Based on the test results, there were 10 students who obtained the good enough category, with a percentage was 37.04%. The following is an example of the completion of one of the students, namely S-4, who obtained a good enough category on the mathematical connection ability test.

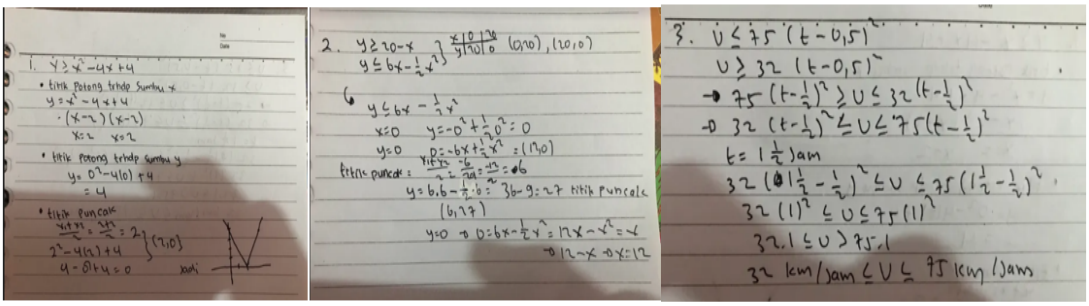

Figure 2. Example of completion of S-4 students with good enough category

Based on Figure 2 shows S-4 students on question number 1, namely: indicators of connecting between topics in mathematics. Students are able to analyze the concept of a quadratic function which is associated with the concept of quadratic inequality. The completion steps have been written well, but S-4 is not able to describe the settlement area intended for the problem. In question number 2, namely: indicators of the connection of mathematics with other sciences, students are not able to relate mathematical concepts to the concept of the relationship between income and production costs. This is seen by the incomplete completion of the solutions made in determining the graph of a quadratic function or a straight line. Through interviews with

S-4 data obtained, those students have never worked on questions of the same type in class, and therefore students do not understand the meaning of the questions. This is certainly very fatal, considering the ability to understand concepts or questions is also important in terms of supporting mathematical connection abilities. This is reinforced by research conducted by Kusmanto (2014), which states that there is an effect of understanding mathematics on the mathematical connection ability of seventh-grade junior high school students. As for question number 3 on the indicator of connecting mathematical concepts with everyday life, S-4 students are able to relate the concept of the inequality of two variables in determining the speed range of vehicles quite well, although there are many notations that are forgotten to write for example the sign of less than equal to or on the contrary. Students who are in the category good enough to use concepts inappropriately in the mathematical process of problems, identify important elements but have many erroneous ideas, and make some calculation errors. Therefore, it can be stated that the overall S-4 students are in the sufficient category (55 ≤ MC < 70).

Less Category

Based on the results of the mathematical reasoning ability test on the inequalities of two variables that have a less category, there are 10 students, if the percentage that has the less category has a percentage of 37.04%. The following is an example of the completion of one of the students, namely S-9, who obtained a lower category on the mathematical connection ability test.

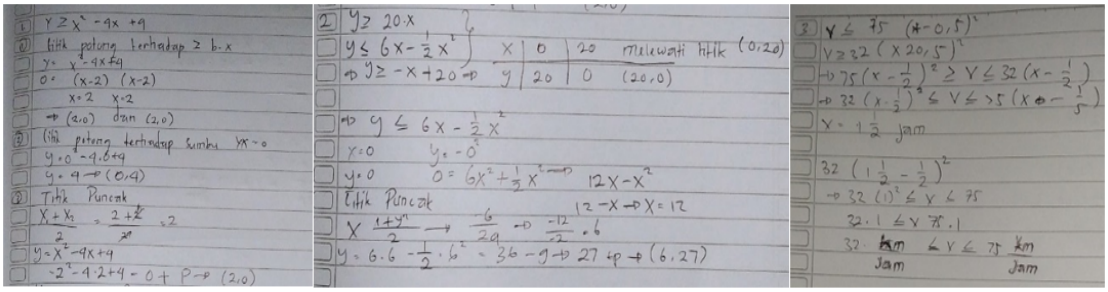

Figure 3. Example of completion of S-9 students with less category

Based on Figure 3, shows that students in question number 1 are less able to read the questions, so they cannot formulate them into mathematical form correctly. This can be observed from the writing of some unclear notations or algorithms. In the answer made, S-9 writes the bx and yx axes which are not correct. In arithmetic operations (2+2)/2, S-9 students divide 2 by 2 without adding the numerators first. Although the results are the same, it shows that S-9 still has misconceptions about integer arithmetic operations. The students' less understanding was supported by the results of interviews with S-9 students, who said that they did not know what they were doing and received answers directly from their friends. This is also following the research conducted by Kusmanto (2014), which examined the relationship between mathematical understanding and mathematical connection ability. S-9 students in question number 2, made many calculation errors, and the notation used was unclear. In the step of determining the vertex of the graph of the quadratic function, students write down formulas and functions that are not appropriate and suddenly get an answer. This student's misconception is caused by seeing his friend's work and not understanding what is written in advance. As for question number 3, S-9 students experienced some notation and algorithm errors, such as in writing the inequality sign and forgetting to write it down. Students with fewer categories use concepts incorrectly in the mathematical process of problems, use inappropriate tools and solving strategies, and make many calculation errors. Therefore, it can be stated that the overall S-9 students are in the less category (40 ≤ CM < 55).

Very Less Category

Based on the results of the mathematical reasoning ability test on the inequalities of two variables that have a very less category, there are 1 student, if a percentage of those who have a very less category has a percentage of 3.70%. The following is an example of the completion of one of the students, namely S-12, who obtained a very less category on the mathematical connection ability test.

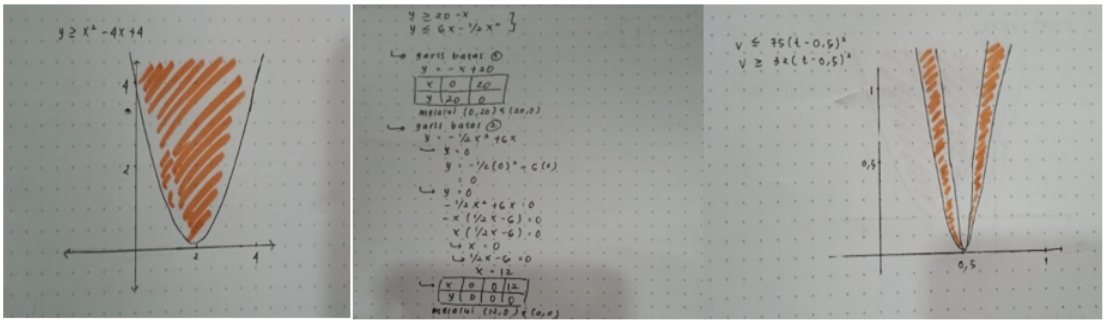

Figure 4. Example of completion of S-12 students with very less category

Figure 4 shows that the S-12 students in question number 1 only wrote the form of the known inequality in the problem and the graph of the quadratic inequality without any completion steps. Through interviews with the students concerned, it turned out that S-12 worked using the help of an application and did not know in detail the steps that had to be taken to describe the graph. S-12 students in question number 2 have problems relating mathematical concepts to the concept of the relationship between income and production costs. This is indicated by the solution that only writes the intersection point without arriving at the form of the graphic image requested in the problem. After conducting interviews with S-12, it was found that S-12 did not understand the meaning of the questions and did not read the questions until they were finished, S-12 honestly said that they imitated their friends, so that students only made the steps of graphing quadratic-linear functions. As for question number 3, S-12 students again only wrote what they knew about the questions and graphic images, even though the meaning of the questions was not so. This is relevant to the results of interviews on questions 1 and 2, which show that S-12 does not understand the meaning of the questions, so there is a misperception in students' understanding. Students who are in the very less category are unable to understand the concept well and are accompanied by incorrect calculations. Therefore, it can be stated that the overall S-12 students are in the very less category ($0 \leq CM < 40$).

Based on the analysis of several students on each indicator of mathematical connection ability, it can be seen that there are still students who have not been able to connect concepts in mathematics, with other disciplines, and with everyday life. This is certainly unfortunate, considering that some of the indicators above have an important role in mathematics. Concepts in mathematics are relationships of ideas or ideas that are used to be able to formulate and test topics in mathematics deductively (Anandita, 2015). Mathematical concepts can help students develop their intellectual potential and make it easier to learn other fields (Fatimah, 2019). Based on the results of interviews with several students, they admitted that it was still difficult to formulate story questions into mathematical form, did not understand what was being asked, and admitted that they lacked time to work on these questions.

CONCLUSION

The level of mathematical connection ability of class X MIPA 1 SMA N 2 Bantul is in the "good enough" category and is further broken down into five categories. Of 27 students, it was found

that 1 student was in the "very less" category with a percentage of 3,70%; 10 students in the "less" category with a percentage of 37,40%; 10 students in the "good enough" category with a percentage of 37,40%; 6 students in the "good" category with a percentage of 22,22%; and none of the students were in the "very good" category. It is clear to note that the mathematical connection ability test, given the level of mathematical connection ability of class X MIPA 1 students is still not optimal. The data was clarified through interviews with the finding that most of the students did not understand the tests given. As a researcher's suggestion, the teacher is expected to be able to give students many opportunities to understand mathematics subject matter and facilitate students' discussions so that students have perfect mathematical connection skills and do not rely on rote systems in learning mathematics.

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