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STUDENTS' MATHEMATICAL CONNECTION ABILITY IN SOLVING PROBLEMS

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Abstract

The purpose of this study is to describe high, mid, and low mathematical abilities in solving mathematics problems of grade VII SMP PGRI 06 Malang in the 2019/2020 academic year. Data analysis techniques were carried out from the results of mathematical connection tests, problem solving tests and interview instruments. The research subjects were 22 students. Researchers took 3 subjects representing high, mid, and low ability students. Researchers used instruments of problem-solving tests and interview guides. Finally, the research concludes that high-ability students do all activities in the indicators of mathematical connection ability in solving problems; mid-ability students do not do all the activities in the indicator of mathematical connection ability in solving problems; Students with low mathematical abilities do not do all activities in the indicator of mathematical connection ability in solving problems.

Keywords: Mathematical connections; problem solving

Abstrak

Tujuan dari penelitian ini adalah untuk mendeskripsikan kemampuan matematika tinggi, sedang dan rendah dalam menyelesaikan masalah matematika siswa kelas VII SMP PGRI 06 Malang tahun pelajaran 2019/2020. Teknik analisis data dilakukan dari hasil tes koneksi matematis, tes pemecahan masalah dan instrumen wawancara. Subjek penelitian adalah 22 siswa. Peneliti mengambil 3 subjek yang mewakili siswa berkemampuan tinggi, sedang dan rendah. Peneliti menggunakan instrumen tes pemecahan masalah dan pedoman wawancara. Hasil penelitian ini bahwa siswa berkemampuan tinggi melakukan semua aktivitas dalam indikator kemampuan koneksi matematis dalam memecahkan masalah; siswa berkemampuan sedang tidak melakukan semua aktivitas pada indikator kemampuan koneksi matematis dalam menyelesaikan masalah; Siswa dengan kemampuan matematis rendah tidak melakukan semua aktivitas pada indikator kemampuan koneksi matematis dalam menyelesaikan masalah.

Kata kunci: *koneksi matematis; pemecahan masalah*

INTRODUCTION

The ability to connect and solve mathematical problem is an important part of cognitive abilities that must be owned by students. Students who have good mathematical connection skills succeeded in solving mathematical problems well, while students with poor mathematical connection abilities failed in solving mathematical problems (Pambudi et al., 2020). The mathematical connections are the parts of the knowledge network that are constantly linked to other knowledge networks that are focused on important concepts to understand and strengthen the relationships between ideas, concepts, and mathematical procedures (Kenedi et al., 2019). Students who have the ability to connect mathemati-

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cally will be able to apply it to real problems in their environment, and connect mathematics with other subjects

Having good mathematical connection ability is an important thing in solving problems in other fields of science and the real world. This is in accordance with the opinion of Hadiat & Karyati (2019) in which mathematical connection is important for developing students' reasoning and mathematical problem solving skills. Students have a very important mathematical connection ability, because this ability connects mathematics with the real world, with other disciplines and other mathematical concepts (García-García & Dolores-Flores, 2018; Jahring, 2020)

According to Son et al (2020) problem solving abilities and mathematical connection abilities have a strong connection. According to Pradika et al (2019) students who have mathematical connection skills in solving mathematical problems find it easier to solve difficult problems

Students do not only need the ability to understand problem situations, create algorithms, process various informations and perform calculations, but also must be able to identify and choose several methods to solve problems. Problem solving needs to be done by each individual in solving the problems they face. Every individual has their own way of responding to a problem and of course individual attitudes will be different from the attitudes of other individuals when facing problems. Students' problem-solving abilities are affected differently by their thinking abilities (Sari et al., 2020).

In the context of learning mathematics, a problem is related to mathematics assignments and not related to the obstacles in learning experienced by students or the students' low learning outcomes obtained in mathematics material.

Problem-solving abilities are the skills mostly learned and paired with learning models (Purnama et al., 2020). Mathematical problem solving is a skill using previous acquired knowledge, experiencing while doing assignments and understanding that uses mathematical ideas to meet demands, in situations that were previously unknown. The ability of each student in completing tasks related to solving math problems is different.

Mathematical problem solving is a human activity, therefore the teaching model and student cognitive style are very important to take into account when learning mathematics so that students are able to solve mathematical problems (Son & Fatimah, 2020). Every student in each class has different math abilities. There are students who have high math abilities, mid math abilities and low math abilities.The ability to connect mathematically and solve mathematical problems is an ability that must be achieved in learning mathematics, however, these two components are still considered as difficult abilities for students to master. The components that play important role in the successful achievement of learning objectives are teachers, students, teaching materials, and the instructional (Pradyumnati & Harta, 2019))

The ability of mathematical connections must be a concern because there are still many students who make mistakes in solving problems of mathematical connection ability. So it is important to be characterized as a basis for further research (Arjudin, 2016). The results of other research by (Son et

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al., 2020) said that the ability to solve math problems of most students was still low. Solving math problems are a difficult cognitive activity in most cases (García-García & Dolores-Flores, 2018).

A common problem is that teachers do not consider students' initial mathematical abilities, so that certain students do not have sufficient knowledge to support problem solving. Therefore, it is important to describe the ability of mathematical connections in solving mathematical problems in terms of students' initial abilities, so that teachers can provide appropriate learning material.

RESEARCH METHODS

The research's approach uses a qualitative approach that produces descriptive data in the form of written or spoken words from people and observable behavior. The qualitative approach in this study intends to understand the phenomena experienced by research subjects.

The research's subjects in this study were three students of grade VIIB SMP PGRI 06 Malang. The pretest sheet instrument was used to measure or categorize the students' mathematics abilities. It was commonly known as the Problem Solving Test which was used to select research's subjects. Researchers analyzed the results of the Mathematical Ability Test based on the students' grade categories as shown in the students' mathematical abilities score. It was converted into qualitative form by taking into account the assessment guidelines as shown in Table 1.

Table 1. Students' Mathematical Ability (SMA) Criteria

No	Score	Score Category Mathematics Ability
1	$x \geq 80$	High
2	$65 \leq x \leq 80$	Middle
3	$x \leq 65$	Low

Modification of (Arikunto, 2021)

Table 1 shows selection of students' test scores into students' ability to communicate their ideas orally. The researcher also used interview guidelines to explore students' mathematical connection skills in solving problems. Researchers used interviews to explore information about students' mathematical connection abilities in solving math problems based on written results or students' answers. The researcher conducted a problem solving test (PST) analysis according to the mathematical connection ability indicators in solving problems as shown in Table 2.

Table 2. Indicators of mathematical connection ability in solving problems

No	Solving Step	Mathematical Connection Indicator
1	Understanding problem stage	Can mention the relationship between concepts on math problems
2	Planning Stage	Can make plans for problem solving by creating a concept map to complete math problem
3	Implementing plan stage	Can use the relationship between concepts into arith-metic operation procedures for solving math problems
4	Looking back stage of completion step	Re-check the obtained completion.

Modification of (Baiduri et al., 2020)

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The research was conducted by giving a mathematical connection ability test first to all of class VIIB's students, SMP PGRI 06 Malang, with the total is 22 students (consisting of 9 male students and 13 female students). Subjects were determined from the test results which were then grouped based on the students' mathematical connection ability test results. Mathematical connection abilities are divided into 3 groups, namely high, mid, and low categories of mathematical connection abilities. Conclusions in this study can be obtained by comparing the analysis of the written tests' results and interviews conducted to the 3 students. The students represent student with high, mid, and low categories of mathematical connection abilities who become the subject of research, so that it can describe the students' mathematical connection abilities in problem solving.

RESULTS AND DISCUSSION

The test results from 22 students of class VII B SMP PGRI 06 Malang found that 3 students had high mathematical ability categories. There were 11 students with mid mathematical ability categories and 8 students had low mathematical ability category. Based on the results of the data on the subject ability category, 3 subjects were chosen and shown in Table 3.

Table 3. List of Research Subjects

No	Code Name	Gender	Grade	Mathematical Connection Ability
1	**St_2**	F	97	High
2	St_5	M	78	Mid
3	St_1	M	45	Low

Table 3 consists of three columns; students' name, students' gender, and mathematical connection ability test scores. The results of the mathematical connection ability test scores were classified into three mathematical connection abilities; high, medium and low.

Based on the results of the St2 Problem Solving Test (PST), it was obtained data on the ability of mathematical connections in solving problems as follows:

1. Description of Students with High Mathematical Ability (St2): Mathematical Connection Ability in solving the problem is shown in Figure 1.

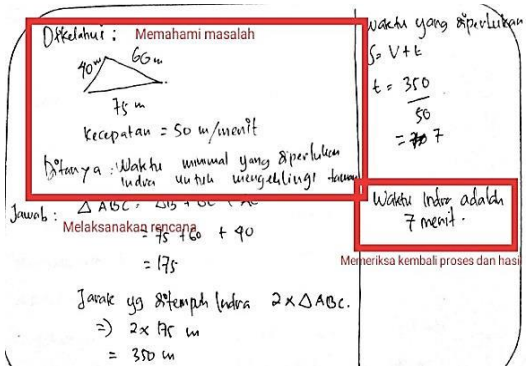

Figure 1. Results of PST Subject St2

Based on Figure 1, the S2's work in doing problem solving with questions on triangle material, starting with writing down what is known and being asked, and writing the final answer. St2 can understand the problem given and write it down correctly. Based on the results of interviews and written results, St2 was able to write down what information was known and asked in

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great detail. St2 was able to convert questions in colloquial form into mathematical symbols. St2 can obtain information on questions that can be used in solving the problem

St2 can explain the relationship between concepts in math problem material, including the relationship between the concept of length and the distance, the concept of velocity using comparison. St2 can connect the concepts in the problem appropriately. Thus St2 can be said that she can explain and relate among concepts in mathematical material.

In planning stage to solve the problem, St2 used a map concept to make it easier to work on the problem. St2 can explain at the interview the completion steps based on question given. So it can be concluded that St2 has planned problem solving by making a concept map on calculating paper to solve mathematical problems

At the stage of implementing the problem solving plan, St2 used the relationship among concepts to facilitate the arithmetic operation procedure used to solve mathematical problems. St2 conveyed the relationship between the concept of length and distance, and comparison with velocity. Through interviews with the researchers, St2 used certain counting operation procedures so that she gets the answer for the minimum time to go around the park twice. St2 makes connections between concepts to facilitate arithmetic operations to solve mathematical problems.

At the stage of re-checking the solutions obtained, St2 reread the questions, whether what she knew was correct or not and understood what was being asked. St2 rechecked the problem planning, whether it was correct in the counting operation procedure from the beginning to the end. Researchers confirmed with questions that indicate the existence of activities to review problem completion; that is writing down errors made on the calculation sheet and recalculating what he did. So it can be concluded that St2 has reviewed what he obtained in solving mathematical problems.

2. Description of Students with Middle Mathematics Ability (St5): Mathematical Connection Ability in solving the problem is shown in Figure 2

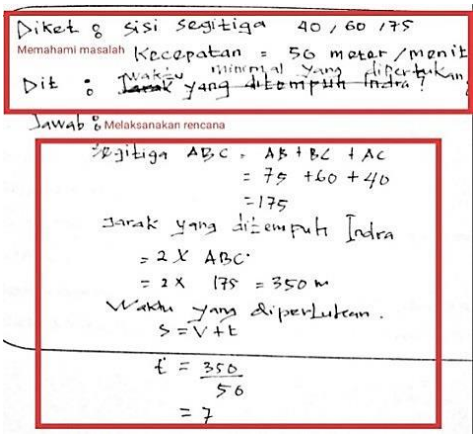

Figure 2. Results of PST Subject St5

Based on Figure 2, it shows that St5 worked in working on problem solving questions on triangle material, starting with writing down what they know and asked, until writing the final answer. St5 understood the problem by reading questions to find out what information was needed in answering the questions. St5 needed what information was known in the questions and managed into useful information for problem solving. At the reading stage, understanding what was important in solving the problem. St5 can explain the questions in own language.

Researchers conducting inter-views on St5 and he can explain the relationship between the concept of

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math problems among others, the relationship between the concept of length and the distance, and the concept of speed by comparison. St5 can connect the concepts in the problem appropriately. Thus it can be said that St5 can name and relate mathematical concepts to triangles correctly.

St5, in the planning stage for solving the problem, used direct calculation by adding what was already known. By directly adding up the numbers that were already known, he can still explain the numbers he wrote when conducted the interview. St5, in taking the steps to solve the problem, was based on the questions. So it can be concluded that St5 had planned problem solving by making a map concept on calculating paper to solve mathematical problems

St5, at the stage of implementing the problem solving plan, connected between concepts on calculating paper to facilitate arithmetic operations procedures in solving mathematical problems. St5 conveyed the relationship between the concept of length and distance, comparison between speeds through interviews with researchers. St5 used the direct count operation procedure by adding up each side of the triangle and multiplying by two. St5 obtained the answer to the length of the path with the perimeter of the triangle multiplying by two, then dividing by the velocity per 50 meters. St5 used the relationship between concepts in the arithmetic operation procedure to solve mathematical problems at the stage of checking the solutions obtained. St5 reread the questions, whether what he knew was correct or not and understood what was being asked. St5 rechecked the results of the answers that had been done. The counting operation procedure from start to finish was correct. Researchers confirmed the results of the answers with questions that showed cognitive activity, checking again. The results of St5's answers, arithmetic paper and the results of the interviews showed that there was an activity to look back at the solution in solving math problems.

3. Description of Students with Low Mathematical Ability (St1): Ability of Mathematical Connection in solving the problem is shown in Figure 3.

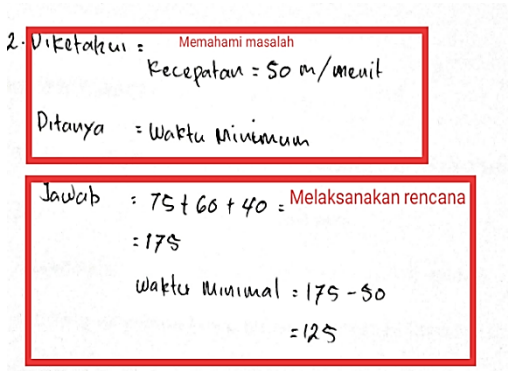

Figure 3. Results of PST for St1

Based on Figure 3, it shows the work of St1 in working on problem solving questions on triangle material, starting with writing down what is known and being asked, until writing the final answer. St1, in understanding the problem when reading the questions to find what information is needed in answering the questions, had difficulty in restating what was known. St1 did not write what was known thoroughly, only wrote part of what was known. St1 had not been able to express again in his own language what was meant by questions. St1 cannot mention the relationship between concepts in mathematics, including the relationship between the concept of length and the distance, the concept of velocity with comparison. St1 has not been able to

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connect the concepts in the problem correctly. Thus, St1 had not been able to mention and connect the mathematical concepts.

St1, in planning stage for solving the problem, did not use the correct procedure. Since St1 did not use symbol, image, or chart representations to facilitate the order of work just like what have carried out by St5 and St1. St1 cannot identify any arithmetic operations that were used in planning the resolution of the problem. St1 also had not been able to make a sequence or steps of calculation operations that wee used to solve the problem. St1 could not explain why he wrote the numbers when the researcher conducted the interview. St1, in taking the steps to solve the problem, was not in accordance with the question. So it can be concluded that St1 cannot plan problem solving by making map concept on calculating paper or during interviews in solving math problems.

St1, at the stage of implementing the problem solving plan, did not use the relationship between concepts by using calculating paper to facilitate arithmetic operation procedures in solving mathematical problems. St1 could not convey the relationship between the concept of length and distance, comparison with speed through interviews. St1 did not use the counting operation procedure sequentially by adding up each side triangle and multiply it by two. St1 made the mistake of subtracting the velocity by the sum of the distances in the triangle. St1 did not use the relationship between concepts in the arithmetic operation procedure to solve mathematical problems.

At the stage of re-checking the solutions obtained, St1 did not carry out cognitive activities to re-read the questions, whether what she knew was correct or not and understood what was being asked. St1 did not re-check the problem planning, whether it was correct in the counting operation procedure from start to finish or not. Researchers confirm with questions that show activity of looking back at the completion. Students with high category of mathematical connection skills in understanding and planning problems can mention the relationships between mathematical concepts and create concept maps. Students write down what is known and asked in the problem completely in the form of sentences and mathematical symbols (facts) that have been understood. It is in line with Romli (2016) in which students with high category mathematical connection abilities in carrying out problem solving plans using concept linkages with procedures or certain arithmetic operations.

Students with moderate category of mathematical connection skills in carrying out problem solving plans using concepts related to certain arithmetic procedures or operations. Students with medium category of mathematical connection abilities did not perform well at the stage of reviewing the steps that had been done, so that the results of the arithmetic operation were wrong.

Students with low category of mathematical connection ability in understanding and planning problems did not mention the relationship between mathematical concepts. Students in writing what they know have not been able to make information that can be used to plan problems. Students in writing what is asked, cannot express the problem in their own language. Students have low independence, make mistakes in

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understanding mathematical relationships in other fields of science as well as in everyday life. The difficulty for students to understand the questions is because students are still confused and unable to interpret the sentences presented and express in their own language what the questions mean (Yuwono et al., 2018); Hadin et al 2018)

Students have difficulty understanding questions because students are still confused and have not been able to interpret the sentences presented and forget with material. This is in accordance with the opinion of Warih et al. (2016) Students with low category mathematical connection abilities in carrying out problem solving plans cannot use concept linkages with certain arithmetic procedures or operations (Sitaresmi et al., 2016) . Students with low category mathematical connection abilities did not carry out cognitive activities at the stage of looking back at the problem-solving stage. Students have difficulty understanding the information on the problem, because they are not used to working on problem solving problems

Subjects with medium and high abilities were able to meet the criteria for the mathematical connection aspect in the step of understanding the problem, namely students wrote down known facts by connecting the meaning of the questions in writing to make it easier to solve problems. In line with research (Maryanasari & Zanthy, 2019) high-ability students are able to relate mathematical concepts well. The problem solving process requires the right concepts, principles, and procedures in order to obtain the desired answer and is called an internal connection, a connection in mathematics. The teacher's role in learning mathematics in the classroom (Davadas & Lay, 2020; Winarso & Haqq, 2020) and the teacher's skills in choosing math problem solving strategies are very important so that students are skilled in problem solving (Barham, 2020). The teacher's must be well-versed in the subject matter and able to guide the students' attention to ever-more abstract and challenging subjects if she is to support their growth, assist them accomplish higher goals, and ensure that they never stop learning (Österman & Bråting, 2019). Students' previous knowledge at the basic level is very important to strengthen their knowledge and provide appropriate information needed to solve the problem (Amin & Sulaiman, 2021)

CONCLUSIONS

Subjects with high and medium initial abilities can recognize these mathematical ideas, then connect the information known in the problem with the knowledge they already have to obtain a solution to the problem given. Subjects with low initial abilities are unable to connect ideas in mathematics because subjects with low abilities do not have sufficient knowledge to support problem solving.

Weaknesses in this study is the subjects of this study are only represented by 1 subject in each ability category, so that coincidences could occur, so that there was no comparative data originating from the same phenomenon.

Comparison with research from two previous studies which stated problem solving ability, mathematical connection ability, strong association relationship and mathematical connection ability in solving mathematical problems easier to solve difficult problems, while in this study, describe the category of students' abilities with the concepts understood in

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each problem-solving episode. The result is that students who are able to connect between concepts well, at each stage of the problem solving episode do well.

The theoretical impact of this research is that students who have the ability to relate concepts well in solving math problems are easier to work on each problem-solving episode.

SUGGESTIONS

Based on the results of data analysis, students' answers, interviews, discussions and conclusions, suggestions for further research : profiles of students with high mathematical abilities that can be used for learning for students with high mathematical abilities, for learning medium and low ability students in forming students' mathematical connections in solving mathematical problem solving.

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