Profile of Mathematical Connection of Junior High School Students Viewed From Mathematical Ability

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Abstract. *This research is a descriptive qualitative study that aims to describe the profile of students mathematical connections with high, medium and low mathematical abilities to solving mathematical problems. This research was conducted at Junior High School 5 Gresik class VIII C with 3 students as research subjects. Based on the results of data analysis it can be concluded that: (1) The profile of mathematical connection of student with high mathematical ability is that student can recognize and use connections among mathematical ideas, understand how mathematical ideas interconnect and build on one another and can to recognize and apply mathematics in contexts outside of mathematics which covers other subject areas and disciplines as well as to students' daily lives. (2) The profile of the mathematical connection of student with medium mathematical ability is that student can recognize and use connections among mathematical ideas, simply understand how ideas in mathematics are interconnected and build on one another, can not connect mathematics with other subject areas and can connect mathematics to daily lives. (3) The profile of the mathematical connection of students with low mathematical ability is that student can recognize and use connections among mathematical ideas, can not understand how ideas in mathematics are related, can not connect mathematics with other subject areas and can connect mathematics to daily lives.*

Keywords: *profile of mathematical connection, mathematical ability*

Abstrak. *Penelitian ini merupakan penelitian deskriptif kualitatif yang bertujuan untuk mendeskripsikan profil koneksi matematis peserta didik berkemampuan matematika tinggi, sedang dan rendah dalam memecahkan masalah matematika. Penelitian ini dilaksanakan di SMP Negeri 5 Gresik kelas VIII C dengan 3 peserta didik sebagai subjek penelitian.Berdasarkan hasil analisis data diperoleh bahwa: (1) Profil koneksi matematis peserta didik berkemampuan matematika tinggi adalah peserta didik dapat mengenali dan memanfaatkan hubungan antar ide dalam matematika, memahami bagaimana ide dalam matematika saling berhubungan dan membangun satu sama lain dan dapat mengaitkan matematika dengan konteks di luar matematika yang meliputi disiplin ilmu lain dan kehidupan sehari-hari. (2) Profil koneksi matematis peserta didik berkemampuan matematika sedang adalah peserta didik dapat mengenali dan memanfaatkan hubungan antar ide dalam matematika, cukup memahami bagaimana ide dalam matematika saling berhubungan dan membangun satu sama lain, tidak dapat menghubungkan matematika dengan disiplin ilmu lain dan dapat menghubungkan matematika dengan kehidupan sehari-hari. (3) Profil koneksi matematis peserta didik berkemampuan matematika rendah adalah peserta didik dapat mengenali dan memanfaatkan hubungan antar ide dalam matematika, tidak dapat memahami bagaimana ide dalam matematika saling berhubungan, tidak dapat mengaitkan konsep matematika dengan disiplin ilmu lain dan dapat menghubungkan matematika dengan kehidupan sehari-hari.*

Kata Kunci: *profil koneksi matematis, kemampuan matematika*

Introduction

The success of education has a close relationship with the progress of a nation. This is because education is part of the development of science and technology. Through educational programs, a person can develop his potential and thinking abilities. To realize the success of education, learning activities must be carried out effectively and efficiently. This applies to all subjects, including mathematics.

As part of the scientific discipline, mathematics has an important role in the survival of human life. As stated by Hodanova and Nocar (Hodaňová & Nocar, 2016) that Mathematics is important for life

and supports all-round personal development. Mathematics significantly influences pupils' and students' education both in a special branch (mathematical knowledge) and in terms of moral education. Cockroft (Cockcroft, 1982) added, it would be very difficult perhaps impossible to live a normal life in very many parts of the world in the twentieth century without making use of mathematics of some kind. Therefore, mathematics is one of the subjects that must be given to students starting from elementary school.

Mathematics is one of the subjects that deals with numbers and various formulas in it. However, in reality learning mathematics is not only limited to students' knowledge of mathematical formulas. More than that, learning mathematics requires reasoning and thinking skills to solve problems. According to the *National Council of Teachers of Mathematics* (NCTM, 2000) processes standard used by learners in learning mathematics includes problem solving, reasoning and proof, connection, communication and representation.

Mathematical connection is one of the processes standard that must be applied by students in learning mathematics. According to the *National Council of Teachers of Mathematics* (NCTM, 2000) *"mathematical connection is the relationship between mathematical topics with other disciplines and the relationship between mathematics and the real world or everyday life"*. Mathematical connections are needed in learning mathematics because science in mathematics is a unified whole, where one concept relates to other concepts in mathematics and with other fields of science (NCTM, 2000).

Connection is one of the most important processes emphasized in the mathematics teaching and learning process curriculum (Chapman, 2012). Mathematical connections have an important role in learning mathematics for students, such as the opinion expressed by Siregar and Siagian (Siregar & Siagian, 2019) that with mathematical connection abilities, students will feel the benefits of learning mathematics and students understanding of the concepts they learn will last longer. In addition, good mathematical connection skills will support students success in learning (Siagian et al., 2021).

In learning mathematics, mathematical connections cannot be separated from problem solving activities (Pambudi et al., 2018). This shows that the mathematical connection has a close relationship with problem solving. Lappan, Fey, Fitzgerald, Friel and Phillips (Lappan et al., 2002) add that "*to solve mathematical problems, students must understand the problem and make connections between ideas in mathematics"*.

The mathematical connection ability of students depends on the level of mathematical ability they have (Mulbar et al., 2017). Facts in the field show that there are differences in the level of mathematical ability possessed by students. Based on the description above, it is important to carry out research to determine the profile of students mathematical connections in solving problem viewed from mathematical ability. The results of this study are expected to be input for mathematics learning activities that involve the mathematical connection process of students with different levels of mathematical ability.

Literature Review

Mathematical Connections in Solving Mathematical Problems

Mathematical connections have been defined by various different figures. Hiebert and Carpenter (Zengin, 2019) describe *"mathematical connection is a part of a network structured like a spider's web: where the junctures, or nodes, can be thought of as pieces of representation information, and threads between them as the connections or relationships"*. Mathematical connections are part of a network of interconnected knowledge with other knowledge composed of critical concepts to understand and develop relationships between mathematical ideas, concepts, and procedures. (Kenedi et al., 2019). Eli, Schroeder and Lee (Eli et al., 2013) describe mathematical connections as schema components or schema group relationships in mental networks. Marshall (Marshall, 1995) argues that what determines the schema is the presence of connections.

According to Larasati and Apriani (Larasati & Apriani, 2017) there are two types of mathematical connections, namely modeling connections and mathematical connections. Modeling connections are relationships between problem situations that arise in the real world or in other disciplines with mathematics. While the mathematical connection is the relationship between two equivalent representations and between the completion process of each representation. Mathematical connections have a close relationship with problem solving. As the opinion expressed by Hodgson (Dindyal, 2009) that the connection is a problem solving tool. Arjudin, Sa'dijah, Sutarto and Hastuti (Arjudin et al., 2020) also revealed the same thing that mathematical connections function as a tool in solving problems where when students solve problems, information about the problem must be related to the knowledge that has been mastered. Students with good mathematical connection ability will succeed in solving mathematical problems (Pambudi et al., 2020).

There are several indicators of mathematical connections that need to be taught by teachers to students, including: (1) recognize and use connections among mathematical ideas, (2) understand how mathematical ideas interconnect and build on one another to produce a coherent whole, (3) recognize and apply mathematics in contexts outside of mathematics (NCTM, 2000). Then, Anthony and Walshaw (Anthony & Walshaw, 2009) added that effective teachers support students in creating connections between different ways of solving problems, between mathematical representations and topics, and between mathematics and everyday experiences. The indicators used as a reference in this study are the mathematical connection indicators proposed by NCTM, namely: (a) recognize and use connections among mathematical ideas, (b) understand how mathematical ideas interconnect and build on one another to produce a coherent whole (c) connecting mathematical concepts with other disciplines and (d) connecting mathematical concepts with everyday life.

The Relationship of Students Mthematical Connections in Solving Mathematical Problems Based on Mathematical Ability Levels

Everyone has some mathematical abilities (Borovik & Gardiner, 2006). Mathematical ability is defined as the ability to deal with mathematical problems that have 5 content standards, namely: numbers and operations, algebra, geometry, measurement and data analysis and probability (NCTM, 2000). Mathematical abilities are grouped into three groups, namely high, medium and low mathematical abilities (Kattou et al., 2013). Based on the opinion of Krutetskii (Krutetskii et al., 1977), students with high mathematical abilities are able to memorize mathematical objects, schemas, principles and relationships. According to Baiduri, Putri and Alfani (Baiduri et al., 2020) the mathematical abilities possessed by students will affect the method of solving mathematical problems.

Based on previous research, it was also found that mathematical ability affects students' mathematical connections in solving mathematical problems. Research conducted by Diana, Suryadi and Dahlan (Diana et al., 2020) shows that students with high mathematical abilities have excellent connection skills, even students can provide alternative answers in different ways. This is inversely ratioal to students who have moderate and low mathematical abilities. Students with moderate mathematical abilities can understand the problem well but are less thorough in solving problems, so the knowledge obtained previously is not used. Meanwhile, students with low abilities are not able to understand the problem well, so they cannot solve the problem given.

Mathematical abilities also affect students' mathematical problem solving methods (Baiduri et al., 2020). Nursyahidah, Saputro and Rubowo (Nursyahidah et al., 2018) added that students with high mathematical abilities can solve problems very well. The problem solving process goes through several stages, including: (1) understanding the problem, (2) developing a plan, (3) carrying out the plan and (4) looking back (Polya, 1973).

Methods

Subjects

Researcher gave a test of mathematical ability to students of class VIII C Junior High School 5 Gresik which consisted of 32 students. This mathematical ability test consists of four questions. The four questions are questions in mathematics that have been previously studied by students. From the mathematical ability test, researcher can group students in each category of mathematical ability as stated in the Permendikbud (Andari & Setianingsih, 2021) as follows:

Table 1 Category of Mathematical Ability

Category	Score
High	$80 \leq \text{score} \leq 100$
Medium	$65 \leq \text{score} < 80$
Low	$0 \leq \text{score} < 65$

Ethics/permissions

This research has obtained permission from the school concerned. The names of participants in this study have also been changed to protect the identity of participants from the study, so that participants do not feel afraid at all times.

Setting

This research was conducted in one of the state junior high schools in East Java Province in Indonesia, precisely located in the southern part of the city of Gresik, namely Junior High School 5 Gresik.

Design

This research is a qualitative descriptive study. One of the characteristics of qualitative research is exploring a problem and developing a detailed understanding of a central phenomenon (Creswell, 2012), so this study was conducted to describe the profile of students mathematical connections in solving mathematical problems. Qualitative data has advantages compared to quantitative data, for example qualitative data is richer in terms of description and explanation (M. B. Miles et al., 2014).

Instruments and its validation

The main instrument in this research is the researcher herself. The supporting instruments used are mathematical connection test questions and interview guidelines. The mathematical connection test instrument used in this study was in the form of questions containing mathematical problems. Mathematical connection test questions consist of four questions in the form of essay, where each question represents one indicator of mathematical connection. Each question used will go through a content validation process first. The validation process is carried out with the aim of validating the material or content of the questions and the language used. Mathematical connection test instrument is used to collect data about students mathematical connection profile in solving mathematical problems.

In validation of material or content, several criteria must be met, including the following: (1) clarity of instructions for working on questions, (2) clarity of purpose and formulation of questions, (3) compatibility of questions with mathematical connection indicators and (4) questions can be used to describe mathematical connections. Meanwhile, the validation of the language aspect must meet the following criteria: (1) the language used in the questions is in accordance with good and correct language rules, (2) the sentences in the questions do not contain double meanings and (3) the questions use language that is simple and easy to understand.

1. Every Monday, Andina always brings food to school. Andina's lunch box is in the shape of a cuboid with a length 12 cm and a width of 7 cm. The volume of the lunch box is 336 cm^3. The height of the lunch box is...
2. Davina has a gift box in the shape of a cuboid with the ratio of length, width and height is 5 : 2 : 3. If the volume of gift box is 810 cm^3. Define:
   a. The length, width and height of the gift box
   b. The space diagonal of the gift box
3. Amel has a dice in the shape of cube with the density is $16\ {}^{g}/_{cm^3}$. After weighing, the mass of the dice is $128\ g$. The side length of the dice is...
4. Anton will fill water in a bathtub that is in the shape of a cube with a side length is 60 cm. How much water does Anton need to fill $\frac{2}{3}$ of the bathtub?

Figure 1. Mathematical Connection Test

Data collection and analysis procedures

Data collection was carried out by task-based interviews with three research subjects. The subject works on the mathematical connection test questions given on the answer sheet and presents the results of the answers. Data collection on each subject was carried out alternately according to the schedule previously agreed between the researcher and the research subject.

The data validation process is carried out by comparing the subject's mathematical connection data in solving mathematical problems in the first mathematical connection test and the second mathematical connection test. Then, the valid data that has been obtained will be analyzed with the stages of qualitative data analysis proposed by Miles and Huberman (Matthew B Miles & A. Huberman, 1994) as follows: (1) data reduction, (2) data presentation and (3) withdrawal conclusion or verification. Test the validity of the data in this study is a triangulation technique. The triangulation technique used in this study is time triangulation, where data collection is carried out at different times. The data in question is a mathematical connection test carried out at different times with an equivalent level of question.

Results

The purpose of this study was to describe the profile of students mathematical connections with high, medium and low mathematical abilities in solving mathematical problems. The following is a description of the mathematical connections of students with high, medium and low mathematical abilities in solving mathematical problems:

Subject 1: Subject with high mathematical ability (SHM)

Problem 1

In the first problem, the subject can understand the problem well and mentions all information from the problems given, starting from the length, width and volume of the lunch box. In devising a plan of completion, the subject relates the information that is known from the problem, namely the length, width and volume of the lunch box with the formula for the volume of the cuboid to find the height. The subject carry out the completion plan by applying the formula for the volume of the cuboid that has been previously planned and concluding the results of her work. The following are the results of student's work on the first problem:

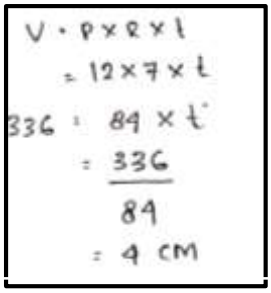

Figure 2. The results of the SHM work on the Question number 1

At the time of re-checking, the subject re-checked by calculating answers using the strategy that has been previously done. That is, the subject uses the relationship between length, width and height with the formula for the volume of the cuboid. The following is a snippet of interviews conducted by researcher (R) with the subject (SHM) to strengthen the answers on the mathematical connection test:

R : What information do you know from the question?
SHM : Length, width and volume
R : Okay, what was asked in this question?
SHM : The height of the lunch box
R : Approximately, what mathematical concepts did you use to solve problem number 1?
SHM : Search volume
R : What volume are you search?
SHM : Volume of cuboid
R : Why use volume of cuboid?
SHM : Because the shape of the lunch box is a cuboid
R : How can you relate it to the concept?
SHM : Because the lunch box is in the shape of a cuboid, then in the problem there is already a length, width and volume. So to find the height using the formula $V = p \times l \times t$

From the results of the mathematical connection test and interviews, it can be concluded that subject with high mathematical abilities can recognize and use the relationship of mathematical ideas in the same topic correctly and accurately.

Problem 2

In the second question, subject with high mathematical abilities can understand the problem and mention information that is known and asked from the problem. The subject devising and carrying out the plan with connecting several mathematical concepts, including the concept of volume of a cuboid, ratio and the pythagorean theorem. The first step taken by SHM is to find the actual length, width and height of the cuboid by connecting the formula for the volume of the cuboid and the concept of ratio as shown in the following figure:

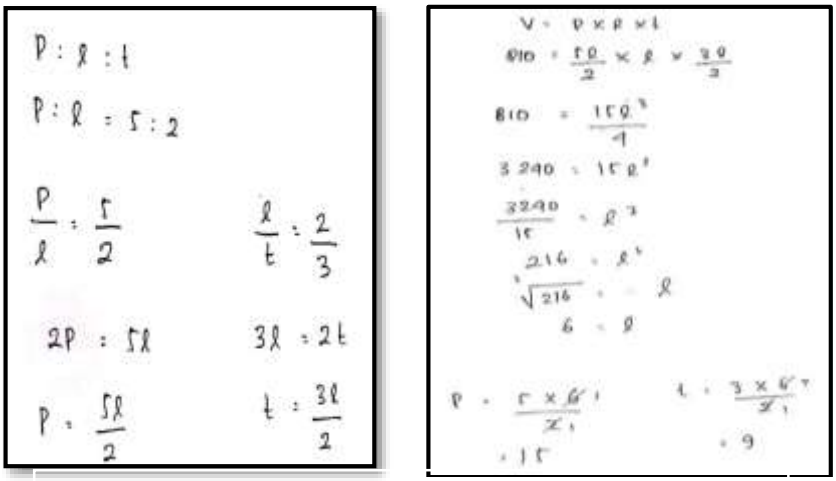

Figure 3. The results of the SHM work on the Question number 2

The following is a transcript of the interview to find out more about the subject's understanding of connecting the concept of volume of a cuboid with the concept of ratio:

R : What do you know from this question?
SHM : The ratio of length, width and height is 5 : 2 : 3 and the volume is 810 cm^3
R : What is being asked in this question?
SHM : The length, width and height of the cuboid and the length of the space diagonal
R : What mathematics materials are related to this question?
SHM : Cuboid and rasio
R : Is there any other materials?
SHM : Yes, anything else
R : What other mathematic material?
SHM : Pythagorean theorem to find the length of the space diagonal
R : Are these materials related?
SHM : Yes
R : How do you relate the materials?
SHM : There is a ratio of the length, width and height of the cuboid. From this ratio, the actual size of the cuboid can be found. After that, the space diagonal can be found.

The next step taken by SHM is to determine the length of the space diagonal using Pythagorean theorem. Before determining the length of the space diagonal, the subject first determines the length of the side diagonal as shown in the following picture:

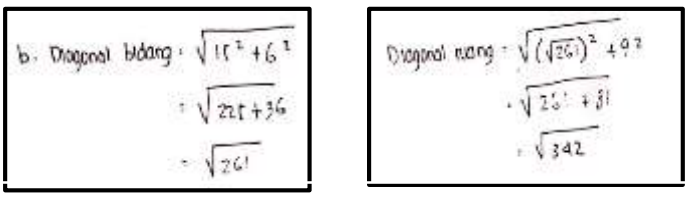

Figure 4. The results of the SHM work on the Question number 2

This can be strengthened by SHM's statement during the interview as follows:

R : what else was asked?
SHM : The length of space diagonal
R : From what you already know, are you able to determine the length of the space diagonal?
SHM : (Subject mumbles) not yet
R : So, what should you search for first?
SHM : Side diagonal
R : How to find the side diagonal?
SHM : Use Pythagorean theorem

When re-checking, the subject relates the length, width and height of the cuboid that have been obtained from the completion process with the volume formula of the cuboid. Thus, based on the results of tests and interviews, it can be concluded that subject with high mathematical abilities can understand how mathematical ideas interconnect and build on one another to produce a coherent whole.

Problem 3

In the third question, the subject can understand the problem well and mention all the information in the problem. The subject devise and carry out the solution plan by linking the concept of density learned in science with the concept of the volume of a cube to determine the length of the side. The first step taken by the subject is to find the value of the volume of the cube using the density formula, which is $\rho = \frac{m}{V}$, as shown below:

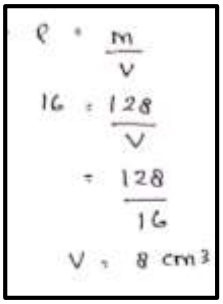

Figure 5. The results of the SHM work on the Question number 3

After obtaining the value of the cube volume, the next step taken by the subject is to find the length of the cube side by using the formula for the volume of the cube as shown in the following figure

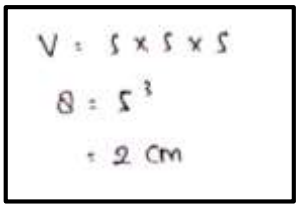

Figure 6. The results of the SHM work on the Question number 3

The test result in the picture above are reinforced by the following interview result:

R : What do you know from this question?
SHM : Rho and m
R : What was asked in this question?
SHM : The length of the side
R : Approximately, what material is related to question number 3?
SHM : (Subject is silent for a moment) cube and density (smiling)
R : How do you relate density to question number 3?
SHM : Find the volume using the formula $\rho = \frac{m}{V}$
R : Okay, why do you have to find the volume first?
SHM : So that we can determine the length of the side
R : Please explain your answer!
SHM : I've already found the volume. So to find the length of the side equal to $V = s \times s \times s$. V is 8, so $s = 2$

Subject re-checking by doing calculations using the strategy that was previously done. Thus, the subject re-checking using the existing relationship between the concept of density and the volume of a cube. The results of the test and interview showed that subject with high mathematical abilities could relate mathematical concepts to contexts outside of mathematics, which in this case were other disciplines.

Problem 4

In the fourth question, the subject understand the problem well and can state what is known and asked from the question. Subject can relate the concepts that exist in mathematics with problems of everyday life. The subject relates the problem solving to the formula for the volume of a cube to determine

the amount of water needed to fill $\frac{2}{3}$ of the bathtub. The first step taken by the subject was to find the overall volume value using the formula $V = s \times s \times s$, then multiplied by $\frac{2}{3}$. The following are the results of the subject's work in question number 4:

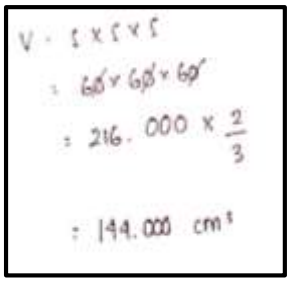

Figure 7. The results of the SHM work on the Question number 4

At the re-checking, the subject re-calculating using the same strategy as in the previous process, namely using the formula for the volume of a cube. That is, the subject uses the relationship of concepts in mathematics to solve problems related to everyday life.

From the results of test and interview that have been conducted, it can be concluded that subject with high mathematical abilities can recognize and apply mathematics in contexts outside of mathematics, which in this case is everyday life.

Subject 2: Subject with medium mathematical ability (SMM)
Problem 1

In the first question, the subject can understand the problem and can mention all the information that is known from the problem. Furthermore, in devising and carrying out the completion plan, the subject relates the length, width, height and volume to the volume formula of the cuboid as shown below:

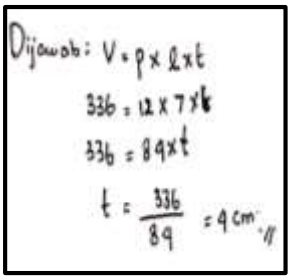

Figure 8. The results of the SMM work on the Question number 1

That is reinforced by the result of interview between researcher (R) and subject (SMM) as follow:

R : What do you know from this question?
SMM : There are length, width and volume
R : What is asked in this question?
SMM : The height of the lunch box
R : What mathematical concepts did you use to solve problem number 1?
SMM : Finding the volume of a cuboid
R : How can you relate it to the concept?
SMM : The length, width and volume are known. So, just enter it into the formula for the volume of a cuboid

Then, at the stage of re-checking, the subject re-calculates with strategy the same as in the previous work using the formula for the volume of the cuboid. Thus, the subject relates the relationship between mathematical ideas.

From the results of the test and interview above, it can be concluded that subject with medium mathematical abilities can recognize and use relationship between ideas in mathematics correctly and appropriately.

Problem 2

In the second question, the subject can understand the problem by mentioning all the information from the question. The subject also knows clearly what is being asked of the question. Furthermore, the subject devise and carry out a completion plan by linking between concepts in mathematics even though it is not complete. In this case, the subject relates the concept of the volume of the cuboid to the concept of ratio to find the actual size of the cuboid as shown in the following work:

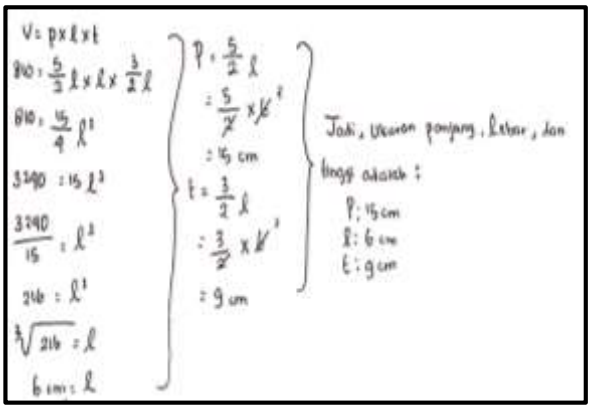

Figure 9. The results of the SMM work on the Question number 2

The following is a snippet of the interview conducted with the subject in question number 2 to find out understanding subject on the mathematical connections that have been made to solve the problem:

R : What do you know from the problem?
SMM : The ratio of length, witdh, height and volume
R : What is asked in this question?
SMM : Length, width, height and length of the diagonal
R : What mathematical concepts are related to question number 2?
SMM : Geometry
R : Is there anything else?
SMM : Yes, ratio
R : How do you relate these materials?
SMM : Use ratio to find length, width and height.

In answering this question, the subject cannot determine the length of the space diagonal. The subject cannot relate the problem solving to the pythagorean theorem. This is reinforced by the following interview result:

R : What about the next question?
SMM : The length of the space diagonal
R : From the existing information, can you determine the length of the space diagonal?
SMM : I don't know (smiling)
R : How do you determine the length of the space diagonal?
SMM : I don't know (smiling)

Then, at the re-checking stage, the subject re-calculating with the same strategy. Based on the results of the answers to the connection test and in-depth interviews with the subject, it can be concluded that subjects with medium mathematical abilities can understand the connection of mathematical ideas even though they are incomplete.

Problem 3

In the third question, the subject can mention all the information from the question. Subject can also mention what is asked of the question. Then, when devising and carrying out a solution plan, the subject could not relate the concept of the cube volume to the density so that the subject gave an incorrect answer. Thus, the subject cannot relate mathematical concepts to other disciplines, namely science. The following are the result of the subject (SMM) work on question number 3:

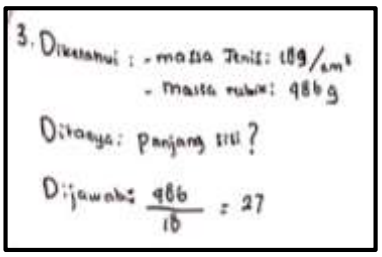

Figure 10. The results of the SMM work on the Question number 3

The following is a snippet of the result of interview between researcher and subject (SMM) to strengthen the result of the subject (SMM) answer on the mathematical connection test above:

R	:	Approximately, what material is related to question number 3?
SMM	:	Density miss
R	:	Is there a relationship between density and this question?
SMM		(Subject is silent)
R		Is there a relationship between density with this problem?
SMM	:	(Subject mumbles) yes miss
R	:	How do you relate density in this problem?
SMM		To find the length of the side is equal to the mass divided by the density
R		Are you sure the relation is like that?
SMM	:	(The subject was silent for a long time before answering) i'm not sure, because i forgot.

Next, at the re-checking stage, the subject checks by recalculating the completion process that has been done previously so that the subject believes in the correctness of the answer even though the answer given is not correct. Based on the results of test and interview, it can be concluded that subject with medium mathematical abilities cannot relate mathematical concepts to the concept of density. Thus, the subject cannot relate mathematical concepts to contexts outside of mathematics which in this case is another discipline.

Problem 4

In the fourth question, the subject can understand the problem and mention all the information contained in the problem. Furthermore, at the stage of devising and carrying out a completion plan, the subject relates the information known from the problem, namely the length of the side with the volume formula of the cube to solve problems related to everyday life. The first step taken by the subject is to find the overall volume of the bathtub first as shown in the figure below:

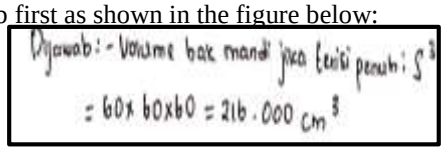

Figure 11. The results of the SMM work on the Question number 4

The next step taken by the subject is to multiply the result of the overall volume by $\frac{2}{3}$ as shown in the figure below:

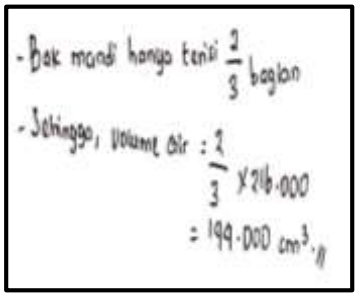

Figure 12. The results of the SMM work on the Question number 4

Then, at the re-checking stage, the subject re-calculate using the formula for the volume of a cube. Thus, the subject has connected the concepts in mathematics to solve problems in everyday life. Thus, it can be concluded that subject with medium mathematical abilities can recognize and apply mathematics in everyday life.

Subject 3: Subject with low mathematical ability (SLM)
Problem 1

In the first question, the subject understands the problem well and can mention all the information from the question including what is known and asked in the question. Furthermore, at the stage of devising and carrying out a completion plan, the subject can relate the information known from the problem, namely the length, width and volume with the height of the cuboid by using the formula for the volume of the cuboid as shown in the following figure:

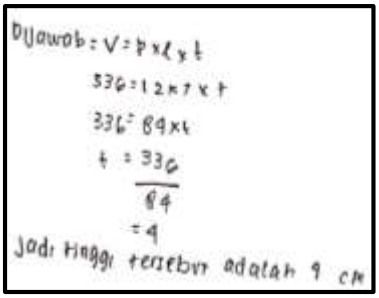

Figure 13. The results of the SLM work on the Question number 1

The following is an interview between the researcher (R) and the subject (SLM) to strengthen the results of the subject's answer above:

R : What do you know from the question?
SLM : The length, width and volume
R : What is asked in this question?
SLM : t
R : What mathematical concepts did you use to solve problem number 1?
SLM : Finding the volume of a cuboid (smiling)
R : How can you relate it to the concept?
SLM : Using the formula $V = p \times l \times t$ to get the height

Next, at the re-checking stage, the subject only looked at the answer sheet whose solution process used the volume formula of the cuboid. From the results of test and interview, it can be concluded that subject with low mathematical abilities can recognize and use the relationship between mathematical ideas in the same topic.

Problem 2

In the second question, the subject can understand the problem and mentioning all the information that is known and asked from the question. Then, at the stage of devising and carrying out a completion plan, the subject was unable to recognize some mathematical concepts related to the problem. Some of these concepts include the concept of volume of a cuboid, ratio and the pythagorean theorem . This can be seen from the results of her work that is not right. Here are the results of the subject's work on question number 2:

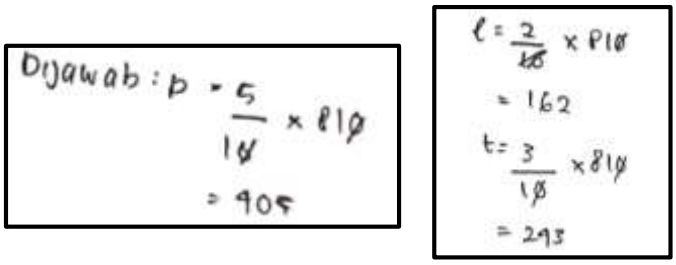

Figure 14. The results of the SLM work on the Question number 2

This can also be strengthened by the results of subject interview as follows:

R : What do you know from that question?
SLM : The ratio of length, width and height is $5 : 2 : 3$ and the volume of the gift box is 810 cm^3
R : What is asked in the that question?
SLM : Length, width, height and diagonal of space
R : What mathematical concepts are related to this problem?

SLM : Material about volume of cuboid
R : Is there anything else?
SLM : (Subject mumbles) No.

Furthermore, when re-checking, the subject only sees on the answer sheet. The subject believes the answer is correct, even though the answer given is incorrect. From the results of test and interview, it can be concluded that subject with low mathematical abilities cannot understand the relationship between ideas in mathematics.

Problem 3

In the third question, the subject can mention all the information from the problem. Furthermore, at the stage of devising and carrying out a completion plan, the subject was unable to relate the concept of the volume of a cube to the density to determine the length of the side, so the answer given by the subject was not correct. Thus, the subject cannot relate mathematical concepts to other disciplines, namely science. Here are the results of work on the subject of the third question:

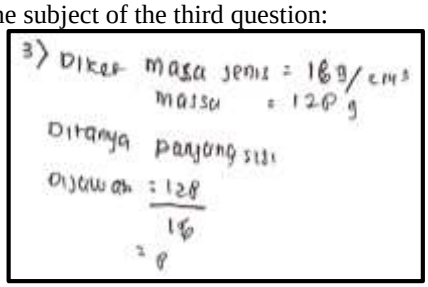

Figure 15. The results of the SLM work on the Question number 3

This can also be strengthened by the result of interview as follows:

R : Approximately, what material is related to question number 3?
SLM : Cube
R : Is there anything else?
SLM : Yes, density
R : Have you ever studied material about this density?
SLM : Yes miss
R : Now, how do you relate the density to this problem?
SLM : (Subject is silent)
R : How do you relate density to this problem?
SLM : (Subject mumbles) directly divided miss
R : How is it divided?
SLM : The length of the side equal to mass divided by density

Furthermore, at the re-checking stage, the subject only saw the answer sheet and believed the answer was correct, even though the answer given was incorrect. Thus, it can be concluded that subject with low mathematical ability cannot relate mathematical concepts to other disciplines.

Problem 4

In the fourth question, the subject can understand the problem and mention all the information from the problem. The subject solves the problem by relating it to the concept of the cube volume. The first step taken by the subject is to find the overall volume by using the formula for volume of the cube which will then be multiplied by 23. Here are the results of the subject's work on the fourth problem:

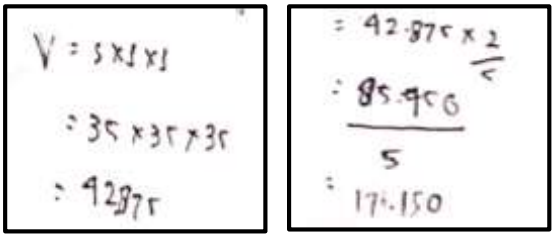

Figure 16. The results of the SLM work on the Question number 4

From the results of the mathematical connection test and in-depth interview with the subject, it can be concluded that subject with low mathematical ability can recognize and apply mathematical concepts to everyday life.

Discussions

Subject 1: Subject with high mathematical ability

In the indicator of recognizing and using the relationship between ideas in mathematics, subjects with high mathematical ability can relate and explain the relationship of information known from the problem to mathematical concepts. This finding is in accordance with the research results of Qondiyana, Riyadi and Siswanto (Qondiyana et al., 2021) that subject with high mathematical abilities can recognize and relate mathematical ideas, even though there are wrong in the calculations. Subject can devise and carry out a detailed and correct completion plan. This is in accordance with the research results of Nursyahidah, Saputro and Rubowo (Nursyahidah et al., 2018) that students with high mathematical abilities can solve problems very well, it can be seen from the answers of students who can apply concepts correctly so as to produce the right answer.

In the indicator of understand how mathematical ideas interconnect and build on one another to produce a coherent whole, subject with high mathematical abilities can relate several mathematical concepts used to solve problems. This finding is in accordance with the research results of Qondiyana, Riyadi and Siswanto (Qondiyana et al., 2021) which show that subject with high mathematical abilities can understand the interconnect of concepts between mathematics to solve problems. Subject can relate information from problems with mathematical concepts to solve problems. This finding is in accordance with the results of research by Mulbar, Purnamawati and Nasrullah (Mulbar et al., 2017) that subject with high mathematical abilities can relate existing information to mathematical concepts. subject with high mathematical abilities can remember the material that has been previously studied well. This is in accordance with the results of Diana, Suryadi and Dahlan's research (Diana et al., 2020) that students with high mathematical abilities can remember the material that has been given previously, so that students can connect ideas in mathematics and give correct answers.

Subject with high mathematical abilities can connect concepts in mathematics with other disciplines. This is in accordance with the results of research conducted by Jannah, Paridjo and Utami (Jannah et al., 2019), where subject with high abilities can relate concepts in mathematics to concepts outside mathematics namely other disciplines.

Subject can use mathematical concepts to solve problems in everyday life. This finding is in accordance with the research results of Qondiyana, Riyadi and Siswanto (Qondiyana et al., 2021) that subject with high mathematical abilities are capable of identifying and applying mathematical concepts to everyday life. subject with high mathematical abilities can understand well that the context of the problem is related to problems in everyday life. This is in accordance with the results of research conducted by Diana, Suryadi and Dahlan (Diana et al., 2020) that subject with high mathematical abilities know that the problems given are the application of mathematical material in everyday life, so that subject can connect mathematics with everyday life.

Subject 2: Subject with medium mathematical ability

In the indicator of recognizing and using the relationship between ideas in mathematics, subject with medium mathematical ability can understand the context of the problem well. In addition, the subject can also relate the information from the problem to the mathematical concepts used to solve the problem.

Subject with medium mathematical ability can understand and use the interconnected of ideas in mathematics. The subject relates several concepts in mathematics, but the mathematical concepts used to solve the problem are incomplete. This finding is not in accordance with the results of research conducted by Diana, Suryadi and Dahlan (Diana et al., 2020) that subject with medium mathematical ability can relate ideas in mathematics and provide detailed answers well and correctly, although several times they think of ways to solve problems with a few scribbles on paper. In this study, subject with medium mathematical ability was able to understand the problem and mention some mathematical concepts used to solve the problem correctly even though it was incomplete. This finding is not in accordance with the results of research by Mulbar, Purnamawati and Nasrullah (Mulbar et al., 2017) which shows that subject with medium mathematical abilities have not understood the given problem and have not been able to connect mathematical concepts, the subject has also not been able to mention how to connect concepts related to the material.

In the indicator of connecting concepts in mathematics with other disciplines, subject cannot connect concepts in mathematics with concepts in other disciplines to solve problems. This finding is not in accordance with the results of research conducted by Jannah, Paridjo and Utami (Jannah et al., 2019) that subject with medium mathematical abilities can connect concepts in mathematics with topics outside mathematics namely other disciplines.

Subject with medium mathematical ability understand well the context of problems related to real life. Subject can also recognize and relate mathematical concepts to solve problems in everyday life. This finding is in accordance with the results of Diana, Suryadi and Dahlan's research (Diana et al., 2020) that subject with medium mathematical abilities can relate mathematical ideas to everyday life as evidenced by the subject's answers in solving contextual problems. However, the results of this research are also different from previous research. The results of these different research are related to the subject's understanding of the context of the problem. Subject can understand questions well, subject can also relate concepts in mathematics to solve problems in everyday life. The results of this study are not in accordance with the research conducted by Saminanto and Kartono (Saminanto & Kartono, 2015) that out of 32 students, there were only 2 students who did the questions incorrectly, while other students only gave blank answers, so that students could not relate mathematical concepts to problems in everyday life. Likewise, the results of research by Altay, Yalvac and Yeltekin (Altay et al., 2017) show that students in connecting mathematics with real life are not at a sufficient level.

Subject 3: Subject with low mathematical ability

In the indicator of recognize and use connections among mathematical ideas, subject with low mathematical abilities understand the context of the problem well and can relate all information in the problem with mathematical concepts to solve problems.

In the indicator of understand how mathematical ideas interconnect and build on one another to produce a coherent whole, subject with low mathematical abilities cannot relate several mathematical concepts to solve problems. This finding is in accordance with the results of Diana, Suryadi and Dahlan's research (Diana et al., 2020) that subject with low mathematical abilities cannot connect between concepts in mathematics, subject also unable to recognize formulas correctly so that the results obtained are not precise. Likewise, the results of research conducted by Mulbar, Purnamawati and Nasrullah (Mulbar et al., 2017) showed the same results, where subjects with low mathematical abilities could not mention and explain the relationship between mathematical concepts to solve problems.

Subject with low mathematical abilities cannot connecting concepts in mathematics with concepts in other disciplines, so the answers given by the subject are not correct. This finding is in accordance with the results of research by Ayunani, Mardiyana and Indriati (Ayunani et al., 2020) which shows that students are not able to connect mathematical concepts with other disciplines, it can be seen from students' mistakes in determining the concepts used to solve problems.

Subject with low mathematical ability understand that the context of the problem is related to everyday life. Subject can recognize and use mathematical concepts to solve problems in everyday life. This finding is not in accordance with the research results of Jannah, Paridjo and Utami (Jannah et al., 2019) that subject with low mathematical abilities cannot relate mathematical concepts to everyday life. Likewise with the research results of Diana, Suryadi and Dahlan (Diana et al., 2020) that subject with low mathematical abilities cannot relate mathematical concepts to solving problems of daily life.

Table 2. Profile of Students Mathematical Connections viewed from Mathematical Ability

Indikator of Mathematical Connections	**Student with High Mathematical Ability**	**Student with Medium Mathematical Ability**	**Student with Low Mathematical Ability**
Recognize and use connections among mathematical ideas	Student can connect all the information contained in the problem to concepts mathematics in the same topic	Student can connect all the information contained in the problem to concepts mathematics in the same topic	Student can connect all the information contained in the problem to concepts mathematics in the same topic

Understand how mathematical ideas interconnect and build on one another to produce a coherent whole	Student can connect various concepts in mathematics to solve problems	Student can connect concepts in mathematics even though are not complete to solve problems	Student cannot connect between concepts in mathematics to solve the problem
Connecting mathematical concepts with other disciplines	Student can connect concepts in mathematics with other disciplines	Student cannot connect mathematical concepts with other disciplines, so the answers given are not appropriate	Student cannot connect mathematical concepts with other disciplines, so the answers given are not appropriate
Connecting mathematical concepts with everyday life	Students can connect mathematical concepts to solve daily life problems	Students can connect mathematical concepts to solve daily life problems	Students can connect mathematical concepts to solve daily life problems

Conclusion

The results of this research indicate that there are differences in mathematical connections between students with high, medium and low mathematical abilities. The differences include the second indicator of mathematical connection, students with high mathematical abilities can relate several concepts in mathematics completely and coherently, students with medium mathematical abilities can connect between mathematical concepts even though are incomplete, while students with low mathematical abilities cannot connect between concepts in mathematics. The next difference in the third mathematical connection indicator, student with high mathematical abilities can connect mathematical concepts to other disciplines. Meanwhile, students with medium and low mathematical abilities can recognize the relevance of the context of the problem to the concepts of other disciplines, but they cannot connect mathematical concepts to other disciplines in solving problems.

From these results, it is recommended for mathematics teachers to create learning that is able to facilitate students to develop and improve mathematical connection ability so that they are successful in solving mathematical problems.

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