

Mathematical Engagement When Solving Mathematical Problem With Brawijaya Temple Context Based on Mathematical Ability Level

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ABSTRACT

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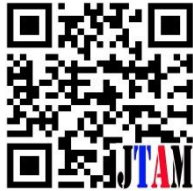
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This research to describe the mathematical engagement of seventh grade junior high school students in problems solving with the theme of Brawijaya Temple with high, medium, and low levels of mathematical ability. This type of research is qualitative research using an exploratory approach. The students used were 6 grade VII students of Junior High School 1 Karangrejo who were students working on problem solving and interviewing. The results showed: (1) mathematical engagement of highly skilled students in problems solving with the theme of Brawijaya Temple, namely students having the engagement of “get the job”, (2) mathematical engagement of students with moderate abilities in problems solving with the theme of Brawijaya Temple, namely students having engagement is “I am really into this”, (3) Mathematical engagement of students with low abilities in problems solving with the theme of Brawijaya Temple is that students have “pseudo-engagement”.



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A. INTRODUCTION

The industrial revolution 4.0 is an era in which technology has become the basis of human life in the social, economic, political, artistic and cultural fields and even education. Education is the main pillar in advancing a nation and country by increasing quality human resources. To prepare quality education, it is carried out by increasing learning abilities, maximizing the use of the environment, good facilities and infrastructure, measuring and planning evaluation and monitoring, as well as good relations between schools and the community (Tabroni, 2013). With the engagement of students in learning, it will make learning more conducive. According to Fredricks, Blumenfeld & Paris (2004) student engagement in school is a multidimensional concept which consists of three components, namely behavioral, emotional and cognitive. According to Dharmayana (2012), that student engagement consists of the psychological aspects of the school, which shows the attention, interest, investment, effort and engagement of students devoted to learning work in schools.

Student engagement is an important component and must be given special attention because student engagement is seen as an antidote to low achievement, high levels of

hopelessness, high levels of boredom and immodesty (Fredricks, 2003). In other words, student engagement is very important to increase achievement. Various attempts have been made to increase student engagement, both by the government and schools. This is supported by the existence Republic of Indonesia Government Regulation Number 32 of 2013 concerning National Education Standards article 19 which states that the learning process in educational units is held in an interactive, inspirational, fun, challenging, motivating students to participate actively, and provides sufficient space for initiative, creativity, and independence according to their talents, interests, and physical and psychological development of students. In addition, the efforts made by the teacher are developing the art of teaching by applying various new teaching techniques, models and methods, which are useful for activating students in the learning process later.

The engagement of students between students is different, and one of the things that affects engagement is the behavior and personality of students. Olson and Peterson (2015) said that student engagement refers to the desire, interest, optimism, level of attention and enthusiasm that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education. In addition, student engagement is determined by various factors including how teachers motivate and provide support to students (Saeed and Zyngier, 2012) activities carried out by the teacher, the way the teacher presents mathematics material, and is even determined by the design of the math assignments prepared for students (Silver and Perini, 2010). Designing activities that are relevant, authentic and collaborative will increase student engagement in class (Kantan, 2011).

One of the goals of education is to prepare students for the future and have the ability to solve complex and varied problems (Hayuhantika, 2019). One of the ways to increase engagement is through learning mathematics. Mathematics learning is learning that is colored by the creation of various student activities. Through mathematics learning, students are expected to develop skills so that they can be more active, think critically, logically, systematically, carefully, and efficiently in problems solving. Problem solving is an intellectual activity to find solutions to problems faced by using the knowledge that is already owned (Asmara, Haji & Hanifah, 2018). Of the many ways to analyze student engagement, there is no one specific way of showing how students look mathematically. Based on this, to determine student engagement using aspects of mathematical engagement by Goldin, Epstein, Schorr, & Warner (2011) these include: (1) Motivational goals / impulses, (2) Behavior, (3) Initial / final emotions, (4) External expressions, (5) Meaning of emotions, (6) Metta-affect, (7) Thoughts, (8) Interaction of beliefs and values, (9) the interaction between personality traits, self-identity towards mathematics, with a motivation orientation, (10) Interaction to all aspects with problem solving. The structure of student mathematical engagement adapts the structure of engagement Goldin (2017) to analyze students mathematical engagement, among others: (1) get the job done, (2) look how smart i am, (3) check this out, (4) i am really into this, (5) don't disrespect me, (6) stay out of trouble, (7) it's not fair, (8) let me teach you, (9) pseudo-engagement. Based on the description above, the purpose of writing this article is to describe the mathematical engagement of students with high, medium and low ability levels in problems solving with the theme of Brawijaya Temple. Information about students mathematical engagement is needed by practitioners of mathematics education to be used as a reference for improvement in teaching students when learning mathematics in class, so that students become more actively involved.

B. METHODS

This type of research is a qualitative study using an exploratory approach. According to Sugiyono (2016) qualitative research is research based on the philosophy of postpositivism which is used to examine the conditions of natural objects, where the researcher is a key instrument, data collection techniques are carried out in triangulation (combined), data analysis is qualitative, and qualitative research results emphasize more. Meaning rather than generalization (Sugiyono, 2016). This research was conducted in June 2020 at Junior High School 1 Karangrejo, Tulungagung. The students involved in this study were 6 students of class VII-A. The 6 students were taken by using purposive sampling technique, which is based on the students mathematical abilities (high, medium, low) on the results of the students UTS scores. The instrument uses worksheets and interview guidelines. Each level consists of 2 students for worksheets and interviews conducted individually as a data collection technique.

Data were collected through student worksheets that have been done. The worksheets are in the form of essay questions as many as 2 points which aim to measure the extent to which students ability to solve math problems if given questions related to the circumference and area in the context of Brawijaya Temple seen from the students answers. Researchers also conducted interviews with each student, aiming to dig deeper into the structure of student engagement in problems solving. The researcher also recorded the entire interview process using a voice recorder and made a transcript of the interview results. The data analysis carried out were: data reduction, display data, and verification.



Brawijaya Temple which is located in Trenggalek district is a replica temple with Hindu-Buddhist style which was built in 1969. The building of this temple is made of andesite relief with a square base measuring 6x6 meters with the temple building towering as high as 10 meters. At the edge of the temple a rectangular paving will be installed and a guardrail around it will be provided.

Question:

1. Around the temple, paving will be installed as wide as 2 m from the temple. If the paving to be installed is in the form of a rectangle with a size of 10 x 20 cm. So how much paving is needed to cover the entire edge of the temple?

2. Around the temple there will be a guardrail in the form of a pole made of iron as high as 1 m and between one pole and the other is connected by a chain. The distance between the piles is 2 m and the chain length needed to connect the piles is 2.5 m. At the front there will be a door with a width of 2 m right in the middle of the fence. If in every corner there must be a pole and the door should not have a chain.

Specify:

- a. The number of poles required.
- b. Chain length required.

Figure 1. Problem 1 and Problem 2

The word engagement is commonly used to show meanings such as commitment, agency, and reciprocity, which makes the concept synonymous with self-participation in several activities (De Vito, 2016). According to Gunuc (2014), student engagement as the time allocated by students for educational activities, contributing to the desired results and as the quality of their efforts. Furthermore, the mathematical understanding according to Indonesia Dictionary, means concerned with mathematics, is mathematical, and very definite and precise. According to Watson and Gest (2012), engagement in mathematics includes covering awareness of all objects, intelligent details, viewing equations and relationships, focusing on properties, and viewing properties such as definitions or axioms. There is no specific definition for mathematical engagement, but some references use the term mathematical engagement, which means engagement in mathematics, among others Ingram (2011), Patahuddin (2018). Mathematical engagement is considered as student engagement in mathematics activities in the classroom and their commitment to learning mathematics content (Ingram, 2011).

To measure students mathematical engagement in learning, it can refer to several aspects of students mathematical engagement according to Goldin (2011) namely as follows: (1) Purpose/motivation drive; (2) Behavior; (3) Emotions beginning to end; (4) External expression; (5) The meaning of emotions; (6) Metta-affect; (7) Thoughts; (8) Interaction of beliefs and values; (9) The interaction between personality traits, self-identity towards mathematics, with motivation orientation; (10) Interaction to all aspects with problem solving and heuristics. The structure of engagement is used to describe patterns in student engagement during group mathematics activities (Goldin et al., 2011), are in the following table.

Table 1. Mathematical Engagement Structure

No.	Mathematical Engagement Structure	Description
1	Get the job done	Students wish to complete the given math assignment correctly in accordance with the instructions given.
2	Look how smart i am	Students desire to impress others with their mathematical abilities, knowledge and genius.
3	Check this out	Students wish to get prizes in obtaining the final result, so as to increase interest in the given assignment.
4	I am really into this	Students want to be involved in work on assignments, because they are interested in mathematics or problem solving.
5	Don't disrespect me	Students desire to meet the perceived challenges of existing mathematical ideas.
6	Stay out of trouble	Students wish to avoid interactions that can cause conflict or make friends difficult, so they prefer to solve it themselves.
7	It's not fair	Students wish to correct perceived injustices in group problems, for example the level of participation by others.
8	Let me teach you	Students desire to help others to problems solving.
9	Pseudo-engagement	Students desire to appear to be good to teachers or peers by being involved while avoiding genuine participation.

Source: Goldin (2011)

To find out student engagement, it is important to problems solving in mathematics learning, because the problem solving process will make student understanding better (Sapitri, Utami & Mariyam, 2019). Troubleshooting introduced by Bransford and Stein (1993) is IDEAL problem solving, which is a problem solving model that is able to improve thinking skills and improve skills in the problem solving process.

Table 2. Indicators and Guidelines for the Assessment of Mathematical Problem Solving Ability by Steps Bransford and Stein (1993)

Stages of Problem Solving	Category		Description
Identify the problem	Well	B1	Identify and identify problems completely
	Enough	C1	Recognizing the problem and not being able to present the problem completely
	Less	K1	Not able to identify problems
Define goals	Well	B2	Able to determine the right problem-solving approach
	Enough	C2	There is a misperception in determining the problem-solving approach
	Less	K2	Not able to determine problem solving approach
Exploring possible strategies	Well	B3	Be able to describe problems based on appropriate and systematic problem solving approaches
	Enough	C3	1. Describe the problem based on an inappropriate problem-solving approach 2. Not careful in describing the problem 3. Incomplete in describing the problem
	Less	K3	Not able to decipher the problem
Anticipate	Well	B4	Determine the correct answer from the description of problem solving
	Enough	C4	Does not display the correct answer from the problem solving description
	Less	K4	Has no answer
L-look back and learn	Well	B5	Successfully found the right problem-solving results
	Enough	C5	Unsuccessful in determining the correct result of problem solving
	Less	K5	Do not have the effort to find solutions to problems and choose to give up

Source: Maini & Izzati (2019)

The presentation of the categories of problem solving steps is used as a reference to describe the students mathematical problem solving abilities in completing worksheets. The ability and inability of students to solve these problems are categorized into three abilities including good, adequate, and lacking. Descriptions of the table are expected to describe the ability to solve mathematical problems that are sequential and structured according to the steps of Bransford & Stein in the worksheet. The description of the results of students mathematical problem solving abilities in this study is used as an evaluation to see the extent of the improvement in students mathematical problem solving abilities.

C. RESULT AND DISCUSSION

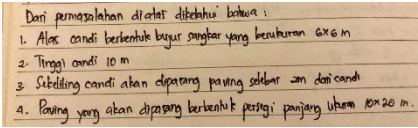
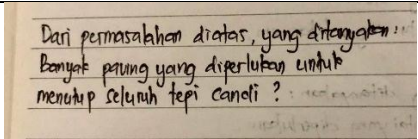
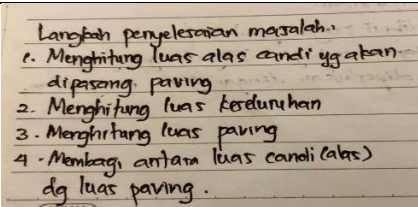
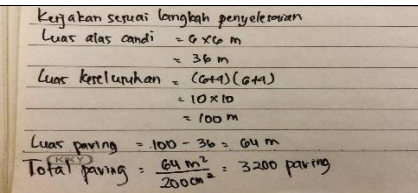
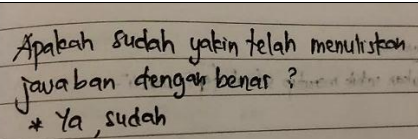
In the results and discussion will explain about the mathematical engagement of students in solving student problems with high, medium and low abilities. The results of the research and discussion are described in several subsections as follows:

1. Description of Student Engagement with High Ability in Solving Mathematical Problems

Problem solving is very important in learning mathematics, because the problem solving process will make student understanding better (Sapitri, 2019). To find out the description of

the results of the spelling of the worksheet of students with high abilities in problems solving in the context of Brawijaya Temple can be seen in the following Table 3.

Table 3. Results of Problem Solving High Able Students

Troubleshooting Steps	Student Work Results	Description
Identify the problem		Students are able to write down what is known on the questions. Each student tries to provide the information provided in his own language.
Define goals		Students are able to complete by determining what is being asked in the question.
Explore possible strategies		Students are able to write down the problem solving strategies /steps used. Next, describe them using their own sentences.
Anticipate		Students are able to find the method used to solve the problem so that they can solve it with the final result correctly.
Look back and learn		Students review the answers so that they can make conclusions on the last question.

Furthermore, during the interview session, students were able to explain what the steps of working on the questions were from the first step to completion and found the correct results.

P : "Can you tell us how you did the worksheets?"

ST : "Yes, sis"

P : "Please explain for problem 1 first, okay?"

ST : "For problem 1, the first one was asked to write down known information, then I wrote the base of the temple in a square shape measuring 6x6m; temple height 10m; around the temple will be installed paving 2m wide from the temple; and the paving that will be installed is in the shape of a 10x20cm rectangle. Then what was asked was how much paving was needed to cover the entire edge of the temple. Then the finishing steps I used included calculating the area of the base of the temple to be installed with paving; then knowing the area of the whole; then calculate the paving area; and the latter divides the area of the temple base with the paving area. Then I did it according to my steps and found the answer. And I believe I wrote the answer correctly.

P : "Okay, then move on to the second problem"

ST : "From problem number 2 it is known that a 1m high iron pole will be used as a guardrail; distance between poles 2m; chain length for connecting 2.5m; and in the middle of the fence is a door 2m wide. then the question is how many poles are needed and the length of the chain required? Furthermore, the finishing steps that I use start from calculating the circumference of the temple which will be given a guardrail; counting the number of poles by dividing the circumference by the distance; to calculate the length of the chain by multiplying it. Then do it according to the steps I chose earlier and find the answer. And I am sure of the answer.

P : "Why did you use that step?"

ST : "Because I think using that step can make it easier for me to do it"

To find out the validity of data about the engagement of highly skilled students in problems solving can be compared in the following Table 4:

Table 4. Engagement of High Ability Students in Problem Solving

Problem solving stage	Worksheet	Interview	Conclusion of engagement
Identify the problem	Students write down what is known on the questions.	Students say with certainty what is known in the problem correctly	Get the job done
Define goals	Students determine what is asked in the questions correctly	Students say what was asked in the questions correctly	
Explore possible strategies	Students write down the problem solving strategies / steps used	Students are able to explain with certainty what steps are used in completing the worksheet	
Anticipate	Students complete the questions that have been given with the correct results	Students are able to explain how they do it until they find the right results	
Look back and learn	Students review their answers so they can make conclusions	The student explains that he is able to make conclusions on the last question.	

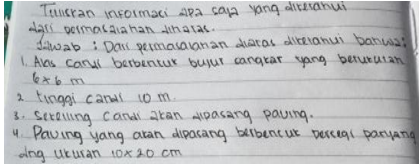
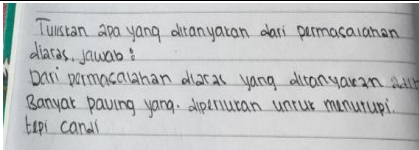
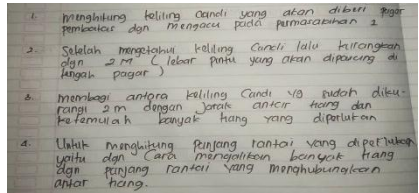
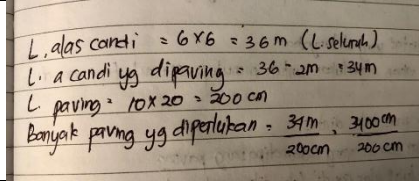
Mathematical engagement of high-skilled students at the stage of identifying the problem, students are able to get through it, namely by reading and understanding the problems given. Next write down what is known in the problem. Students try to provide information appropriately and are able to complete it in their own language. At the stage of determining the goals students are able to determine what is being asked in the questions. Judging from the answer, students can gather information appropriately and be able to convey it in their own language. In this case, students feel motivated and become active participants (Febrilia & Nissa, 2019). At the stage of exploring possible strategies, students plan well and clearly. At the stage of overcoming the results and acting students are able to get the correct answer. Students are also very enthusiastic about explaining their feelings when working on worksheets. This is in accordance with the opinion Watson (2007), student engagement can be seen from the ability of students to identify the properties of mathematical objects.

Based on the stages of solving students' mathematical problems in solving mathematical problems according to Bransford & Stein, high-skilled subjects can fulfill all stages of problem solving including, identifying, setting goals, exploring possible strategies, overcoming results and acting, and seeing and learning. Based on the description above, the engagement that occurs in high-ability students is get the done.

2. Description of Student Engagement with Medium Ability in Solving Mathematical Problem

Problem solving is very important in learning mathematics, because the problem solving process will make student understanding better (Sapitri, 2019). To find out a description of the results of the spelling of the Worksheet of Students with moderate abilities in problems solving in the context of Brawijaya Temple can be seen in the following Table 5.

Table 5. Problem Solving Results of Medium Ability Students

Troubleshooting Steps	Student Work Results	Description
Identify the problem		Students try to understand the problem and gather relevant information as an initial step to problem solving. Then write down what is known in the problem.
Define goals		Students are able to determine what is being asked in the questions by using their own sentences.
Exploring possible strategies		Students are able to write down the problem solving strategies/steps used. Next, describe them using their own sentences.
Anticipate		Students are able to problems solving using the steps to solve them coherently, but the results are not correct.
Look back and learn	-	Students are not able to complete this stage, so they cannot display the results of the answers to the existing questions.

At the time of the interview session, students were able to explain what the steps of working with the questions were from the first step to the finish, but the results obtained were not correct.

P : "Can you tell us how you did the worksheets?"

SS : "Yes"

P : "Please explain for problem 1 first, okay?"

SS : "For problem 1, it is known that the base of the temple is a square shape with a size of 6x6m; temple height 10m; paving will be installed around the temple; rectangular paving with paving size 10x20cm. Then asked how much paving is needed to cover the edge of the temple. Continue to be calculated using the steps "

P : "Okay, then move on to the second problem"

SS : "From problem number 2, it is known that the iron pole is 1m high; distance between poles 2m; chain link length 2m. It asks how many poles are required and the length of the chain required. Then calculated using steps and find the answer "

P : "Why did you use that step?"

SS : "Because it's easier for me to understand"

To find out the validity of data about the engagement of students with moderate abilities in problems solving, it can be compared in the following Table 6:

Table 6. Engagement of Students with Medium Ability in Problem Solving

Problem solving stage	Worksheet	Interview	Conclusion of engagement
Identify the problem	Students write down what is known in the problem correctly	Students say what is known in the problem correctly	
Define goals	Shiva determines what is being asked on the question correctly	Students say what was asked in the questions correctly	
Explore possible strategies	Students write down what steps are used in the questions with confidence	Students are able to explain what steps are used in completing the worksheets	I am really into this
Anticipate	Students are able to complete the questions that have been given but the final result is wrong	Students are able to explain the process until they find the final result even though the answer is wrong	
Look back and learn	Students are not able to complete this stage, so they do not provide final conclusions.	Students are unable to explain the final conclusion	

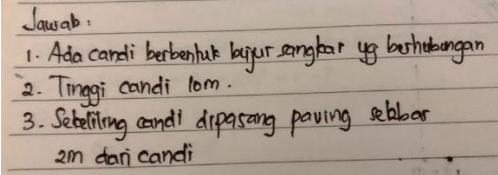
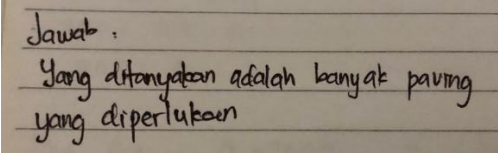
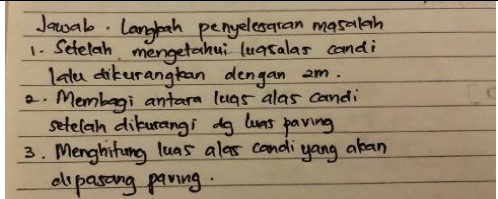
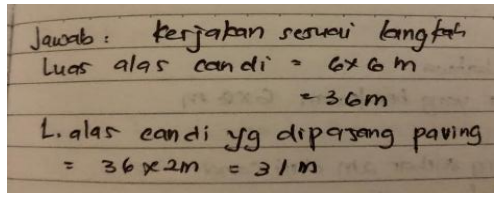
The mathematical engagement of the subject students is at the stage of identifying the problem, the subject is able to get through it, namely by reading and writing the known elements. In accordance with the opinion Abidin (2015), that reading is defined as a complex information processing process. And understand the context of the problem that must be resolved with the information needed to solve the problem. At the stage of determining the objectives, the subject is able to determine what is being asked in the question. Judging from the answer, students can gather information appropriately by using systematic reasoning so that they are able to convey it in their own language. In accordance with the opinion Salmina & Khairun Nisa (2018), namely the ability to connect problems into an idea or idea so that it can solve mathematical problems. At the stage of exploring possible strategies, the subject is able to write down steps that will be used in problem solving. At the stage of overcoming the results and acting the subject is able to solve the questions that have been given but the final result is still not correct. The subject was also a little confused in explaining his feelings while working on the worksheets.

Based on the stages of solving students mathematical problems in solving mathematical problems according to Bransford & Stein, medium-capable subjects can fulfill four stages of problem solving, including identifying, setting goals, exploring possible strategies, overcoming results and acting. And not being able to get past the problem solving stage of coping with the results and acting, because the subject did not provide an answer to the last question. Based on the description above, the engagement that occurs in students with moderate abilities is I am really into this.

3. Description of Student Engagement with Low Ability in Solving Mathematical Problem

Problem solving is very important in learning mathematics, because the problem solving process will make student understanding better (Sapitri, 2019). To find out a description of the results of the spelling of the worksheet of students with low abilities in problems solving in the context of Brawijaya Temple can be seen in the following Table 7.

Table 7. Problem Solving Results for Low Ability Students

Troubleshooting Steps	Student Work Results	Description
Identify problem		Students choose the information that is known in the questions, and dig up the information appropriately as an initial attempt to solve the problem.
Define goals		Students are able to determine what is being asked in the questions by using their own sentences.
Explore possible strategies		Students write down the problem solving steps that will be used when solving the problem but the steps used are wrong.
Anticipate		Students do not complete the questions using predetermined completion steps, and student work has not been completed and has not found the final result of completion.
Look back and learn	-	Students are not able to complete this stage, so they cannot display the results of the answers to the existing questions.

At the time of the interview session, the students were unable to explain what the steps of working on the questions were from the first to the finish, it can be seen from the following interview excerpt.

- P : "Can you tell us how you did the worksheets?"
 SR : "I can't sis because I don't understand"

To find out the validity of data about the engagement of students with moderate abilities in problems solving, it can be compared in the following table.

Table 8. Engagement of Low Ability Students in Problem Solving

Problem solving stage	Worksheet	Interview	Conclusion of engagement
Identify the problem	Students write down what is known in the problem correctly	Students cannot say what is known in the problem because they are not sure	<i>Pseudo-engagement</i>
Define goals	Students write down what is asked in the questions	Students are not able to say what is being asked in the questions	
Explore possible strategies	Students are able to write down what steps are used when working on worksheets	Students are not able to explain the steps used in working on the worksheets	
Anticipate	Students are unable to solve questions	Students are unable to explain how they solve the problems	
Look back and learn	Students are not able to make conclusions on the last question.	Students are unable to explain the final conclusion	

Mathematical engagement of low-ability students at the stage of identifying problems, students are able to get through it, namely by reading and writing what is known but cannot explain it at the time of the interview. At the goal-setting stage, students are able to determine what is being asked in the question, but cannot explain it. Here, students are able to tell their motivation and purpose in doing the worksheets, but in explaining it, students are not excited. This corresponds to Appleton, Christenson, and Furlong (2008), that students who are not involved in learning tend to be apathetic, not excited, chat with friends, and not focus or even sleep during the lesson. At the stage of exploring possible strategies, students are able to write down the steps that will be used in problem solving but cannot explain the steps. At the stage of overcoming the results and acting students are not able to solve the questions that have been given and cannot display the final results. For the seeing and learning stage students are unable to pass it, because in the answer sheet students cannot answer it because they do not do it. This corresponds to Kartiwi, the difficulty of learning mathematics is because students are less able to apply mathematical concepts in real life so that this learning is less meaningful for students.

Based on the stages of solving students mathematical problems in solving mathematical problems according to Bransford & Stein, low-ability students can fulfill two stages of problem solving, including identifying, determining goals. Meanwhile, to explore possible strategies, overcome the results and act, students are not able to solve them. Based on the description above, the engagement that occurs in students with moderate abilities is pseudo-engagement.

D. CONCLUSION AND SUGGESTIONS

Based on the results of the analysis, it can be concluded that the mathematical engagement of students with high, medium and low ability levels in problems solving in the worksheet, namely: (1) Mathematical engagement of high-skilled students has good problem-solving abilities so that they can fulfill the 5 stages of problem solving, namely identifying problems, setting goals, exploring possible strategies, coping with results and acting, and seeing and learning. Student engagement in problem solving, namely “get the job done”; (2) The mathematical engagement of moderate-capable students has sufficient problem-solving abilities because it can fulfill the 3 stages of problem solving, namely identifying problems,

determining goals, exploring possible strategies. Student engagement that occurs in students with moderate abilities is that “I am really into this”; (3) Mathematical engagement of low-ability students have less problem-solving abilities because they can fulfill the 2 stages of problem solving, namely identifying problems, determining goals. The engagement that occurs in low-ability students is “pseudo-engagement”. And suggestion for future research, this research works on worksheets individually, and it is recommended for further research in groups. and activate the different types of engagement in this study.

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