Analysis of Students' Metacognition Ability through Problem Based Learning Assisted by Worksheets on Environmental Pollution Material

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Abstract

Metacognition ability are important for students to be able to organize and examine their thinking processes. In fact, the seventh grade students of SMP Negeri 13 Semarang do not yet know their metacognitive abilities and teachers have not deliberately built students' metacognitive abilities in various lessons with certain strategies. Problem-based learning (PBL) has the potential to build students' metacognitive abilities. This study aims to analyze the profile of students' metacognitive abilities through PBL assisted by environmental pollution worksheets. This research is a mix method approach which refers to Sugiono with a sequential explanatory strategy. Quantitative data were obtained through test, while qualitative data were obtained through a metacognition ability questionnaire. The sample used was class VIIB and selected by purposive sampling. The results based on the test analysis showed that the VIIB students had the most level 3 metacognition ability with a percentage of 54% and based on a questionnaire reach 76%. Students with the level 3 metacognition ability are able to develop their thinking processes and have poor analytical power. Students with level 1 and level 2 metacognition abilities have not been able to develop their thinking processes and have poor analytical power. Students with level 4 and level 5 metacognition abilities are able to develop their thinking processes and have good analytical power. Students responses analysis about PBL assisted by worksheets are in the good category. Learning with the right method is needed in building and developing students' metacognitive abilities for the better.

INTRODUCTION

Graduate Competency Standards (SKL) at the junior high school level in Indonesia in the knowledge dimension include metacognition abilities listed in Permendikbud Number 54 of 2013. Metacognition abilities are part of higher-order thinking skills in 21st century learning (Febriana & Mukhidin, 2019). Metacognition abilities need to be possessed by students to be used in the learning process. Students who are able to build their metacognitive abilities will be able to provide knowledge about self-awareness to better understand the concept of thinking on the material they want to study.

Metacognition refers to higher order thinking skills that involve active control over cognitive processes in learning which is defined as "thinking about thinking" (Livingston, 1997). There are three essential skills that enable the regulation of the cognitive process, namely planning, monitoring, and evaluation. According to Haryani (2012) metacognition ability is an ability or mental activity in cognitive structures carried out by individuals to regulate, control, and examine their thinking processes. Metacognition abilities help students to be able to manage their learning process independently and be able to think critically, so they can make the right decisions in overcoming the problems at hand (Magno, 2010).

Metacognition ability can be known by measuring it in a lesson. Science learning is one of the subjects that requires metacognition skills to achieve knowledge understanding. Science deals with how to find out about nature systematically and is also a process of discovery (Yatno et al., 2015). Science learning focuses on how students reconstruct the knowledge they have. The results of the reconstruction of knowledge obtained by students are in the form of facts, principles, laws, and theories related to the phenomena being discussed (Magno, 2010). Students need to have metacognitive abilities which can then be developed through the learning process. Sumampouw (2011) states that metacognition needs to be developed to improve higher-order thinking skills that lead to improving the quality of education.

The results of observations and interviews with a science teacher at SMP Negeri 13 Semarang whose address is Jl. Lamongan Raya, Kec. Gajahmungkur, Semarang City, Central Java 50236, has a problem, namely the teacher has not been able to know the extent of metacognition abilities that have been achieved by students. Teachers have not deliberately developed their students' metaconetic abilities. The results of interviews with students also revealed that when working on questions where the material had been explained by the teacher, many of them were still hesitant to give answers. This is because the problemsolving process in questions requires good metacognition skills in order to be able to use proper and structured thinking processes and steps to do things. Meanwhile, daily test tests, midterm assessments (PTS), and end-of-semester assessments (PAS) still use ordinary multiple choice, so they can only be used to determine cognitive achievement and cannot determine students' metacognition achievement. This is in line with the results of research by Dewi et al., (2017) which examined metacognitive competence in junior high schools which showed that teachers needed to develop metacognitive abilities in junior high school students.

Building students' metacognition abilities can be done through problem-based learning, because this learning has the most potential to build five levels of metacognition. Haryani (2012) states that metacognitive competence can be measured through tests as a metacognitive indicator of conceptual mastery. There are five indicators of the level of metacognition that are used according to Haryani (2012), including: level 1: awareness of the thought process and the ability to develop it, level 2: developing an introduction to thinking strategies, level 3: systematic procedural reflection, level 4: transferring procedural experiences to context others and level 5: linking conceptual understanding with procedural experiences.

Delivery of knowledge that emphasizes learning in the active role of students or students as a learning center (student centered). Problem-based learning (PBM) was chosen because it was able to help students improve the development of reflective, critical, and active learning skills. The PBM model also facilitates the success of problem solving, communication, group work and interpersonal skills better than other learning models (Resti, 2017). The PBM model has a syntax, namely organizing students to learn, guiding students in the problem-solving process, presenting work, and evaluating (Sudarmin, 2017). The teacher facilitates investigations and encourages students to raise or create questions that develop them for further investigation.

One of the science materials that can be taught through the PBM model is material about environmental pollution. This material has many problems and applications related to everyday life. The science learning process will be more meaningful when linked to the real world of students. Students learn and understand themselves and the environment around them, so that the learning experience is more applicable. According to Fitriana (2016) states

that to improve students 'metacognition abilities, supporting tools are needed to help implement the learning model, because the learning model alone is not enough to improve students' metacognition abilities. One of the learning support tools that can be used is student worksheets which function to control and direct learning activities properly (LKS). Students' metacognition abilities can be trained using worksheets adapted to the learning syntax to ensure that learning is carried out according to the stages.

Research by Horak & Galluzzo (2017) states that PBM can improve student achievement and the quality of learning in the classroom. Amir & Kusuma (2018) research results suggest that contextual PBM devices can improve students' metacognition abilities. Satwika et al., (2018) also support that PBM is able to improve critical thinking skills which include higher order thinking skills in students. PBM is also able to significantly improve students' critical thinking skills on the concept of static electricity compared to conventional learning (Herayanti & Habibi, 2017). Therefore, choosing the PBM model for junior high school students in science subject matter will have the potential to build higher thinking skills. One of these abilities is metacognition ability. Students are expected to be able to develop and improve their abilities as the student's educational level increases.

Research with the title "Analysis of Student Metacognition Ability through Problem Based Learning Aided by Environmental Pollution Material Worksheets" needs to be carried out. This research was conducted at the junior high school (SMP) level as a first step to improve the learning process to focus on the active role of students. This analysis includes a preliminary study activity to obtain data about the profile of the level of metacognitive ability of students at SMP N 13 Semarang. Students with known metacognition through this research are expected to be able to practice their metacognition skills in other lessons.

METHOD

The research that has been carried out is the type of combined research (mix methods), which is a type of research that combines quantitative and qualitative data in research. This type of mix methods research is sequential explanatory, a research method that combines quantitative and qualitative methods sequentially (Sugiyono, 2017). The research design uses a one shot study case pattern, this design uses a group that is given a certain treatment which then observes the results. This research was conducted at SMPN 1 Semarang in the second semester of the 2019/2020 school year. The sample of this research was class VII students and only took one class, namely class VII B with a total of 32 students.

Data collection techniques in this study include metacognition ability tests (form of description questions), questionnaires (metacognitive abilities and student responses), interviews and documentation. Quantitative data analysis in this study were in the form of: (1) students 'metacognition abilities based on tests, (2) students' metacognition abilities based on questionnaires (3) student responses to learning based on questionnaires, while qualitative data analysis was in the form of interview results.

RESULT AND DISCUSSION

Student Metacognition Outcomes

The research that has been carried out aims to obtain a profile of students' metacognition abilities in problem-based learning assisted by student worksheets. The profile of students 'metacognition abilities in research through posttest analysis, metacognition ability questionnaires, interviews and student responses to learning that was carried out in class VII B. The results of the recapitulation of students' metacognitive ability levels based on test results can be seen in Table 1 below:

Table 1. Achievement of Metacognition Level

Interval Score	Criteria	Number of Students
51 < x ≤ 60	Level 5	1
42 < x ≤ 51	Level 4	3
33 < x ≤ 42	Level 3	17
24 < x ≤ 33	Level 2	9
15 < x ≤ 24	Level 1	2

Class VIIB students have the most metacognition abilities at level 3. Then the large percentage of the achievement of these students' metacognition abilities can be seen in Figure 1.
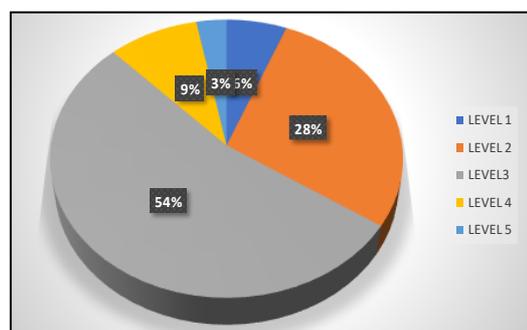

Figure 1. Percentage of Metacognition Level Achievement

Level 1 (aware of the thought process and able to describe it), level 2 (developing an introduction to thinking strategies), level 3 (reflecting evaluative procedures), level 4 (transferring knowledge and procedural experiences to other contexts) and level 5 (connecting conceptual understanding with procedural experience). Metacognition ability is also viewed from metacognition indicators at each level. This review provides an overview of the magnitude of achievement at each metacognition level indicator. The amount of achievement of metacognition indicators can be seen in table 2 below:

Table 2. Percentage of Metacognition Indicator Achievement

No	Information	Achievement (%)
1	Indicator 1	55
2	Indicator 2	60
3	Indicator 3	67
4	Indicator 4	57
5	Indicator 5	38

Indicator 1 identifies information, indicator 2 decides the most suitable operation, indicator 3 compiles and interprets the data, indicator 4 applies its understanding to a new situation and indicator 5 relates the observed data to the discussion.

The results of students' metacognition achievements through problem-based learning assisted by LKS in Table 2 show that students have the most metacognitive abilities at level 3, namely students are able to reflect evaluative procedures. The percentage of metacognition level achievements can be seen in Figure 4.1, namely 54%. Indicators representing level 3, namely indicators of compiling and interpreting data obtain the highest achievement of 67% which can be seen in Table 2. Students are able to achieve this indicator because at the time of learning students do practicum. These practicum activities are able to improve students' abilities through writing reports on practicum results. In line with Haryani's (2010) research which states that indicators of compiling and interpreting data can be achieved by students by carrying out practicum activities. Meanwhile, the lowest level of metacognition is level 5 (linking conceptual understanding with procedural experience) by 3%. Level 5 is the highest level in the metacognition level. The indicator that

represents level 5 is linking the observation data with the discussion to get the lowest achievement of 38%. This happens because students are not strong enough to express their ideas in writing the discussion. Most of the students still feel confused because this is the first time doing practicum and writing the discussion in class.

Results of the Student's Metacognition Ability Questionnaire Analysis

The achievement of students' metacognition indicators at level 1 is seen from the highest questionnaire results, namely the indicator of understanding learning objectives, which is 82% with the indicator category being achieved very well. Through worksheets based on problems of everyday life, it makes it easier for students to understand the learning objectives achieved. Furthermore, at the beginning of the worksheets there are learning objectives that can provoke students to know what to learn at that time. This makes students motivated to take part in learning and achieve their learning goals. Then, the learning steps that have been outlined in the LKS make students more focused on the learning process (Lismawati, 2010). This activity is one of the characteristics of metacognition abilities so that students are able to understand the learning objectives being carried out.

The achievement of students' metacognition indicators at level 2 as seen from the results of the highest questionnaire, namely regarding the student's ability to decide the most appropriate operation, which is 73%, which is included in the category of well-achieved indicators This indicator represents the second level of metacognition ability, where students have been able to develop the ability to recognize thinking strategies. Satwika et al., (2018) and Nurmaliah (2013) explain that problem-based learning can improve critical thinking skills which include higher-order thinking skills and are able to develop logical, reflective, and metacognitive thinking skills. Students' thinking strategies are honed through learning activities carried out to require students to complete worksheets according to the set time. Students who have good planning can carry out learning activities in accordance with learning objectives. This ability illustrates that students have been able to develop thinking strategies in

their limited learning time in predetermined lesson hours.

The achievement of students 'metacognition indicators at level 3 was the highest as seen from the results of the questionnaire, namely regarding the students' ability to compile and interpret data, which was 76% including the indicator category, which was achieved very well This indicator represents the third level of metacognition ability, namely to reflect evaluative procedures.

The achievement in indicator 3 is the most prominent because learning activities are carried out by practicum at the investigation stage in PBM, so that the process of interpreting data can be carried out properly by students (Haryani, 2010). The activity of interpreting the data that has been obtained before it is compiled to answer the LKS, students first select the important information to be used. This important information is then compiled according to the procedures in the LKS. This worksheet helps direct students' practicum activities towards problem solving activities. The problem solving activity is also an indicator at this level, namely overcoming errors / obstacles in solving problems and identifying the sources of error from an experiment.

The achievement of students' metacognition indicators at level 4 was the highest as seen from the results of the questionnaire, which was the student's ability to apply understanding to a new situation in everyday life, which was 73%, including the category of indicators that were well achieved. This indicator represents the fourth level of metacognition ability, namely transferring knowledge and procedural experiences to other contexts. The higher metacognition ability indicates that students' understanding also increases (Sudjana & Wijayanti, 2018). The understanding that students have obtained from carrying out practical activities is applied during the problem solving process according to the stages in the problem-based worksheets. This worksheet provides students with experiences through stages adapted to the PBM syntax accompanied by metacognition indicators to obtain information to build their knowledge.

The achievement of students' metacognition indicators at level 5 was the highest as seen from the results of the questionnaire, which was the student's ability to link observational data in the experiment with the discussion, which was 72%, including the category of indicators that were well achieved. The results of research from Sudjana & Wiyanti (2018) found that the higher a person's metacognition ability, the higher the level of understanding. Level 5 is the highest level in metacognition abilities. This achievement was obtained by students because able to relate observational data that has been obtained from practicum at the investigation stage.

One example of data that can be linked by students is the results of observing a certain time interval on several fish that were given treatment in several types of polluted water with different concentrations. Students are able to relate the data they get to discussions written on student worksheets, so that they make students accustomed to practicing their ability to relate data to discussion. Then from the discussion that has been described by students at the stage of presenting the results of activities, making students able to solve problems and think about the process of solving problems related to everyday life in the surrounding environment.

One of the mastery of level 5 metacognition abilities is motivated by the motivation and experience of students in learning activities and self-regulation abilities (Williamson, 2015). Students' metacognition abilities have been identified through the results of tests and questionnaires, in addition to that, interviews are also conducted with students to find out the metacognition process.

The metacognition process that was passed by each student got different results at each level. There is a question that shows the clearest difference between students who have metacognitive abilities at level 5 with level 2 and 1 in the question "would you guess the answer if you didn't know the answer?". Students with high metacognition abilities prefer to work as maximum as possible, think about how to take steps to complete the answer and choose not to guess the answer. In contrast, students with low metacognition abilities prefer to guess answers without thinking about what steps to take to solve the problem. Furthermore, there is also a clear difference in the question "do students identify information to solve problems?". Students with high metacognitive abilities identify information first and then discuss with

group members to provide responses to each other before solving problems, while students with low metacognitive abilities do not identify information first and tend to directly answer problems. Metacognition abilities that have been trained by students through problem-based learning provide experience and motivation in the learning process.

Student's Metacognition Ability Profile

Students who are categorized as having high metacognition abilities based on the posttest results, namely with the category level 4 and level 5. The level 4 metacognition ability is to transfer knowledge and procedural experiences to other contexts. Indicators at this level are applying understanding to new situations, identification is carried out using the answer to the test of metacognition ability number 4. Based on Table 2 the achievement of indicator 4 test results is 57%. The following is an example of an answer from one of the students with high metacognition criteria :

"4. Based on the information, the method can be used is make a stabilization pond. In this way, industrial waste can be neutralized first from water contaminants before being dumped into the river. So that the water will not be polluted."
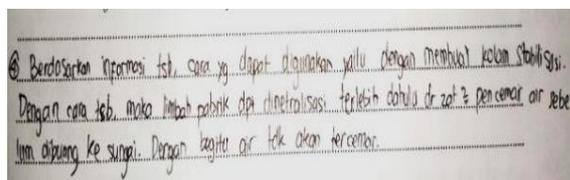

Figure 2. Answers to Student Questions Number 4 with High Metacognition Ability

Based on the students' answers, it can be seen that students are able to analyze the most appropriate stabilization pool to neutralize polluted waste water before being discharged into the river. This shows that students have achieved good results for indicators of applying understanding to a situation. The results of the achievement of the indicators obtained in the questions are in line with the results of the metacognition questionnaire on the statement "I am able to apply to a situation in everyday life". The following is a snippet of interviews with students:

Teacher : *Have you applied the subject matter related to environmental pollution*

that has been obtained in everyday life?
Student : *Yes, Mom*

Based on the results of the questionnaire, interview and description above, it can be seen that the achievement of this indicator is good even though there are only 4 children who fall into this level category. Students with this level of metacognition ability are able to develop their thinking processes and have good analytical power. Meanwhile, students with moderate metacognition abilities with the level 3 category obtained different student answers. The following an example of a snippet of student answers in the medium metacognition category: "4. Use by IPAL or waste water treatment plant, so that the waste water can be treated and the water remains clean."
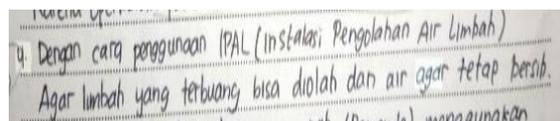

Figure 3. Answers to Student Questions Number 4 with Moderate Metacognition Ability

Based on the students' answers, it can be seen that students are still not strong enough to provide the right reasons to neutralize polluted waste water before being discharged into the river. This shows that students have been able to achieve good enough results for indicators of applying understanding to a situation. This data is also supported by the results of interviews. The following is a snippet of interviews with students with moderate metacognition abilities:

Teacher : *Have you applied the subject matter that has been obtained in your daily life?*
Student : *Not completely ma'am, still trying to implement it.*

Based on the results of the description above, it can be seen that the achievement of this indicator is quite good and the most students are in this level category, namely 17 students. Students with this metacognition ability category are able to develop their thinking processes and have poor analytical power. Meanwhile, students with low metacognition abilities with the level 1 and level 2 categories also obtained different student answers. The

following is an example of a student's answer to the low metacognition category.

"4. The way to overcome the pollution is the use of IPAL or waste wate treatment plant and make a stabilization pond."
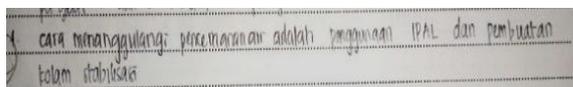

Figure 4. Answers to Student Questions Number 4 with Low Metacognition Ability

Based on the students' answers, it can be seen that students did not give any reasons related to the answers mentioned. This shows that students have not been able to achieve good enough results for indicators of applying understanding to a situation. This data is also supported by the results of interviews. The following is a snippet of interviews with students with low metacognition abilities:

Teacher : *Have you applied the subject matter that has been obtained in your daily life?*
Student : *Not yet able to apply ma'am*

Based on the results of the description above, it can be seen that the achievement of this indicator is not quite well achieved. Students with this metacognition ability category have not been able to develop their thinking processes and have poor analytical power. There are still 9 students who are still in the category of metacognition ability level 2 and 2 students at level 1.

Results of Student Response Questionnaire Analysis on Learning

Students give a relatively good response after implementing problem-based learning with the help of worksheets. This questionnaire aims to support the analysis of students metacognition. There were 12 students who responded "very well" and 20 students responded "well". The following is a recapitulation of the student response questionnaire analysis presented in table 3.

Table 3. Recapitulation of student responses to learning

Item	Statement	Total Score	Student Response
	Using worksheets in problem-based learning makes me:		
1	More interested in learning science	47,34	Good
2	Easy to understand environmental pollution material	49,69	Very good
3	Can connect the application of environmental pollution materials in everyday life	46,88	Good
4	Easy to solve problems masalah.	49,22	Very good
5	Trained to solve problems systematically	45,94	Good
6	Creative and team up with friends	49,69	Very good
7	Active in science learning	48,28	Good
8	Easy to understand the steps of environmental pollution practicum	49,22	Very good
9	Encouraged to learn independently.	47,34	Good
10	Feels appropriate when applied to other science materials.	47,81	Good
11	The more enthusiastic in learning to use LKS	49,22	Very good
12	Can identify science problems well with the help of LKS	47,81	Good
13	Easy to understand experimental data results	50,63	Very good
14	Enjoy learning in the classroom	49,22	Very good
15	It is easy to take conclusions on this problem-based learning.	49,69	Very good

Questionnaire responses to the PBM assisted by LKS were distributed to each student to determine the response or reaction of students to the learning that had been implemented. There were 12 students with very good responses and 20 students with good responses. The students gave a positive response to the PBM using the LKS because they felt that by using the LKS in the learning process it became focused and understood the concepts on the theme of environmental pollution. In addition, the existence of LKS makes group discussions more focused and encourages students to work well together.

More specifically, this student response questionnaire was also analyzed for each item. The highest response is in statement number 13, namely the use of student worksheets makes it easier for students to understand the results of the experimental data. The total response score on these items was 50.63. This can be achieved because in learning to apply practical activities, allowing students to more easily understand the information that has been obtained from practicum activities. Therefore, it can be said that this theme is appropriate if the process of teaching and learning activities is carried out through PBM assisted by LKS. In addition to statement number 13, statements on points 2 and 6 also received quite high responses, namely 49.69 respectively. The statement of item 2 is that the use of student worksheets in PBM makes it easy for students to understand environmental pollution material. This can occur because students are easy to understand the concept of environmental pollution, because the information provided is more detailed, especially on indicators of polluted environment, factors that cause pollution and different methods prevention of pollution. Then the statement of item 6 is the worksheets to encourage students to be creative and work together.

Learning using worksheets is carried out by students in groups using the discussion method so that it can encourage students to work together and find answers according to the group. Overall student responses to based learning with the help of using worksheets are good. Students also considered that problem-based learning using this LKS could be applied to materials other than environmental pollution.

CONCLUSION

Based on the research results, the following conclusions can be obtained : (a) the profile of the achievement of students' metacognition abilities after implementing problem-based learning assisted by worksheets, among others: there were 2 students in the level 1 category with a percentage of 6%, 9 students in the level 2 category with a percentage of 28%, 17 students in the level 3 category with a percentage of 54%, 3 students at the level 4 category with a percentage of 9%, and 1 student at the level 5 category achievement with a percentage of 3%. Students with level 1 and level 2 metacognition abilities have not been able to develop their thought processes and have poor analytical power. Students with the level 3 metacognition ability category are able to develop their thinking processes and have poor analytical power. Students with level 4 and level 5 metacognition abilities are able to develop their thinking processes and have good analytical power. (b) overall student responses to problem-based learning activities assisted by environmental pollution material worksheets were in the very good category. The use of these worksheets can help students understand learning on environmental pollution material. Students become more active, creative and independent in working together in groups and individually through practicum to solve problems. Finally, for better research in the future, researcher can be developed a methods or strategies to increase metacognition ability that can be used in many various subject.

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