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Analysis of students' metacognition level in solving scientific literacy on the topic of static fluid

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ABSTRACT

The purpose of this study is to describe students' metacognition level in solving scientific literacy. This research use the descriptive method. The subject of this research is 99 students of grade XI in SMA Batik 2 Surakarta. Data collection methods used are test methods which its instruments based on an indicator of scientific literacy and metacognition ability. Data analysis techniques use quantitative descriptive analysis. The results showed that the achievement of scientific literacy in science as a body of knowledge, science as a way of thinking, science as a way of investigating, and science as an interaction between technology and society is still low at below 35%. This is due to 84% student occupy in low metacognition level that is 30% students in tacit use level, 54% students in aware use level, and only 16% students occupy in high metacognition level that is in strategic use level.

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1. INTRODUCTION

Indonesia is currently facing the era of globalization. One of the characteristics of the era of globalization is the rapid development of science and technology. Advances in science and technology have had an impact on the development of education in Indonesia [1]. The development of the world of education can be seen through renewal in the education system to balance the progress of science and technology globally. This is because education can be a force for change to get better. The changes are expected to produce quality learners with a demonstrated attitude of science literacy. Literacy of science aims at developing the scholarly thinking of learners [2]. Furthermore, scientific literacy is very important mastered by students in relation to how they perceive the environment, health, economy, and the problems of modern society [3].

The term of scientific literacy has been used in the literature for more than four-decade, although not always with the same meaning of scientific literacy [4, 5]. Science literacy means appreciation of science by enhancing the components of learning within themselves in order to contribute to the social environment [6]. According to DeBoer scientific literacy means understanding science and its application to the needs of society [7]. Chiapetta and Udeani more specifically explain scientific literacy into four themes or category of science: science a body of knowledge, science a way of thinking, science a way of investigating, an interaction of science, technology, and society [8, 9].

Science a body of knowledge discusses facts, concepts, principles, laws, theories, etc. Science a way of thinking gives an overview of science in general and scientists especially in conducting investigations. science a way of investigating gives problems to stimulate thinking and doing something by assigning students to "investigate". Interaction of science, technology and society provides an overview of the impact

or impact of science on society. Referring to the four themes / dimensions of science literacy put forward, then the indicator dimension of science literacy in each category can be seen in Table 1.

Table 1. Indicator for Each Category of Scientific Literacy

No	Category of Scientific Literacy	Indicator of Scientific Literacy for Each Category
1	science a body of knowledge,	(1) Facts, concepts, principles and laws of physics. (2) Hypotheses, theories and models of physics. (3) Situations / questions that require students to remember knowledge or information.
2	science a way of thinking	(1) Direct students to answer questions through the use of materials. (2) Directing students to make calculations. (3) Directing students to explain the answers. (4) Involving students in experiments or thinking activities.
3	science a way of investigating	(1) Require students to answer questions through the use of graphs, tables, and diagrams (2) Provide a cause and effect relationship. (3) Discuss facts and evidence. (4) Presents scientific method and problem solving.
4	interaction of science, technology and society	(1) Describe the usefulness of science and technology for society. (2) Demonstrate the negative effects of science and technology for society. (3) Discuss social issues relating to science or technology. (4) Mention of careers and jobs in science and technology.

One of the factors that influence students ability in solving science literacy problem is metacognition level. This is due to metacognition affects the learning process of a person [10]. Metacognition is defined as thinking about thinking [11]. Metacognition ability is the ability to reflect on something that is being considered. Metacognition plays an important role in regulating and controlling one's cognitive processes in learning and thinking more effectively and efficiently [12]. Metacognition ability is able to regulate the cognition of learners in learning activities [13-15]. Some important steps relating to metacognition processes that can help students solve problems) are: (1) identifying the problem, identifying and defining elements of the given situation, (2) representing (3) planning how to implement it, deciding on the steps, (4) evaluating the results and completion made [16].

Metacognition skills can help students recognize that physics requires logical reasoning in solving a problem that needs to be improved. Students need to be aware of every step of problem-solving in order to improve their metabolic skills. But each student has different metacognition skills in solving problems. There are 4 levels of metacognition capabilities, namely tacit use, aware use, strategic use and reflective use [17].

Students at tacit level solve problems without thinking in making decisions. In this case, the student does not answer the question (procedural knowledge) or answer the question but not according to the question. This is because students do not understand the question (declarative knowledge), so that students only answer in trial and error and answer in solving the problem. Students at the aware use level are aware of their own thought processes. This can be seen from the way students use prior knowledge to connect with the material (declarative knowledge). Students try to link the information they have to determine the problem-solving steps (procedural knowledge).

Students at the strategic use level are able to organize thinking processes to improve the accuracy of their thinking. In this case, the student is aware of her own thought process by using specific strategies that can improve the accuracy of her thinking. In this case, students are aware and able to select specific strategies or skills to solve the problem but can not explain the reason why to choose the step. Students at the reflective use level are aware of their own thought processes. This can be seen from the way students use prior knowledge to connect with the material (declarative knowledge). Students at this level can reflect on the thinking process before and after or during the process of solving the problem. Then consider the continuation and improvement of his thinking results so that the problem-solving answers are highly structured (procedural knowledge) because of students immediately correct when there are fewer steps. Students at this level can also explain the reasons why they chose to solve the problem.

Based on the description, it can be concluded that the metacognition level can to improve student skills in solving scientific literacy. Therefore it's important to analyze students' metacognition level in solving scientific literacy. The results of the analysis can be used as a reference or evaluation base for teachers to determine the appropriate learning to improve the quality of students.

2. RESEARCH METHOD

The type of this research is quantitative descriptive research. The method used in this research is survey method. This research uses survey research procedure by Biemer and Lyberg: 1) Research objective,

2) Concepts, 3) Questioner, 4) Population, 5) Sampling, 6) Data collection, 7) Data processing, 8) Interpretation [18]. This research was conducted in the even semester of academic year 2017/2018 in SMA Batik 2 Surakarta. The sample in this research is the 99 students of grade XI IPA SMA Batik 2 Surakarta.

Data collection methods used were test and questionnaire. The instruments used in this research are test sheets and questionnaires. The test sheet is used to find out the profile of students' critical thinking ability in solving the science literacy problem based on metacognition ability level. The questionnaire was used as the supporting data of the test result to know the level of students' metacognition ability.

The problem on the test sheet consists of 4 questions that have met the valid and reliable criteria. In each of the questions developed, it contains three description questions to analyze students' metacognition ability in solving science literacy problem. The assessment rubric on the test sheet was adopted from indicators made by Rompayom et al ie 1) Declarative Knowledge, 2) Procedural Knowledge, 3) Conditional knowledge [19]. Scoring rubric for measuring students' metacognition knowledge level can be seen in Table 2.

Table 2. Scoring Criteria of Metacognition Knowledge

Score	Description of Metacognition Knowledge		
	Declarative Knowledge	Procedural Knowledge	Conditional Knowledge
0	Nothing relevant to the task. The students does not describe what the task related	Students do not describe which strategy they use to solve a problem, and how they solve that problem	Students do not explain when and why to use strategies in solve problem
1	Student write nonspecific statements that are relevant to content, but not related to the question	Students seem to understand of the task purpose, but they make non specific statements that are not related or connected between given information and question	Student list general strategies used to solve a problem, but they do not explain when or why to use that strategies or nonspecific statement
2	Student has a clear overview of what the task related to	Student has clearly defined which strategy they use. Students explicitly consider to the implication between given information and the question	The student generates clearly when and why to use strategies they use to solve problem. The overview of their strategy connects concretely to the given information and the question

The analysis of metacognition rate profile of students in solving science literacy was done after giving a score based on indicator score in Table 1. The data was calculated to determine the number of students metacognition. The amount of knowledge metacognition students obtained will be grouped by category of metacognition level of students in Table 3.

Tabel 3. Category of Level Metacognition Based on Score Metacognition Knowledge

No	Level Metacognition	Interval of Score Metacognition Knowledge
1	Tacit Use	Score Metacognition Knowledge ≤ 1
2	Aware Use	1< Score Metacognition Knowledge ≤ 2
3	Strategic Use	3 < Score Metacognition Knowledge ≤ 4
4	Reflective Use	5 < Score Metacognition Knowledge ≤ 6

3. RESULTS AND ANALYSIS

The material on the test sheet used in this study is static fluid. This is because static fluid material occurs a lot in everyday life but students still often experience misunderstandings on static fluid material [20]. This is because a static fluid material has the characteristics of conceptual analysis that allows students to link physics concepts with natural phenomena and requires the ability to infer which includes the ability to analyze, evaluate, and create [21, 22]. Results of student answers on the test sheet can measure students 'science literacy and students' metacognition abilities.

3.1. Profile of student scientific literacy

There are 4 categories of students' science literacy measured in this research that is science a body of knowledge, science a way of thinking, science a way of investigating and interaction of science, technology ,and society. The results of the achievement of student science literacy in each category can be seen in Figure 1.

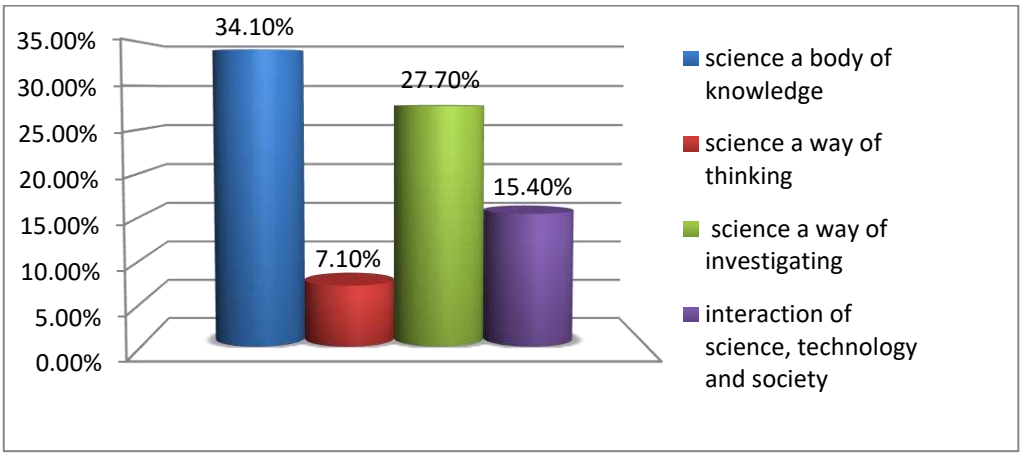

Figure 1. Percentage achievement of student scientific literacy in each category

In Figure 1, it can be seen that the achievement of science literacy of students in each category is still low. Literacy of science in the category of science a body of knowledge is still low with the percentage of achievement of 34,1%. This shows that students still have difficulty in explaining the concept, principle, and law of static fluid that is the concept of hydrostatic pressure on the U-related pipe. Literacy of science in category of science a way of thinking gets the lowest achievement value that is equal to 7,1%. This suggests that students still have difficulty making calculations of the volume ratio of objects if dipped in two different fluids. This is because students are still having difficulty in analyzing the law of Archimedes on the problem. Science literacy in science a way of investigating category is still low with a percentage of achievement 27,7%. This shows that students are still having difficulty in reading the position and pressure relations table and provide cause and effect relationship based on the data contained in the table. Literacy of science in the category of an interaction of science, technology, and society is still low with the percentage of achievement of 15.4%. This shows that students still do not understand the application of static fluids in everyday life such as a hydraulic jack.

The low science literacy of students is due to the lack of trained students in solving the problems with the characteristic of science literacy. Teachers only use judgments that emphasize content rather than on science literacy such as applying science in everyday life, thinking about problem-solving, and the ability of the process of science. This is supported by Noviani et al that teachers prefer students to be proficient in material mastery [23]. This is supported also by Juliyanto et al that the instrument of learning evaluation made more measurable how many students in mastering the material [24].

3.2. Profile of students metacognition level in solving scientific literacy

The low ability of students in solving the science literacy problem due to the level of metacognition ability of students is still low. This is because the ability of metacognition makes students trained to always design the best strategy in choosing, remembering, recognizing, organizing the information it faces, as well as in solving problems. There are 4 levels of metacognition ability of students in solving science literacy measured in this research that is tacit use, aware use, strategic use, reflective use. Percentage of students' metacognition ability level in solving science literacy problem can be seen in Figure 2.

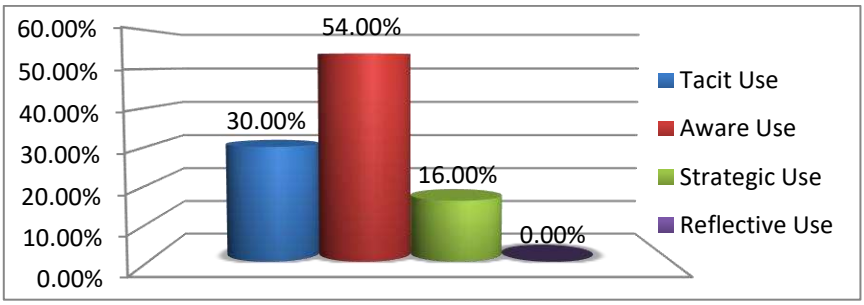

Figure 2. Percentage of students' metacognition level in solving scientific literacy

In Figure 2 it can be seen that the percentage of students who have metacognition level at the level of tacit use is 30%. This shows that 30% of learners solve the problem without thinking in making decisions. In this case, the student does not answer the question (procedural knowledge) or answer the question but not according to the question. This is because students do not understand the question (declarative knowledge) so that students only answer in trial and error and answer in solving the problem.

Percentage of students who have metacognition ability level at the aware use level is 54%. This shows that 54% are aware of their own thought processes. This can be seen from the way students use prior knowledge to connect with the material (declarative knowledge). But students are still trying to relate the information they have to determine the problem-solving steps (procedural knowledge) so that students still have errors in determining the settlement step.

Percentage of students who have metacognition ability level at the strategic use level is 16%. This shows that 16% of students are able to manage the thinking process to improve the accuracy of their thinking. In this case, the student is aware of her own thought process by using specific strategies that can improve the accuracy of her thinking. In this case, the student is aware and able to select specific strategies or skills to solve the problem, but can not explain the reason why to choose the step.

Percentage of students who have metacognition ability level at the strategic reflective use level is 0%. This shows that no student is aware of his own thought process. This can be seen from the way students use prior knowledge to connect with the material (declarative knowledge). Students at this level can reflect on the thinking process before and after or during the process of solving the problem. Then consider the continuation and improvement of his thinking results so that the problem-solving answers are highly structured (procedural knowledge) because of students immediately correct when there are fewer steps. Students at this level can also explain the reasons why they chose to solve the problem.

The level of metacognition ability of students in solving the problem of science literacy needs to be analyzed further related to the level of metacognition ability of students in solving science literacy problem in each category. This is because knowledge of metacognition that dominates in solving each category of science literacy is different. Percentage of students metacognition ability level in solving each category of science literacy can be seen in Figure 3.

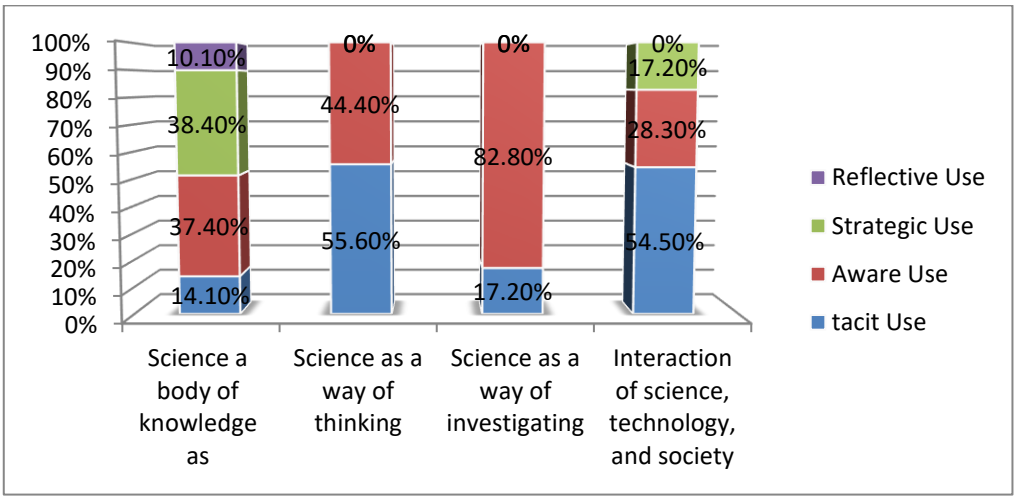

Figure 3. Percentage of students metacognition ability level in solving each category of science literacy

In Figure 3 it can be seen that the percentage of students' metacognition ability level in solving each category of science literacy is different. In the category of science literacy as a body of knowledge obtained data that the percentage of students on the level of tacit use is 14.1%. This shows that 14.1% of students do not have declarative knowledge that causes students to answer the problem by trial and error. The percentage of students at the level of aware use is 37.4%. This shows that 37.4% of students have declarative knowledge that causes students have the ability to mention and explain the concept, but students still do not have the procedural knowledge that causes students' critical thinking skills in the inference stage is still experiencing difficulties so that students have not been able to propose settlement steps. Percentage of students at the strategic use level is 38.4%. This shows that 38.4% of students have declarative and procedural knowledge that causes students to have the ability to mention and explain concepts and propose resolution steps. But the

students still do not have conditional knowledge that causes the students have not been able to provide the reasons for the selection of settlement steps and have not been able to improve the results of his thinking. Percentage of students at a reflective use level is 10.1%. This shows that 10.1% of students have procedural, declarative and conditional knowledge that causes students to have the ability to explain concepts, propose settlement steps, and provide reasons for choosing the steps and evaluating the solution to the given problem.

In the science literacy category as a science a way of thinking, it is found that the percentage of students on tacit use level is 55.6%. This shows that 55.6% of students do not have declarative knowledge that causes students to answer the problem by trial and error. The percentage of students on the awareness level was 44.4%. This shows that 44.4% of students have declarative knowledge that causes students have the ability to mention and explain the concept, but students still do not have procedural knowledge that causes students have not been able to propose the settlement. Percentage of students at the strategic use and reflective use level is 0%. This indicates that no student has procedural and conditional knowledge that causes the student does not have the ability to propose settlement measures so that the student can not give the reason for the selection of the settlement step and make improvements to the outcome of his thinking. One of the factors causing the absence of students who have tacit use and strategic use in solving science literacy problem science a way of thinking category is the incompetence of students in solving comparative problems on legal concepts of Archimedes. This is because the questions that have been given in relation to the law of Archimedes are only a matter of calculating the buoyant force and the condition of the object so that the students are confused when faced with a comparison problem.

In the category of science literacy as a science a way of investigating data obtained that the percentage of students on the level of tacit use is 17.2%. This shows that 17.2% of students do not have declarative knowledge that causes students to answer the problem by trial and error. Percentage of students at the level of aware use was 82.8%. This shows that 82.8% of students have declarative knowledge that causes the students have the ability to mention and explain the concept, but the students still do not have procedural knowledge so that students have not been able to propose settlement steps. Percentage of students at the strategic use and reflective use level is 0%. This indicates that no student has procedural and conditional knowledge that causes the student does not have the ability to propose settlement measures so that the student can not give the reason for the selection of the settlement step and make improvements to the outcome of his thinking. One of the factors causing the absence of students who have tacit use and strategic use in solving science literacy problem of science a way of investigating category is the students' uncertainty in analyzing tables of observations related to position and pressure relationship. This is because the questions that have been given related to hydrostatic pressure is only a matter that calculates the hydrostatic pressure of the object so that students are confused when faced with the matter of a table of observations.

In the category of science literacy as an interaction of science, technology and society obtained data that the percentage of students on the level of tacit use is 54.5%. This shows that 54.5% of students do not have declarative knowledge that causes students to answer the problem by trial and error. The percentage of students at the aware use level was 28.3%. This shows that 28.3% of students have declarative knowledge that causes students have the ability to mention and explain the concept, but the students still do not have procedural knowledge so that students have not been able to propose settlement steps. Percentage of students at the strategic use level was 17.2%. This shows that 17.2% of students have declarative and procedural knowledge that causes students to have the ability to explain concepts and propose resolution steps. But the students still do not have conditional knowledge that causes the students have not been able to provide the reasons for the selection of settlement steps and have not been able to improve the results of his thinking. Percentage of students at a reflective use level is 0%. This indicates that no student has a conditional knowledge that causes the student has not been able to evaluate the solution to the given problem. This is indicated by the errors of students in interpreting the cross-sectional area of pascal law.

4. CONCLUSION

Based on the description of the results and the discussion above, it can be concluded that the achievement of science literacy in the category of science as a body of knowledge, science as a way of thinking, science a way of investigating, science as an interaction between technology and society is below 35%. This is due to almost student occupy in low metacognition level that is 30% students in tacit use level, 54% students in aware use level, and only a few students occupy in high metacognition level that is 16% students in strategic use level and 0% student in reflective use level. Based on the results of research that has been implemented, suggestions that can be given as follows, learning strategies used in the learning process should be able to develop skills and literacy science learners, but it should also be supported by the assessment for monitoring and evaluation related skills and literacy science students.

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