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To cite this article: H Yanti et al 2019 J. Phys.: Conf. Ser. 1155 012083

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The Effectiveness of Students' Worksheets Based on Multi-**Representation in Improving Students' Metacognition Skills** in Static Electricity

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Abstract: This study aims to determine the effectiveness of students' worksheets based on multi-representation in improving students' metacognition skills in static electricity. This study uses pretest design and quasi-experimental posttest. The data were analyzed descriptively and statistically, namely analyzing the observations of the teacher's ability to manage learning, student activities during learning using worksheets based on multiple representations and paired sample t-test to determine differences in n-gain of metacognitive abilities before and after using multipart representation based worksheets. The results showed that worksheets were effectively used in learning with the ability of teachers to manage learning 81.3 included in the excellent category and during the students' activity 80.56 learning included in the category of very active, and there were significant differences in students' metacognition skills after using worksheets based on multi-representation. An increase in n-gain also occurs in every indicator of metacognition capability. These results show that learning using multirepresentation worksheets is more effective in improving metacognition skills.

1. Introduction

Metacognition ability in the context of the problem [1], aspects that require students in the problem, namely planning, monitoring, and evaluation. Children who have a metacognitive strategy will immediately realize that they do not understand and find a way out. Develops metacognitive skills in students which mean education, because they can help them become independent students [2]. Selfregulated learners are responsible for learning independent learning and adaptation of learning strategies to achieve tasks[3]. The importance of applying metacognition in learning has been studied by several researchers, Kipnis and Hofstein at [4] state that metacognition is considered the most important in learning that needs to be developed for students, because in the process of finding that metacognition processes provide meaningful understanding or learning with understanding Application of metacognition will enable students to learn science knowledge and form independent students. The thinking above is supported by Winn and Snyder in [4] which states that students can use metacognition strategies, they become themselves and become independent learners.

Once the importance of metacognition ability in improving students' ability in problemsolving, the government through the education and culture minister's regulation no. 22 of 2016, as stated in the 2013 curriculum, namely including metacognition knowledge, must be formally taught in every learning, even Flavell in [4] suggests that good schools must be ideal places for the development of metacognition, arguing that so much self-awareness learning will take place. at school, children have repeated opportunities to monitor and manage their cognition, also have so much metacognition experience and the opportunity to gain metacognition knowledge about themselves, tasks, and strategies.

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Physics is synonymous with problems that must be solved. Not a few problems in physics, especially in abstract and complex material, are very difficult to solve because they involve complicated mathematics [5]. Physical problem solving involves several processes, such as verbal processes, application of concepts, and metacognitive control [6]. Based on preliminary research conducted by [7] the ability of students to solve problems in physics metacognition in the abstract material included in the low category, both in terms of knowledge and metacognitive skills. Students are less able to recognize easy and difficult questions. the same difficulties experienced by students in giving reasons, making procedures, predicting, planning, monitoring, and evaluating. In everyday learning, the teacher uses worksheets to achieve learning goals. student worksheets are one of the means to help and facilitate learning activities [8]. The role of student worksheets in the learning process according to is as a tool to provide knowledge, attitudes, and skills to students. The use of student worksheets may be a more optimal teacher's teaching, giving guidance to the students who experience difficulties, giving reinforcement, and training to solve the problem [9]. There is the Student Worksheets which are expected to be able to make the participants active and responsive, as well as creative [10]. The use of worksheets in science learning, especially physics is very in accordance with the nature of physics learning which emphasizes more on learning in the process than learning that refers to the end result or product.

Although the teacher in learning already uses student worksheets, the student worksheets are obtained from the market which is designed with the same model or method regardless of student characteristics and material. This causes students to continue to experience difficulties in achieving learning goals. Generally, physics worksheets on the market are only a matter of training with verbal representations to calculate mathematics only, so that they consider physics to be a difficult and frightening lesson. The main contributing factor is the number of mathematical formulas in physics [5]. Students consider these formulas to be like such electrical materials that are very abstract, complex and involve mathematics that is very complicated [5] so that problems in the material are difficult to solve [11]. Learning the main target of electricity is to develop students' thinking ability towards electrical material as a whole both on a macroscopic, microscopic and symbolic scale. Students' understanding of the material is shown by its ability to represent one of these three levels will affect others so that students will experience difficulties in solving complex problems [12]. A verbal explanation through the text that has been made will become easier to understand if the explanation through the text is equipped with an image or graphic that corresponds to the material.

Based on the data above, it is necessary to design a multi-representation representation worksheet to improve students' metacognition skills in physics learning, especially in the abstract material. Students can use student worksheets which are presented with several representations (multi-representation) to support understanding when solving problems or learning new concepts [13]. Explanations that are supplemented with pictures or graphics that correspond to the electrical material will be more easily understood by students. Multi-representation has three main functions, namely: as a compliment, limiting interpretation, and understanding builder [14]. According to [15] states that the role of multi-representation is the core of the science learning process. The presentation of material using one form of representation cannot explain the meaning of a material, it is also supported by Research [11]. regarding the representation of proof in geometry learning which proposes three forms of representation, namely representations of problems, visual representations, and representations of evidence. Multi-representation formats are grouped into verbal, drawing/diagram, mathematical, and graphical [16]. Whereas according to [17] Multi representation is a model that represents the same concept in several different formats. Representation is something that can be symbolized or symbolized on an object or process [18]. They added that in physics representation can be in the form of words, pictures, diagrams, graphs, computer simulations, mathematical equations and so on.

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2. Research methods

The study was conducted in December 2017-April 2018 which consisted of initial observations to determine the state of students. This type of research is a quasi-experimental research. The quasiexperimental goal is to obtain information which is an estimate for information that can be obtained with actual experiments in circumstances that do not allow it to control and or manipulate all variables [19] The population in this study were students of Gajah Mada High School XII class The technique in sampling is cluster sampling. The subject of the research is the XII science class. The independent variable in this study is the multi-representation representation worksheets. The dependent variable in this study is metacognition ability consisting of declarative, conditional, procedural, predictive, planning, monitoring and evaluation capabilities.

The design used in this research is the static group pretest-posttest design [20]. The form of research design is shown in Figure 1.



O1 = the pre-test and O2 = post-test,

X is treated with multiple representation student worksheets

Figure 1 Research Design [20]

Data collection techniques using several methods, namely the observation method, the test method, and documentation method. Non-systematic observation method, aimed at teachers and students to determine the ability of teachers in managing to learn using student worksheets based on multiple representations and observations of student activities during learning using student worksheets based on multiple representations. Systematic observation method is used to find out the ability of metacognition students have when learning takes place. The test used to determine the ability of metacognition is an essay test. The tests given to students are questions that cover all metacognition abilities, namely declarative, conditional, procedural, predictive, planning, monitoring, and evaluation. The documentation method used to collect the initial ability scores taken from the metacognition ability test scores before using the multi-representation student worksheets. Data analysis techniques in this study were carried out with the analysis of statistical analysis in the form of 1) normality analysis to determine whether the data obtained were normally distributed or not after that then performed statistical analysis using 2) test paired sample t-test to determine the improvement of metacognitive abilities before and after using learning Multi representation, worksheets. 4) N gain test to determine the effectiveness of learning using multi-representation representation worksheets. The gain score is the ratio of the actual gain to the maximum gain. The actual gain is the difference between the posttest score and the pretest score. The N-Gain formula is as follows:

 $N-Gain = \frac{postest\ score - pretest\ score}{ideal\ maximum\ score\ - pretest\ score}$

Interpretation criteria for N-gain proposed by Meltzer in Abdurrahman, et al[21], as in Table 1

Table 1 N-gain interpretation criteria					
The amount of Gain	Interpretation Criteria				
g > 0,7	High				
$0,3 < g \le 0,7$	Medium				
g ≤0,3	Low				

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The criteria for the effectiveness of student worksheet are said to be effective if the level of achievement of N-gain is at least in the medium category.

3. Results and Discussion

The results of the test of the effectiveness of static electricity Student Worksheets based on multiple representations are seen from the observations of the teacher's ability to manage learning using multi-presentation based worksheets that follow REAL stages, while the students' activities during learning using multi-representation-based worksheets are taught following REAL stages and metacognitive ability tests. student problem-solving abilities.

3.1 The ability of teachers to manage to learn

The ability of teachers to manage to learn as a whole is in a good category. Graph of teacher's ability at each meeting can be seen in Figure 2.



Figure 2 teachers ability to manage to learn

The teacher's ability to implement each phase of learning is done well. After all, the teacher appreciates, connects what has been learned and what I will learn, and communicates the learning objectives. This stage of the teacher does not only allow students to study and expresses opinions, but also the ability of students to be active in learning. This, of course, affects the activeness of students during learning in line with the opinions expressed by [22] that factors that affect the performance or ability of teachers to learn can be knowledge competencies, skills/expertise competencies, and motivational competence.

3.2 Student activity

Student activity during learning is relatively stable with the overall average being 81 inactive categories. Student activities in learning using multiple representation worksheets are active because students are involved in each phase of the activity from the phase of explaining the concept of the target to the phase of reflection and assessment. In student learning actively ask or give opinions, make observations, conduct experiments, communicate through presentations, make analysis and conclusions of each problem that is done. Students are more confident if they ask, answer and discuss with their peers compared to their teachers. Students are motivated by their peers in asking questions and responding to questions from other groups. In the discussion, the teacher only directs students to

the achievement of learning goals. Results of observation in learning use multiple-based representations displayed in Figure 3



Figure 3 Observations of student activities

3.3 Test results for metacognition ability tests

The effectiveness of student worksheet is also seen from the value of increasing students 'metacognition skills before and after learning using student worksheets which are known from the results of the students' pretest and posttest. To find out the difference in ability to shape the pattern before and after learning, using student worksheets based on a variety of representations, a test using a paired sample t-test was used.

3.3.1 Normality test

Analysis of the normality ability of microchemical analysis was carried out using the Kolmogorov Smirnov test from the SPSS 21.0 program and produced the overall output of the data group showing the significance value (sig value)> 0.05. Because the sig value is> 0.05, Ho is accepted which means that the data group is normally distributed.

3.3.2 Paired Samples T-Test

Data analysis using paired samples t-test aims to determine whether there is a difference in the ability of the metacognitive students before and after carrying out the learning using multiple physics-based student worksheets representations seen from the results of the interpretation and posttest. Test the hypothesis of paired data using paired samples t-test gives the final result in the form of SPSS output which shows the significance value summarized in Table.

			Std. Deviatio	Std. Error	95% Confidence Interval of the Difference		Sig. (2-
		Mean	n	Mean	Lower	Upper	tailed)
Pair 1 (metacognition skills) Aplication 1 (protect postfast	pretest - postest	-49.74	4.97	.84	-51.45	-48.03	.000
metacognition ability							

The results of the statistical hypothesis test on the testing of metacognition ability obtained the significance value of 0.000 < 0.05, it can be concluded that Ho was rejected and H1 was accepted which means that there were differences in metacognition skills before and after learning using worksheets based on multiple representations, and there were differences in measured metacognition abilities using the pretest and posttest results of students.

3.3.3 N-Gain test

The results of the improvement in metacognition ability were seen in the pretest value which was the value before using multiple student worksheets representations and the posttest value was the value after using student worksheets. Multi-representation based was described in table 2, where it was shown that the percentage of metacognition ability in each aspect at the posttest score was higher than the pretest value. The difference in values in procedural aspects is seen to be high compared to other aspects.

No.	Aspect of	Pretes	Postes	pos-	max-pre	<i>N</i> -
	metacognition			pre		Gain
	skills					
1	Declarative	36,00	80,00	44,00	64,00	0,69
2	Procedural	26,00	90,00	64,00	74,00	0,86
3	Conditinal	27,00	84,00	57,00	73,00	0,78
4	Prediction	41.00	86,00	45,00	59,00	0,76
5	Planning	41,00	86,00	45,00	59,00	0,76
6	Monitoring	40,00	86,00	46,00	60,00	0,77
7	Evaluation	48,00	91,00	43,00	52,00	0,83
	Average	36,08	85,96	49,87	63,92	0,78

 Table 2 Test of metacognition skills

Based on Table 2, it is shown that the results of students' metacognition ability increased significantly with an average of 0.78 N Gain included in the high category. The improvement of students'

metacognition ability after using a multi-representation worksheet for each indicator based on the results of the pretest and posttest is shown in Figure 4



Figure 4 Increased Average Value of Metacognition Indicators

Based on Figure 4 shows declarative ability shows that most students have successfully completed declarative questions that are given well, students can declare their ability to solve problems properly. It is supported by learners who have been given the teacher through various representations of imagery, verbal, and symbolic which are able to strengthen the belief of the students to understand their abilities. Learn by some representations more effective in developing students' mental models in understanding the concepts of learning [23].

In conditional abilities, students are required to be able to mention the reasons why applying a particular strategy in resolving electrical power problems. The majority of students of class XII science can provide sufficient answers to assess the ease of the questions given. Large Sis can be stated to have completed all stages of problem-solving given by students correctly, meaning that students can Sort steps to solve problems related to electrical force. This is of course very good to support students' ability to solve problems because knowledge of various strategies can enable individuals to solve problems more efficiently and automatically.

The problem predicts that there is an increase in students' ability to make predictions about their ability to solve problems very well. In the Skills test questions, students write numbers 1 - 3 according to the correctness of the steps in solving the problem. In this indicator, there is also an increase in students' ability in selecting appropriate strategies to work on the problem. On the test of evaluation skills students can improve good evaluation skills, this is of course supported by learning that has been done using multiple representation worksheets, because according to [24] states that the factors are limited or the difficulty of students in understanding a philosophical concept is that they do not use multiple representations in understanding physics concepts. In the test of the skills monitoring, most of the students were able to monitor their metacognition abilities after learning to use multiple forms of representation.

Based on the data above, the ability of metacognition has increased that is in the medium category with a greater n-gain value. indicates that multiple representation worksheets are effectively used in the learning process.

A teacher must pay attention to the effectiveness of teaching and learning activities carried out because of the effectiveness of determining the success of the learning process in achieving the rules that have been formulated. Based on the results of the study there was a significant increase before and after using multiple representation worksheets. This indicates that the effective representation of multiple worksheets is used to improve metacognition skills in class XII science students at Gajah Mada High School Bandar Lampung. This is also in accordance with the statement of [25] in his research saying that multiple representations used in interactive conceptual learning programs have relatively high effectiveness in instilling metacognitive abilities. This is because multiple representations are a way of expressing a concept with various forms including verbal, graphics, and mathematical [26].

The improvement of metacognition skills in Gajah Mada High School students is very good after using student worksheets. Based on multiple representations, this is of course very important thing because metacognition skills are needed by students to solve problems, this is in line with the statement [27] that the ability to solve the problem is in the idea of drafting the plan. So, this expression shows that the better someone plans his thinking process when making a problem-solving plan, the better the resulting solution will be. metacognition skills are needed in improving concept understanding, especially in physical material that is abstraction [28]. This statement is in line with the results of the study [29] shows that students who are skilled in knowing and managing their cognition (assessing their metacognition) and realizing their abilities will demonstrate more strategic thinking skills in solving problems than those who are unaware how the system works. The results of the study [30] show that effective problem solving can be obtained by giving students the opportunity to apply metacognitive strategies when solving problems. It is clear that there is a correlation between metacognition and problem-solving. Metacognition ability can be obtained through learning as said by [28] that metacognitive abilities can be obtained through learning with analogy and reflection strategies.

4. Conclusion

The results of the analysis of the standard and discussion of the physics metacognition abilities of the class Science Twelveth at Gajah Mada High School in Bandar Lampung were found that there was a significant increase in students' metacognition skills before and after learning using multi-representation representation worksheets in the experimental class and there was a significant difference between the posttest control class using conventional worksheets with the posttest results of the experimental class using Multi representation worksheets. Based on the conclusions of the results of the study, the authors suggest that the adoption of a number of physics-based learning representations can be used as an alternative approach to learning in other materials and it is hoped that teachers can provide a more varied approach to physical learning.

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