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Analysis of Students' Difficulties in Solving Physics Problems with Multiple Representation Using What's Another Way Method

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Abstract

Based on the observations that had been made, students experienced some difficulties in solving physics problems, especially in multiple representations. They had a problem in applying a concept with a different form of representation from the previous representation. To overcome this, it is necessary to apply what's another way method as solving problem solution. This study aims to analyze the student's difficulties in solving physics problems with multiple representations using what's another way method on heat and temperature topics in a private islamic senior high school located in Banda Aceh. The design of this study was qualitative descriptive research with five students as subjects. The instruments used were test questions and interviews, then the results of the data were analyzed using what's another way method. The results showed that all students experienced difficulties at level II (planning problem solving), level III (problem solving), level IV (re-checking), and level V (reflection), while for difficulty level I, namely understanding the problem, it is found that no one face the problem. Therefore, the difficulties of students can be grouped into indicators of difficulty in applying the principles and difficulties in solving verbal problems. The factors cause these difficulties may occur due to error in using formulas, error in mathematical calculations, error in unit conversions, error in symbols writing, and error in double-checking.

INTRODUCTION

Competence in problem solving is one of the important things that all teachers want to overcome through problem solving competence students can implement what they have learned from learning to apply in their lives. The competence of a student in solving physics problems properly and correctly is basically the main goal of the learning process of an education (Suryaningsih, 2019). That way the learning outcomes of each student are expected to be more meaningful so that the results of the learning process can be useful for students and their lives (Rizky Novriani & Surya, 2017).

In essence, each student has different difficulties in solving physics problems. Based on initial observations, it was shown that some students were only able to solve physics problems in a systematic order as the teacher gave them. There are some students who are less able to solve physics problems if

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they are in the form of diagrams, tables, graphs or other forms (S. Lestari & Nugraheni, 2022). Understanding the concept of physics is still focused in one form. Therefore, if students can understand the concept of physics as a whole, these students will be able to solve problems in whatever form is given to them (Suwanto & Wahyuni, 2018). Students are required to be skilled in expressing the physics concepts that have been understood in various forms/multiple representations (Ahmad et al., 2015).

Multiple representations, which are often also referred to as multi-representations, are representations or representations of a concept that is applied using various forms. Representation or representation in physics has three representations, namely the first one to have is a verbal representation or spoken language, while the second is a physical representation. The third is mathematical representation or often called mathematical representation (Hidayatulloh, 2020). The use of multiple representation tests can be a tool or device to measure students' difficulties in solving physics problems. In solving problems need to use or steps (Kusairi et al., 2019).

The What's another way step is a step in which the solution method directs students to solve problems using more than one method so that it is possible that each student will get various and different answers (Nurhayati & Angraeni, 2017). In the stages of problem solving using this method, which include: understanding the problem, determining a problem-solving plan, working according to the plan, re-examining the answers obtained along with the steps for obtaining these answers, and reflection, namely answering the challenges of existing problems by finding ways. others to find the answer (H. Lestari & Mustadi, 2019).

In a previous research conducted by Hidayatulloh (2020) on the analysis of learning difficulties in solving physics cases in elasticity and Hooke's law topics, the results showed that students had difficulties at every stage of problem solving. At the stage of understanding questions students' difficulty reached 84%, the planning for problem solving stage reached 87%, the implementation of the completion plan strategy stage reached 99% and the answer checking stage was only 5%. The cause of these difficulties occurs is that students do not know the use of the appropriate formula and have not mastered mathematical operations well. Hidayati (2020) regarding the measurement of the multiple representational ability of high school physics students based on modern test theory obtained the results that the students' physics multiple representation ability is best found in the mathematical component, next is the graphic component, the image component and the lowest is the verbal component. The mathematical component is the best because students think physics depends on counting and have often practiced math problems. Gender differences do not significantly affect the ability of multiple representations.

Furthermore, research conducted by Suwanto (2018) on the ability of students to solve physics problems shows that students' abilities in solving physics problems are still low because they have not been able to solve problems well. In addition, there is an increase in the mathematical representation ability of students with cooperative learning based on multiple intelligences rather than an increase in mathematical representation skills through ordinary learning or expository learning. Lestari and Mustadi (2019) conducted a study about the effect of what's another way method on creativity ability in problem solving and concluded that using what's another way method can improve students' ability to think creatively. This way of thinking allows students to obtain various solutions or problem solving strategies. It is very possible that one of these solutions or ideas is new or unique.

Ahmad et al. (2015) conducted a study to describe the results of the analysis of the consistency of the responses of class XI high school students to the multiple representation test in learning physics for linear motion topics and the results showed that the level of student consistency was different for each type of representation. Most of the students are at the level of consistent and inconsistent while those who are very consistent are only a small percentage. In previous research, no one has discussed the difficulties experienced by students in solving problems in the form of multiple representations. Therefore, the author wants to conduct research on "Analysis of Students' Difficulties in Solving Physics Problems with Multiple Representations using What's Another Way Method."

METHODS

The design of this study was descriptive qualitative research. The qualitative research is used to find out what causes errors made by students in solving physics problems with multiple representations on heat and temperature topics in a private Islamic senior high school in Banda Aceh. In this study, the source of data on students who want to be studied is done by purposive sampling, which is selected with certain considerations and purposes. The research subjects that will be sampled in this study are students of class XI MIA 2 in the private Islamic senior high school (1 Class 34 students). Given and considering time constraints, this study did not take all subjects. In this study only five students were taken in class XI MIA 2.

The instrument used in this research is the main instrument in the form of a researcher, and the auxiliary instrument in the form of five questions with multiple representations. The research instrument was developed by the researcher and then in consultation with the supervising lecturers who each held a doctorate and master's degree in Physics and Physics education. In determining the validity of the instrument, it is done by consulting the instrument made with experts. This research is a qualitative research so that the data analysis is non-statistical. In this study, the data was taken from the results of the tests carried out, then analyzed based on the what's another way method. Followed by interviews to find out more about the difficulties of students in solving physics problems with multiple representations using what's another way method.

RESULTS AND DISCUSSION

Based on analysis of the students' answer sheet and interview, it can be obtained the result as described below.

a. Question number 1

The question number 1 is presented in a pictures while the expected answers are in the form of mathematical equations. Therefore, based on students' answers to this question, students' errors can be categorized into the following table.

Table 1. Students' errors in question number 1

Student	Error	Description
Student I	Re-checking	The missing of units in mathematical calculations and final answer.
Student II	Re-checking	The missing of units in mathematical calculations.
Student III	Re-checking	The missing of units in mathematical calculations.
Student IV	Re-checking	Tidak adanya satuan pada perhitungan matematis.
Student V	Re-checking	The missing of units in mathematical calculations and final answer, also miscalculated.

Then in interview the students were given the question why they did not do re-checking?

"The re-checking step is the last thing to do, for example, when all the questions have been completed, I will re-check the completed answers if I still have enough time." (Student I)

"Re-checking is the last activity that I do and for the questions that you gave me, I just looked at it not too carefully because I also had less time." (Student II, III, IV and V)

b. Question number 2

The question number 2 is presented in a verbal while the expected answers are in the form of mathematical equations. Therefore, based on students' answers to this question, students' errors can be categorized into the following table.

Table 2. . Students' errors in question number 2

Student	Error	Description
Student I	<ul style="list-style-type: none"> • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • No graphics. • Mistake in writing index into symbol. • No other way.
Student II	<ul style="list-style-type: none"> • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • No graphics and miscalculation. • Mistake in writing index into symbol. • No other way
Student III	<ul style="list-style-type: none"> • Planning problem solving • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Not using any formula. • Not perform mathematical calculations. • Mistake in planning and problem solving. • No other way which is different from the previous method.
Student IV	<ul style="list-style-type: none"> • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Miscalculation. • Mistake in solving problems steps. • No other way.
Student V	<ul style="list-style-type: none"> • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Miscalculation. • Incorrect positive and negative sign. • Incorrect in writing index. • No other way.

Then in interview the students were given the question why don't they describe the problem in graphical form?

"I only solve the questions according to the instructions given, which is to calculate using mathematical equations." (Student I and II)

"The description only needs to be done in my mind or at least on an another sheet not on the answer sheet that will be submitted. (Student III)

"I'm not used to doing that" (Student IV and V)

The next question will be why don't they do re-checking the answers? The students give the same answer as they have been given in question number 1.

The next question will be why they can't give a different solution from the previous one?

"I only know one formula for this question." (Student I, II, and III)

"I have never been accustomed to solving problems in more than one way due to also I don't know another formula" (Student IV and V)

c. Question number 3

The question number 3 is presented in a verbal while the expected answers are in the form of mathematical equations. Therefore, based on students' answers to this question, students' errors can be categorized into the following table.

Table 3. Students' errors in question number 3

Student	Error	Description
Student I		<ul style="list-style-type: none"> • Miscalculating. • No units. • No other way.
Student II		<ul style="list-style-type: none"> • Miscalculating • No units. • No other way.
Student III	<ul style="list-style-type: none"> • Problem solving • Re-checking 	<ul style="list-style-type: none"> • Miscalculating. • Error in problem solving step. • No other way.
Student IV	<ul style="list-style-type: none"> • Reflection 	<ul style="list-style-type: none"> • Miscalculating • No units. • No other way.
Student V		<ul style="list-style-type: none"> • Not using any formula. • No problem solving. • No re-checking. • No other way

Then in interview the students were given the question why they don't give other way in solving problem for this question?

"I only know one formula for this question." (Student I, II, III, IV, and V)

d. Question number 4

The question number 4 is presented in a verbal while the expected answers are in the form of mathematical equations. Therefore, based on students' answers to this question, students' errors can be categorized into the following table.

Table 4. Students' errors in question number 4

Student	Error	Description
Student I	<ul style="list-style-type: none"> • Planning problem solving • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Not using any formula. • No problem solving. • No other way.
Student II	<ul style="list-style-type: none"> • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Miscalculating • No other way.
Student III	<ul style="list-style-type: none"> • Problem solving 	<ul style="list-style-type: none"> • No problem solving.

	<ul style="list-style-type: none"> • Re-checking • Reflection 	<ul style="list-style-type: none"> • No other way.
Student IV	<ul style="list-style-type: none"> • Planning problem solving • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Not using any formula. • No problem solving. • No other way.
Student V	<ul style="list-style-type: none"> • Planning problem solving • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Not using any formula. • No problem solving. • No other way

Then in interview the student I, IV and V were given the question why they can't plan problem solving for this question?

"I had no enough time to do that." (Student I and IV)

"I had no clue to use the correct formula for this question." (Student V)

Then the student II and III were given the question why was there no different problem solving from the previous one?

"I only know one formula for this question. I also have never been accustomed to solving problems in more than one way" (Student II and III)

e. Question number 5

The question number 5 is presented in a verbal while the expected answers are in the form of mathematical equations. Therefore, based on students' answers to this question, students' errors can be categorized into the following table.

Table 5. Students' errors in question number 5

Student	Error	Description
Student I	<ul style="list-style-type: none"> • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • No unit conversion. • Miscalculating. • No other way.
Student II	<ul style="list-style-type: none"> • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • No unit conversion. • Miscalculating. • No other way
Student III	<ul style="list-style-type: none"> • Planning problem solving • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Not using any formula. • No problem solving. • No other way.
Student IV	<ul style="list-style-type: none"> • Planning problem solving • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Not using any formula. • No problem solving. • No other way.

Student V	<ul style="list-style-type: none"> • Planning solving problem • Problem solving • Re-checking • Reflection 	<ul style="list-style-type: none"> • Not using any formula. • No problem solving. • No other way.
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Then in interview the student III, IV and V were given the question why they can't plan problem solving for this question?

"I had no enough time to do that." (Student III and IV)

"I had no clue to use the correct formula for this question." (Student V)

Then the student II and III were given the question why was there no different problem solving from the previous one?

"I only know one formula for this question. I also have never been accustomed to solving problems in more than one way" (Student II and III)

It can be concluded that students experienced errors in solving physics problems with multiple representations using what's another way method on questions number 2, 3, 4, and 5. Several previous studies also indicated the same thing. Study conducted by Hidayatulloh (2020) states that students experienced difficulties in solving verbal form questions and they can't apply the correct formulas. Followed by another research conducted by Sari (2019) stated that students were lacking in solving problems in verbal form. In the step of solving these problems, students often make mistakes, this is due to the factor of students being too hasty, imitating their friends, and not understanding what they should do. Therefore, this is in line with the results of the recap of the students' answer sheets. That students have difficulty with multiple-representation questions, especially on verbal representation questions with physical and mathematical representations (Hidayati et al., 2019).

Based on the results that have been obtained, it can be described what difficulties students experience, these difficulties are grouped into indicators of difficulty as follow.

a. Difficulty Level I (Understanding the Problem)

At this level, all students have no problem at all. The students have been able to write correctly what was known and asked according to the description of the questions given. This has been stated by Lestari and Mustadi (2019) that in the study it was very rare to find students who had difficulty at level I. This is because students have been accustomed to working on previous questions so that it has become a habit. Therefore, understanding the problem given is no longer a problem.

b. Difficulty Level II (Planning Problem Solving)

Some students face difficulty at this level. This was triggered by the confusion of students in using the formula. Therefore, students prefer to solve other questions, this is reinforced by interviews that have been conducted. In a previous study conducted by Novriani and Surya (2017) the study showed that 51.0% of students had difficulties in planning to solve this problem. This percentage shows a higher number when compared to the difficulty level I in the study.

c. Difficulty Level III (Solving Problems)

At difficulty level III there are some students who are still having difficulties. This is showed by the inability of students to solve the problems given. For example, in question number two, which provides an opportunity for students to be able to describe the situation according to the description

of the problem which refers to questions in the form of multiple representations, but none of the students can do this. Therefore, all students have difficulty at level III difficulty, especially for questions which in solving require to describe. However, for questions that only require mathematical equations, students are able even though there are often errors in calculations, unit conversions, and there are still many other small errors. Only one out of five students can solve problem number 2 correctly and the solution only uses mathematical equations (Ulfatun et al., 2019).

Other students still make mistakes so that the final result is incorrect. This is directly proportional to the research conducted by Suwanto (2018) that 22.80% of students still made mistakes. This percentage shows a high number because there are some students who can't solve the questions. Then this is supported by research Ramadhani (2020) which states that students have difficulty in solving problems due to lack of accuracy in entering values in the mathematical equation.

d. Difficulty Level IV (Re-checking)

All students experience difficulty at this level due to the students not checking and re-checking the answers and previous steps. This is reinforced by the results of interviews with students. They said that checked their answers only at last minute. Therefore, this triggers students not to be able to correct the steps that are indeed wrong, while other students say that they are sure of what they have answered so there is no need to re-check. This is directly proportional to the research conducted by Sari (2019). In this study, it was stated that students had difficulties because students still made mistakes in the previous step. This is also in line with research conducted by Hidayati (2019). It is stated that students rarely review and examine the steps involved in working on questions. Students also very rarely check whether units have been used in these stages, as well as unit conversions that students still fail to do (Supriyanto, 2020).

e. Difficulty Level V (Reflection)

At difficulty level V (reflection/what's another way) students are required to make a solution in more than one way. However, all students are failed to do this. All students are only able to solve in more than one way on question number one, the rest of the students can't solve more than one way. In interview, students said they still had difficulty with using the formulas and still focused on only one formula.

At the time of the interview they said that in the physics subject itself they were never invited or ordered by the teacher to do more solutions in one way. However, in mathematics, they said they had been taught. If students are taught to solve problems in more than one way, then this will improve students' creative thinking because the solutions vary. The research conducted by Suryaningsih (2019) is in line with what has been stated above. In the study it was said that even students who were categorized as good had not been able to carry out this reflection step correctly. Likewise for students categorized as less.

From the explanation above, the difficulties of students can be categorized into indicators of difficulty in applying principles and difficulties in solving verbal problems. In the difficulty of applying the principle, it can be proven by the three students who are only able to solve 3 questions out of 5 questions given, while the other questions students have not been able to solve them. One other student was able to work on all the questions, but only one correct answer was obtained, while the other questions were incorrect. Next is followed by one student who can only solve 4 questions while one question can't be solved. For the results obtained by these students there are 2 questions that get the correct answer.

Next, students can be categorized in difficulty in solving verbal problems. This is showed by 4 out of 5 students who can't correctly solve questions number 2 and the fifth students can't correctly solve

questions number 3, 4, and 5. Therefore, it can be said that students can be grouped into indicators of difficulty in applying principles and solve verbal problems.

Therefore, the factors that cause students' difficulties in solving physics problems with multiple representations using the what's another way method on heat and temperature topics are using of formulas that are still difficult to understand, low mathematical calculations skill, students still can't convert units correctly (Sari et al., 2019). Students are still confusing in describing the problems given due to lack of practice in solving problems, while external factors that play a major role are the learning process. During the current COVID situation, schools reduce time in the learning process (Ramadhani & Tanjung, 2020).

CONCLUSION

Based on data analysis, it can be concluded that students' difficulties in solving physics problems using multiple representations using what's another way method on heat and temperature topics in a private islamic senior high school located in Banda Aceh are difficulty level II, III, IV, and V. At difficulty level I all students do not experience any difficulty because they can understand the problem given. Students' difficulties can be grouped into difficulty in applying principles and difficulty in solving verbal problems. Factors cause students' difficulties are error in using the formulas, error in mathematical calculations, error in converting units, error in writing symbols, and not re-checking. The weakness in this study is the small number of subjects, so for further research it is recommended to expand the research method, use more subjects and use HOTS-type test questions to analyze students' difficulties.

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