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DIFFICULTY ANALYSIS OF STUDENTS IN SOLVING PHYSICS PROBLEMS IN THE FORM OF GRAPHICS IN STRAIGHT MOTION MATERIAL

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ABSTRACT

This study aims to determine the difficulties of students in solving physics problems in the form of graphs and profiles of students' difficulties in the material of straight motion. This research method is qualitative research. The population in this study were students of class X Science at the state senior high school 3 Sungai Penuh who had studied the material of straight motion. The sampling technique used is Simple Random Sampling. The data collection method was diagnostic tests and was supported by interview results. The analysis was carried out using descriptive percentages. The results show that students' ability to solve physical problems with graphs has a low percentage of interpretation ability of 40.61%; interpolation ability of 30.6%; extrapolation ability of 30.46%; and the ability to transform by 39.65%. The student difficulty profile in this study based on the minimum criteria of mastery learning was still having difficulty for all indicators with an average of weak categories. The student's difficulty profile on the material profile is still having difficulties for all sub-materials with an average of weak categories. In the difficulty profile based on prerequisite knowledge, the proportion of students who have difficulty in determining the area of flat shapes is 51.72% including the medium category, the percentage of students' difficulty in arithmetic operations is 66.05% including the high category, the proportion of students' difficulties in linear equations is 72.41% included in the high category.

Keywords: *Difficulty Learning; Graphic; Problem Solving; Straight Motion.*

I. INTRODUCTION

Physics as a science that is close to natural phenomena, can be described in various forms of representation. One of them is a graphical representation. In this information age, students' ability to understand graphs is very important. One of the important goals behind understanding graphical representations is that graphs can provide easy-to-understand quantitative data. In addition, the data presented in the graph is easier to understand than the data presented in the form of descriptive sentences. The ability to analyze graphs in the form of verbal and nonverbal sentences is needed by students, especially in the field of physics. The ability to analyze the data in question includes the ability to make graphs, express the physical meaning of graphs, make predictions and interpretations and perform graph transformations [1]. Physics learning objectives are said to be achieved if students have excelled in understanding various concepts in physics that are used to solve physics problems in everyday life [2]. The results showed that the students' ability to solve physics problems in the form of graphs had a low percentage for the ability to interpret graphs of 48.30%, interpolation skills of 34.36%, extrapolation abilities of 53.01% and transformation abilities of 48.61% [3]. The results of other studies also show that students still have difficulty in interpreting graphs, transforming graphs and also students experiencing difficulties in distinguishing between uniform straight motion and uniformly changing straight motion and difficulties in understanding concepts [4].

Therefore, students need fast and appropriate help to immediately solve the problems they face. In order for the assistance provided to be effective, the teacher must first understand the location of the difficulties faced by students. The teacher's encouragement to overcome student difficulties is one component in the development of the teaching profession. It is based on the principle of diagnosis in the context of problem solving. The problem of student learning difficulties can be found by giving a diagnostic test. Diagnostic tests need to be done to find out the weaknesses and strengths of students in mastering a part or the whole topic or subject matter. With diagnostic tests, learning difficulties that arise can be identified so that students' failures and successes can be identified. The purpose of this study was to determine the students' ability to solve physics problems in the form of graphs and the profile of difficulties experienced by students.

At the stage of solving physics problems in the form of graphs, the ability to understand graphs appears that must exist. The ability to understand graphs is the ability to make graphs and read graphs, the ability to make predictions using graphs and the skills to transform graphs. some errors that often occur when describing kinematics graphs, (1) students perceive graphs as literal images of a situation, (2) students still do not understand the meaning of the slope of the line on the graph, and (3) students still have difficulty distinguishing distance graphs from time and graphs speed against time.

Problem solving as a key process in learning, especially in areas such as science and mathematics [5]. Errors and obstacles that often arise in solving, as follows: (1) Inaccuracy in reading; (2) Inaccuracy in thinking; (3) Weaknesses in problem analysis; and (4) Lack of perseverance [6]. Based on this, there are many diagnostic steps that teachers can take to determine the location of students' difficulties, namely the well-known Wiener and Senf procedures, namely (1) conducting classroom observations to detect student deviant behavior in class; (2) For students, especially those who have learning difficulties by testing their eyesight and hearing; (3) Interviews with parents or guardians of students to understand family problems that may cause learning difficulties; (4) conducting diagnostic tests in specific skill areas to identify students' actual learning difficulties; (5) Conduct intelligence tests (IQ), especially for students who may have learning difficulties. At this stage, the researcher decided to use a diagnostic test to identify students' difficulties [7].

To improve the quality of education there are three things that must be evaluated [8]. The three elements are input, school environment and results. So far, educational institutions only evaluate students in the cognitive domain, while the affective domain is rarely considered, even though everyone considers it important, but it is difficult to measure. In general, the objectives of the assessment are: (a) Collecting data and information as evidence of the level of development or progress of students after participating in the learning process within a certain period of time. (b) Determine the level of effectiveness of the teaching process carried out by teachers and students. The overall purpose of the assessment is to obtain evidence that shows the level of student performance against the goals or abilities that have been set after they have taken the learning process within a certain period of time.

In education, evaluation is done through tests. The test is a comprehensive, systematic and objective evaluation procedure, the results of which can be used as a basis for decision making in the educational process. A test can be a series of questions or instructions to measure a person's knowledge, abilities, intelligence, talents or other abilities [9]. To find the difficulties faced by students and plan ways to solve the problems or difficulties encountered, diagnostic tests are used. In general, the steps for developing a diagnostic test are identifying basic competencies that are not met, identifying possible sources of problems, determining the appropriate form and number of questions, compiling a grid, writing questions, reviewing questions, and developing evaluation criteria. The characteristics of diagnostic tests are as follows: (1) made to detect learning difficulties in students, in this way the composition and recorded answers must have a diagnostic function, (2) made based on examining the source of errors or difficulties that may arise. be the cause of student problems (diseases), (3) and the use of questions in the form of supply responses (in the form of descriptions or short answers) with the aim of capturing overall information. If there is a specific reason for using the selected response form (such as a multiple choice form), a full explanation of why the answer was selected should be included to minimize guesswork and identify the nature of the error or problem [10].

While the graph is a form of representation that can be used to summarize data, process and interpret information [11]. Graphs are very important in physics, because they are a visual aid for establishing the relationship between two variables. To assist in the interpretation of experimental results during the experiment, and other calculation aids. The importance of graphics on the subject of straight motion is that several explanations of the motion of the material are presented with graphs. In order for students to be able to understand the physical aspects of graphs depicted from straight motion material, students must have the ability to interpret graphs, predict graphs and transform graphs. Therefore, in order for students to have the ability to analyze graphs well, they must

be trained how to interpret graphs, predict and transform graphs on straight motion material with several graphic models. Some teachers in classroom learning have used graphics to explain concepts, but have not explicitly taught this form of visual communication [12]. The weak ability to perform graphic literacy of students will have an impact on understanding the concept of straight motion. Whereas students are required to be proficient in interpreting graphics and able to convey to others (students) both in oral and written form. Graphs are visual aids that reveal the relationship between two factors, for example, when looking at the relationship between two factors in a table can be difficult, but when presented in a graph, the relationship between factors can be seen immediately. In addition, graphs in the experiment to determine which measuring points are still needed and whether strange errors are not made in the experiment.

II. METHOD

The type of research used is descriptive research with a qualitative approach because in this study it describes the current situation in a factual manner that is needed to find a way out. Qualitative research methods are often called naturalistic research methods because the research is carried out in natural conditions (natural settings). The population in this study were students of class X science at the state senior high school 3 Sungai Penuh who had studied the material for straight motion. The sampling technique used in this study is Simple Random Sampling, the reason why it is called simple (simple) is because the sample of population members is chosen at random and does not take into account the strata in the population [13]. From this technique, one trial class was selected, namely X Science 2 and one class as the research sample, namely class X Science 1.

The data collection method used the test method and the interview method. This test method uses a diagnostic test that is used to determine the problem-solving ability in the form of graphs for straight motion material and the student's difficulty profile. The test result data is in the form of the problem-solving ability of the motion concept in the form of a graph, while the interview data is in the form of reconfirming the written test process to find out more about the way or pattern of thinking of the research subject towards the problem-solving ability of the motion concept in the form of a graph from the test given.

The data analysis technique used descriptive percentages to determine the level of students' ability to work on graphical questions. The formula for percentage description analysis is by dividing the student's average score by the student's maximum score multiplied by one hundred percent. The criteria for the ability to solve problems in graphical form can be seen with the very good category being at a percentage of 78% to 100%, the good category being at a percentage of 66% to 79%, the moderate category being at a percentage of 56% to 65% and the less category being at a small percentage. or equal to 55% [14].

Analysis of student difficulties is based on the minimum criteria of mastery learning, material profiles, knowledge prerequisites, and stages of problem solving. For analysis based on the minimum learning completeness criteria and material profile using the percentage of student scores, the formula is the difficulty value of all students divided by the maximum difficulty value of all students multiplied by one hundred percent.

The provisions of the difficulty category are based on the achievement of the minimum criteria of mastery learning is 70%, students have difficulty if: % score ≤ 30% = strong category and % score > 30% = weak category. For difficulty analysis based on prerequisite knowledge and problem-solving stages use the same formula but do not use scores but frequency. The provisions of the student difficulty category are the very high category at the percentage of 80% to 100%, the high category is at the percentage of 66% to 79%, the medium category is at the percentage of 40% to 65% and the low category is at the percentage of 0% to 39% [15]. To support the results of the analysis of the student problem solving difficulty profile, it is added with the results of interviews that have been conducted to describe students' difficulties in solving physics problems in the form of graphs.

III. RESULTS AND DISCUSSION

A. Graphical Problem-Solving Ability

Problem solving ability is the ability of students to utilize existing information to find out what to do in certain situations [16]. Problem-solving skills in the form of graphs measured here are problem-solving abilities related to the ability to interpret graphs, predict graphs such as interpolation or extrapolation and transformation of a graph. Data retrieval is done by using a diagnostic test that is arranged to measure students' ability to solve problems in the form of graphs. Data regarding problem solving abilities in the form of graphs is shown in Figure 1 below.

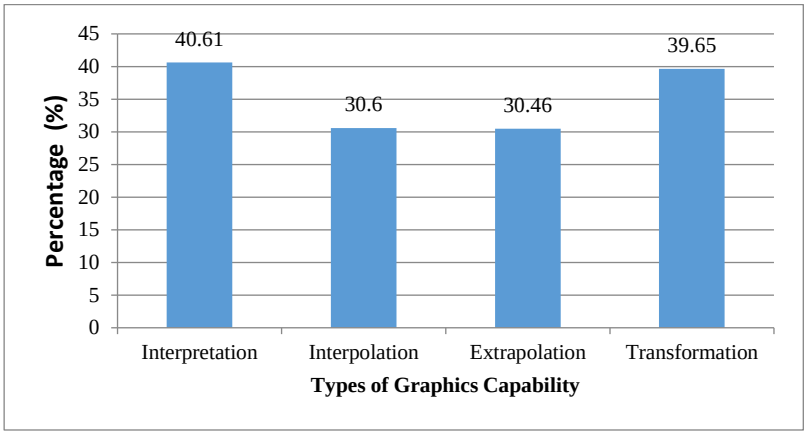

Fig. 1. Graphical Problem Solving Ability

The results of the study of the graph interpretation ability shown in Figure 1 explain that the students' ability in graph interpretation is in the category that does not match the criteria shown in Table 1. The ability to interpret this graph includes several indicators, namely calculating the gradient, knowing what magnitude the gradient is showing, and being able to retrieve information from the graph. In the ability to interpret graphs, students are able to calculate the gradient on the graph, but do not know what magnitude is meant by the gradient. Based on this finding, it can be seen that the problem-solving ability in interpreting the graph is 40.61%. This shows that there are still many students who have difficulty in solving problems in the form of graphs, especially on indicators of graph interpretation ability. Many students who succeeded in solving problems mathematically but could not solve them physically and in terms of understanding the meaning of gradient graphs in the context of physics were still very weak compared to the context of mathematics [17].

In the aspect of the ability to predict the measured indicators, namely estimating based on graphs, both conditions inside the graph or interpolation or conditions outside the graph or extrapolation. In accordance with the results shown in Figure 1, the ability to predict conditions in the graph or interpolation is included in the category that does not match the criteria shown in Table 1. In the aspect of the ability to predict conditions outside the graph or extrapolation, the percentage is not much different from the students' interpolation ability according to the research results obtained, which is shown in Figure 1 that is, for the extrapolation ability, it is categorized as less in accordance with the criteria shown in Table 1. The average percentage of the ability to predict graphs both interpolated and extrapolated is 30.52%. In questions that measure predictive ability, most students tend to guess the answer.

Transformation ability is an ability that is categorized as less in accordance with the criteria shown in Table 1 with a percentage of 39.65%. This shows that the graph is still low and this ability is classified as having a fairly high difficulty among the others [18]. An indicator of this ability is to understand the physical meaning of a graph. In terms of understanding the meaning of a graph, it requires deep understanding and good cognitive ability to explain the meaning of the graph in question.

In this transformation ability study, students were asked to explain from a graph, including uniform linear motion (GLB) and uniformly changing linear motion (GLBB). From the results of students' answers, most students were only able to answer that the graph included uniformly straight motion or uniformly changing straight motion without explaining the reason and without explaining how the speed and acceleration occurred from the motion.

B. Student Difficulty Profile

In this study, in addition to the ability to solve physics problems in the form of graphs, the profile of students' difficulties was also analyzed. The student difficulty profile analyzed here is based on: (1) Minimum Criteria of Mastery Learning achievement; (2) prerequisite knowledge; (3) material profile; (4) misconceptions; and (5) the stages of problem solving. Data analysis was carried out based on the results of diagnostic tests that had been carried out and supported by the results of interviews with students.

1. Analysis of Student Difficulty Profile Based on Minimum Criteria of Mastery Learning

Mastery Criteria Minimum learning is used as a reference to state students' mastery in participating in a lesson. The minimum completeness criteria set at the State Senior High School 3 Sungai Penuh is 70%. Students have no difficulty if the percentage is ≤ 30%.

The results of the research on student difficulty profiles based on Minimum Criteria of Mastery Learning achievement are shown in Figure 2 below.

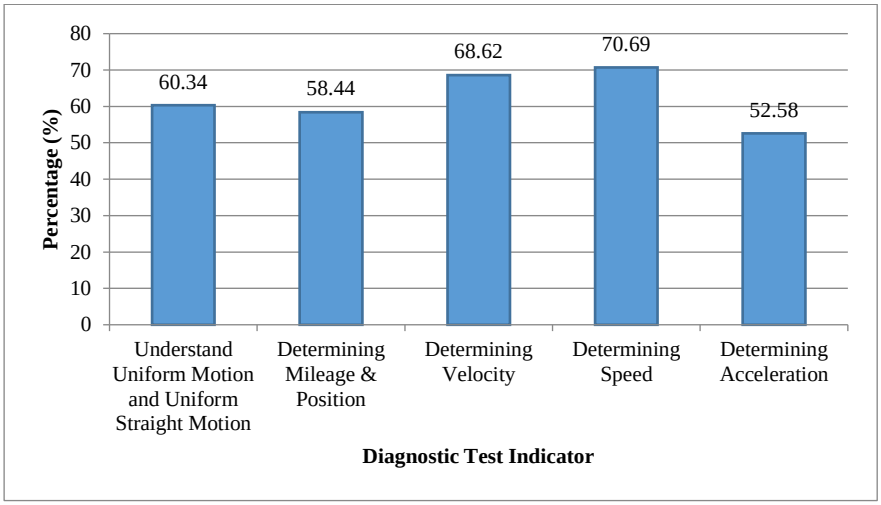

Fig.2. Student Difficulty Profile Based on Minimum Criteria of Mastery Learning

In the study of student difficulty profiles based on the Minimum Criteria of Mastery Learning, the average percentage for all indicators was 62.13%. This value is greater than the Minimum Criteria of Mastery Learning for students of State Senior High School 3 Sungai Penuh, which must be lower than 30%. This means that in general students are still not finished and are still experiencing difficulties. This can be seen from the students' answers to questions that determine the graph including Uniform Motion or Uniform Straight Motion and what the speed and acceleration are, most students are only able to mention the type of graph without explaining the reason and what the speed and acceleration are on the graph. Students conceptions of the concept of uniform straight motion, he found that generally students have wrong conceptions. This misconception is because students assume that if a vehicle moves in a constant direction and speed for 10 minutes, it is a uniformly changing straight motion [19].

2. Analysis of Student Difficulty Profile Based on Prerequisite Knowledge

In general, in the classroom students will usually find it difficult to start participating in the learning that is carried out because they do not have the prerequisite knowledge. In this study, using a diagnostic test, there are three prerequisite knowledge that students must have, namely knowing the formula for the area of a flat shape, mastering arithmetic operations and mastering simple linear equations. The results of the research on student difficulty profiles based on mastery of prerequisite knowledge are shown in Figure 3 below.

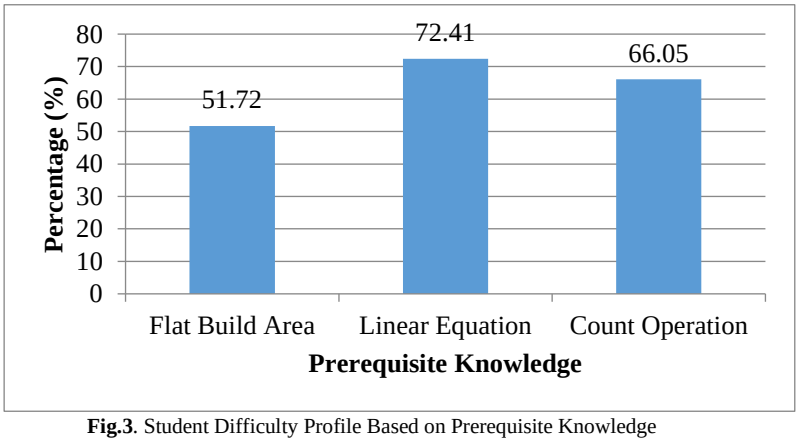

Fig.3. Student Difficulty Profile Based on Prerequisite Knowledge

Based on the results of the analysis obtained as shown in Figure 3 for the mastery of the area of flat shapes, the percentage value is 51.72% with a moderate level of difficulty. Mastery of the area of the plane is determined in determining the distance traveled from a graph of the relationship of speed to time. From the students' answers, most students did not know the formula for the area of a flat shape, this was supported by the results of interviews where students said they forgot or did not know the formula for finding the area of a flat shape.

Mastery of arithmetic operation prerequisite knowledge obtained the percentage of difficulty 66.05% as shown in Figure 3. This prerequisite knowledge is included in the high category. One of the causes of student learning difficulties is difficulty in mathematical calculations and other causes are understanding concepts and converting units [20]. For the mastery of linear equation prerequisites, the percentage is 72.41% mastery of this prerequisite has a higher difficulty than the others and is included in the high category. Mastery of simple linear equations is used to help predict based on graphs both interpolated and extrapolated.

3. Analysis of Student Difficulties on Material Profile

To determine the percentage of students difficulties in mastering a material for each sub-material, a student difficulty profile is used based on the material profile. The sub-materials of this research material are distance and displacement; speed and speed; acceleration; uniform straight motion; and uniform motion in a straight line. This analysis also uses the minimum learning completeness criteria as the limit of student mastery. The sub-materials of this research material are distance and displacement; velocity and speed; acceleration; uniform straight motion; and uniform linear motion. This analysis also uses Minimum Criteria of Mastery Learning as the limit of student mastery.The results of the research on students' difficulties with the material profile are shown in Figure 4 below.

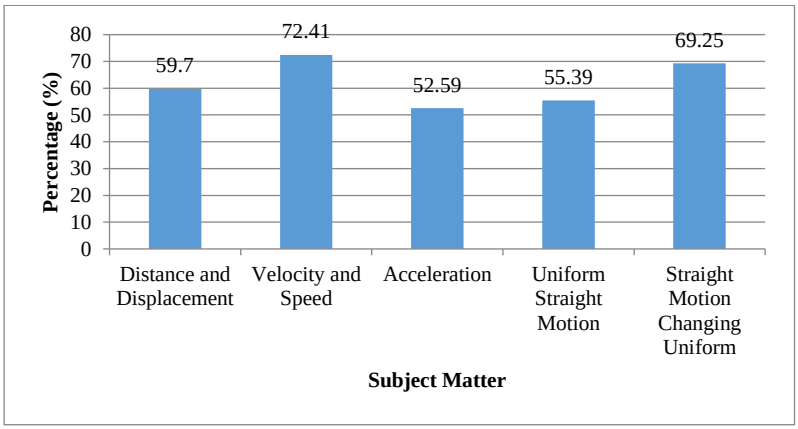

Fig.4. Student Difficulties on Material Profile

Of the five sub-materials in this straight motion material, the percentage of student difficulty profiles in the distance and displacement sub-material is 59.7%, velocity and speed is 72.41%, acceleration is 52.59%, uniform straight motion is 55.39% and straight motion changes uniformly by 69.25%. From these results, the speed and speed sub-materials have the highest percentage of difficulty compared to the other sub-material percentages as shown in Figure 4.

In general, the difficulty in the distance and displacement sub-material is because students have difficulty in predicting the distance traveled based on the existing graph. The difficulty in the acceleration sub material is generally because students do not understand the concept of acceleration. Students have the most difficulty in mastering the velocity and speed sub-materials. This is because students are still confused between the concepts of speed and speed and also students have difficulty finding the value of s (distance) and also the displacement on the graph. This is also supported by the results of interviews where students say that speed and speed are the same.

4. Student Difficulty Analysis Based on Problem Solving Stages

Analysis of student difficulties based on the stages of problem solving used, namely the stages of problem solving according to Polya. The results of the research on student difficulties based on the stages of problem solving are shown in Figure 5 below.

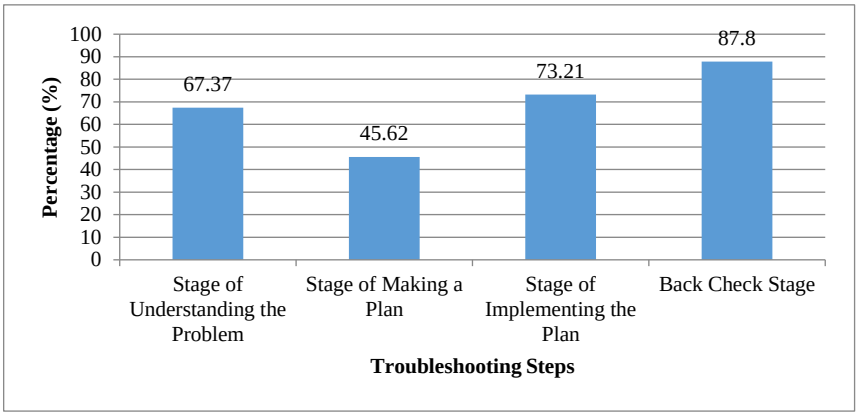

Fig.5. Student Difficulty Profile Based on Problem Solving Stages

In general, students experience difficulties at the re-checking stage, based on the results of the difficulty analysis shown in Figure 5, the average percentage of students who experience difficulties at the re-checking stage is 87.8%, this is included in the very high category. The percentage of students at the stage of understanding the problem, which is 67.37%, is included in the high category. Furthermore, for the percentage of students who have difficulty at the stage of making plans, which is 45.62%, it is included in the medium category. And for the stage of implementing the plan the percentage of students who have difficulty is 73.21% including the high category.

The difficulties experienced by students at the stage of understanding the problem are that students do not write down things that are known and asked in the questions, and some students write things that are known and asked but are incomplete. At the planning stage, most students are confused and do not know the exact formulas that must be used and students have difficulty in applying the concepts they have learned. At the stage of implementing the plan, students have difficulty in the arithmetic operation process and have difficulty entering known data into existing formulas. At the review stage, it has the highest percentage among the others, based on the results of interviews, students who do not review their answers because they feel confident in their answers and also students reason that they have run out or lack of time to review.

Based on the results of the analysis of problem-solving abilities and profiles of students' difficulties in solving problems in the form of graphs on straight motion material, basically students are still having difficulties. This may be due to the fact that when learning in class the teacher uses graphics to explain concepts, but does not explicitly teach how this form of visual communication is. So that the results of the study were found for the problem-solving ability and the profile of students' difficulties in solving problems in the form of graphs were at a high percentage. The weak ability of students to solve physics problems in the form of graphs in straight motion material has an impact on understanding the concept of straight motion. Whereas students are required to be proficient in interpreting, predicting and transforming graphs and being able to convey to others (students) both in oral and written form. The solution that can be given in overcoming this is the need to familiarize students in dealing with problems in the form of graphics, especially straight motion material, such as with students presenting praktkum data in graph form, in this case the teacher plays an important role in overcoming the difficulties experienced by students.

IV. CONCLUSION

Based on the results of data analysis, 2 conclusions can be drawn. Students ability to solve physics problems in the form of graphs has a low percentage for the ability to interpret graphs of 40.61%; interpolation ability of 30.6%; extrapolation ability of 30.46%; and the ability to transform by 39.65%. The difficulty profile of students in this study based on the achievement of the Minimum Criteria of Mastery Learning is still experiencing difficulties for all indicators with an average of weak categories. The student's difficulty profile on the material profile is still having difficulties for all sub-materials with an average of weak categories. In the profile of student difficulty based on prerequisite knowledge, the percentage of students who have difficulty in determining the area of the flat shape is 51.72% including the medium category, the percentage of student difficulty in arithmetic operations is 66.05% including the high category, the percentage of student difficulty in linear equations is 72.41 % including high category. For the problem-solving stage with the percentage of difficulty at the stage of understanding the problem, which is 67.37% including the high category, the planning stage is 45.62% including the medium category, the stage of implementing the plan is 73.21% including the high category, and the re-checking stage is 87 ,8% belongs to the very high category.

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