Lensa : Jurnal Kependidikan Fisika
Penerbit: Program Studi Pendidikan Fisika IKIP Mataram
e-mail: lensafisika@gmail.com
url: http://ojs.ikipmataram.ac.id/index.php/Lensa/index

June 2020. Vol. 8, No. 1
e-ISSN: 2686-0937
p-ISSN: 2338-4417
pp. 9-16

Analysis of the Ability of Junior High School Students to Solve the Physics Problems in Various Forms of Problem Representations

I Wayan Gede Sutirta[1*)], Muslimin[1)], Marungkil Pasaribu[1)]

[1)] Science Education Study Program, Postgraduate-UNTAD, Indonesia

**Corresponding Author Email: gedesutirta@gmail.com*

Article History
Received: March 2020
Accepted: April 2020
Published: June 2020

Key Words
Solve physics problems; problem representation

Abstract
This research is a descriptive study with a qualitative approach, which aims to describe the ability of junior high school students to solve physics problems in various forms of problem representation. The subjects in this study were the IX grade junior high school students in six Palu city schools. Respondents for interviews in the study amounted to 4 people for each form of problem representation, with the criteria of students who answered right, students who answered ± 50% correct, students who answered incorrectly, and who did not answer. The instrument used was a test of problem solving skills and interviews. The data obtained were analyzed qualitatively including data reduction, presenting data and verification while descriptive analysis was performed by calculating the total score, calculating the percentage and categorizing problem solving abilities. The results obtained by the average ability of junior high school students to solve physics problems in various forms of problem representation 21.86% (less category), with the percentage of each form of representation ie verbal representation 36.09% (less category), image/picture representation 23.78% (less category), diagram representation 19.47% (poor category) and graphic representation 8.10% (poor category).

How to cite this article? Sutirta, I., Muslimin, M., & Pasaribu, M. (2020). Analysis of the Ability of Junior High School Students to Solve the Physics Problems in Various Forms of Problem Representations. *Lensa: Jurnal Kependidikan Fisika, 8*(1), 9-16. doi:https://doi.org/10.33394/j-lkf.v8i1.2682

INTRODUCTION

Physics studies about natural phenomena formed by the interaction of various physical quantities. In forming natural phenomena, one or more physical quantities are interconnected and interact with each other, this makes it difficult for students to understand them (Suhandi, 2012). Other difficulties in learning physics are caused, inter alia, by the different things inherent in the presentation of physics lessons. These things are practicum sessions, formulas and calculations, graphs, diagrams, pictures, and concepts (Nina & Heru, 2018). To understand the various relationships and interactions between physical quantities that form natural phenomena and other difficulties in learning physics requires the ability to solve problems.

One of the skills students are expected to have in the 2013 curriculum is problem solving skills. But so far the implementation of the 2013 curriculum has not been able to improve the ability of Palu city junior high school students to solve physics problems. Though the ability to solve problems is an important skill in science, especially in physics. Because these skills provide opportunities for the application of scientific knowledge. From a pedagogical perspective, problem solving can be used as a tool to assess student learning (Haratua & Judyanto, 2016) and be one aspect in measuring improvement in student learning outcomes in order to realize quality learning (Erni et al., 2018).

One indicator of the low ability of junior high school students in the city of Palu in solving physics problems, can be seen from the low national exam results of natural science subjects obtained by students in the last three years. From a total score of 100, in 2017 the average national exam score was 48.93, in 2018 the average score was 44.43 and in 2019 the average score was 44.77. Physics problems are presented in various forms of representation such as verbal forms, diagrams, pictures and graphs. Solving physics problems for different formats of representation requires different steps. However, what happens so far is that students often use mathematical equations directly because they do not have enough steps or procedures to determine the best solution, as a result, most students fail to find solutions to these problems (Haratua & Judyanto, 2016). According to Docktor & Mastre (2014) problem solving can be explained as exploration using multi representations. The use of richer representations by increasing variations in external representations that affect cognitive configurations provides more effective results. It can be stated that many representations will facilitate the transformation of information from one form to another (Mehmet & Ayesegul, 2014).

Representation in learning physics can be used to minimize student difficulties in learning. As stated, a successful problem solving process depends on the skill of representing problems such as constructing and using mathematical representations, words, graphs, diagrams, pictures, tables, equations, and symbol manipulation (Laras et al., 2015). Several research results have shown the ability of students to solve physical problems in various forms of problem representation, including Ana et al (2019) states that diagrams can help students in problem solving but the effect is statistically less significant. Zhongzhou et al (2017) stated that for students with low and middle skills overall students who were correct for problems using diagrams were about 5% higher than conditions without diagrams, and the difference was statistically significant. However, for high-ability students, the difference in overall performance is smaller (<3%), and statistically insignificant the results of the study also show that for many physical problems the benefits of diagrams are very small.

Research on the benefits of using graphs also shows that students are still having trouble solving problems in the form of graphs. Ana et al (2018) stated students had difficulty in understanding the slope of the graph and the area contained under the graph. In line with Anton et al (2016) which states the ability of students to solve problems in the form of graphs is relatively low. In a different study, Ana et al (2017) stated that graphical representations help process data and reduce data usage in students, so students who have graphic data representations spend less time understanding data. From some research results show that the presentation of problems using diagrams / graphs and graphs does not have a significant impact on students' ability to solve problems, whereas on the other hand various problem solving strategies have been proposed and carried out, including problem solving through some form of diagramming drawings. For example, the PER group at the University of Minnesota suggests sketching a picture in the first step of understanding and visualizing a problem. Next step describes the problem, students are asked to draw a diagram or graph that helps understand the problem (Ana et al., 2019). Therefore it is necessary to conduct research to obtain a picture of students' ability to solve problems in each different form of problem representation.

Some of the research that has been done only focuses on the role of diagrams, pictures and graphs on students' ability to solve physical problems, not many studies that illustrate the ability of students to solve physics problems in various forms of problem representation, especially if examined based on Polya's problem solving indicators. So this paper aims to describe the ability of students to solve physics problems in various forms of problem representation.

METHOD

This study uses a descriptive research method with a qualitative approach that aims to describe the ability of junior high school students to solve physics problems in various forms of problem representation. The subjects in this study were the IX grade junior high school students in six Palu city schools. Respondents for interviews in the study amounted to 4 people for each form of problem representation, with the criteria of students who answered right, students who answered ± 50% correct, students who answered incorrectly, and who did not answer. The instrument used was a test of problem solving skills and interviews.

Qualitative descriptive analysis is carried out by stages determining the percentage of the ability to solve physical problems for each form of problem representation based on the problem solving indicators from Polya, calculated by the formula:

$$\text{Persentage} = \frac{\text{number of acquisition scores}}{maximum\ score} x100\%$$

Then the students' ability in solving physics problems is categorized into various forms of problem representation, as in Table 1.

Table 1. Problem solving ability category

Range perentage	Category
81 – 100	Very good
61 – 80	Good
41 – 60	Enought
21 – 40	Less
0 - 20	Poor

(Suci et al., 2017)

Based on the results of the analysis of the ability to solve the problem then interviews were conducted.

RESULTS AND DISCUSSION

The ability of junior high school students to solve physics problems under study is the ability to solve physical problems in the form of verbal representations, diagrams, pictures and graphics. The test results are processed based on Polya's problem solving indicators. The results of the test can be seen in Figure 1.

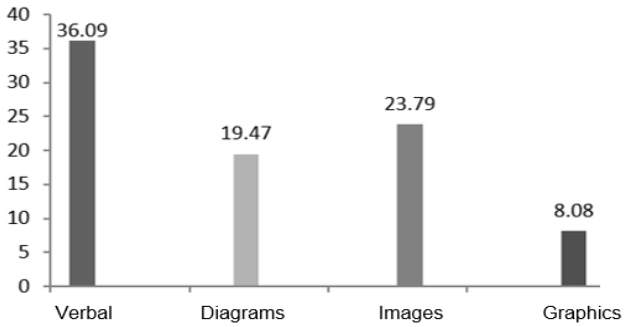

Figure 1. Verbal representations, diagrams, images and graphics

The results of tests on the ability of junior high school students to solve physics problems in various forms of problem representation obtained an average percentage of 21.86 (in the less category). From the four forms of problem representation, the highest ability to solve problems in a row is the ability to solve physical problems in questions in the form of verbal and image representations of 39.09% and 23.79%, followed by the form

of diagram and graph representations of 19, 45% and 8.10%. The ability of junior high school students to solve physical problems in the form of verbal representations is higher than the ability to solve problems in the form of representations of images, diagrams and graphs because students are accustomed to solving problems in the form of verbal representations. Based on the results of interviews, in learning activities students are more often confronted with problems in the form of verbal representations compared to the representations of images, diagrams and graphs. This makes students accustomed to solving problems in the form of verbal representations. In line with Wahyuddin (2016) who revealed the ability of verbal representation in teaching activities determines one's success in learning. Because with high verbal skills one can understand ideas and concepts and can also easily think and solve problems.

The results of tests on the ability of junior high school students to solve physical problems in the form of verbal representation based on Polya indicators can be seen in Figure 2.

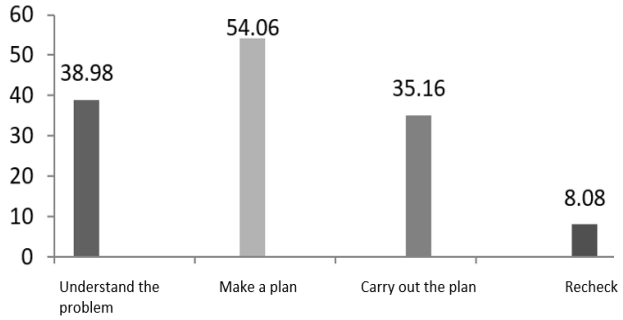

Figure 2. Polya problem solving on verbal representation

The ability of junior high school students to solve physical problems in the form of verbal representations obtained an average percentage of 39.06 (in the less category). Based on the results of the interview one of the factors causing students difficulty in solving verbal problems because the problems presented in verbal form are still abstract, so it requires the ability to concretize problems before solving them mathematically. Students who make representation of drawings / diagrams first before completing to a mathematical equation can solve problems well. These results are in line with the results of Haratua & Judyanto's research (2016) which found that many students succeeded in solving problems that were preceded by a visualization process using sketches or diagrams, rather than students who were directly on mathematical solutions. While based on the polya indicator students have the highest difficulty at the stage of checking back with an average percentage of 8.08% (poor category). These results are consistent with research of Anton et al (2016). Based on the results of the interview the low ability to recheck answers due to lack of training in the learning process of students how to recheck answers. In learning activities, teachers are more dominant using the final assessment approach of learning (assessment of learning) and assessment of the learning process (assessment for learning) which is focused only on learning outcomes, rather than using the assessment approach as learning (assessment as learning).

The results of tests on the ability of junior high school students to solve physics problems in the form of diagrammatic representation based on Polya's indicators can be seen in Figure 3.

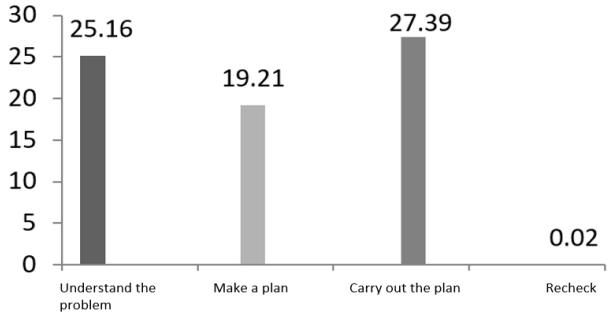

Figure 3. Polya problem solving on diagrams representation

The ability of junior high school students to solve physics problems in the form of diagram representation is in the poor category with an average percentage of 19.47. This is because students do not understand the physical meaning of the physical concepts in the diagram. When diagrams are presented students tend to understand the problem based on the diagram presentation not based on concepts, students are unable to analyze the diagram and are unable to translate it into sentence form.

Based on the results of the interview, students who succeeded in solving physics problems in diagram form are students who are able to translate problems in diagram form into sentence form in accordance with the physics concepts that underlie the problem. According to Sudjarwanto (2014), students must be able to recognize problems according to principles/concepts in order to be able to determine the next process in solving physics problems. On the other hand the use of diagrammatic representation demands more student thinking activities, because students must read diagrams, understand diagrams, analyze symbols, and conclude then determine problem solving steps. The use of symbols on diagrams can also cause confusion in students. Ana et al (2019) state that diagrams can help students in problem solving but the effect is statistically less significant. In line with the above, Zhongzhou et al (2017) state that for many physical problems, the benefits of diagrams are very small and may not justify attempts to make them. This finding is consistent with previous research showing that the benefits of providing small diagrams, and in certain cases can even damage problem solving

The results of tests on the ability of junior high school students to solve physics problems in the form of image representation based on Polya's indicators can be seen in Figure 4.

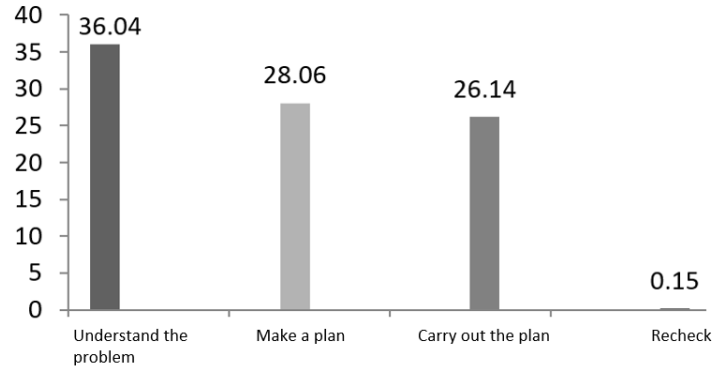

Figure 4. Polya problem solving on image representation

The ability of junior high school students to solve physics problems in the form of image representation is in the less category (average percentage 23.79). In general, students are able to understand images, this can be seen from the ability to understand the problem 36.04%. This percentage is higher than other indicators. But students are not able to

understand the physical meaning of the picture, are not able to translate the meaning of the symbolic form, so they are not able to make a plan for solving the problem. When the picture is presented students analyze the image without linking it to the concept, so that the students' answers are less precise. Based on the results of the interview, students who succeed in solving physics problems in the form of pictures are students who are able to represent problems in the form of images into symbolic forms in accordance with the principles and concepts of physics that underlie the problem. According to Haratua (2016), the ability to identify variables through verbal and non-verbal sentences using symbols is very helpful for making problem solving plans.

Presentation of questions in the form of images helps students understand the problem. But a better understanding does not necessarily affect the next step in problem solving, it can be seen from the percentage of problem solving results where the percentage of students' ability to understand a problem is 36.04%, making a plan 28.06%, implementing a plan of 26.14%, and checking again 0.15%. Ana et al (2019) state that even if the diagram/picture is useful in the initial stages of visualizing the problem, it will not guarantee a more efficient implementation of the next phase of problem solving.

Another difficulty faced by students is the inability to determine solutions to solve problems, students have difficulty using / understanding concepts and formulas. For example in determining voltage and current strength, students do not understand the concepts of voltage and current strength in series circuits, parallel circuits and combined circuits. Students are also still weak in mathematical operations, especially numeracy operations. In line with the research results of Rismatul et al (2015) which states students have difficulty in solving physics problems, these difficulties include difficulty understanding concepts and formulas, difficulty using equations or formulas, and difficulty understanding figures.

The ability of junior high school students to solve physics problems in the form of graphic representation based on Polya indicators can be seen in Figure 5.

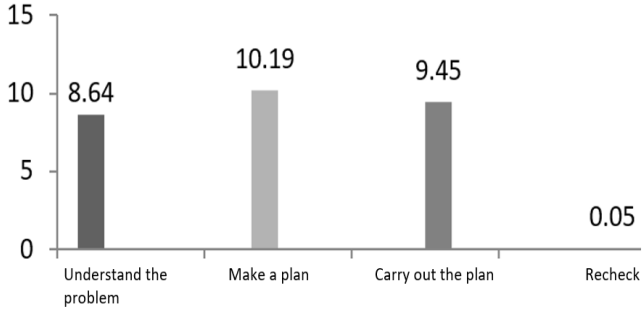

Figure 5. Polya problem solving on graphic representation

The ability of junior high school students to solve physics problems in the form of graphic representation is in the poor category (an average percentage of 8.06%). Based on the results of interviews the low ability of junior high school students to solve problems in the form of graphical representation, because most students have difficulty expressing the physical meaning of the graph and difficulty connecting the meaning of the graph to the actual phenomenon. Another difficulty experienced by students is the difficulty understanding the slope of the graph and the area contained under the curve, students understand the slope of the graph as a real picture of a situation, for example in the problem presented (the graph of the relationship between speed and time of GLBB is slowed) students consider the slope of the graph as the path of objects move down from the high to the lower. Students also do not understand that the area under the curve on the graph has a physical meaning, in this case the area under the curve is the distance of the

object. In line with Ana et al (2018) which states that students still have difficulty in interpreting the slope and area under the curve caused by the students' weak understanding of important concepts related to graphs, this shows understanding the area under the graph is a fairly difficult concept that is not it might be developed without formal teaching and learning, and more than that attention must be given to this topic in physics learning.

CONSLUSSION

The ability of junior high school students to solve physics problems in various forms of problem representation is in the less category with an average percentage of 21.86%. While the ability for each form of problem representation; (1) The ability of junior high school students to solve physics problems for verbal representation problems is in the less category. Based on the polya indicator, the percentage of the ability to understand the problem 38.98%, the ability to plan 54.06%, the ability to carry out the plan 35.16% and the ability to check the answers 0.34%. (2) The ability of junior high school students to solve physics problems in the form of diagrammatic representation is in the less category. Based on the polya indicator, the percentage of the ability to understand the problem 25.16%, the ability to plan 19.21%, the ability to carry out the plan 27.39% and the ability to re-examine the answer 0%. (3) The ability of junior high school students to solve physics problems for the form of image representation is in the less category. Based on the polya indicator, the percentage of the ability to understand the problem is 36.04%, the ability to draw up a plan of 28.06%, the ability to carry out a plan of 26.14% and the ability to check the answers 0.15%. (4) The ability of junior high school students to solve physics problems for problems in the form of graphical representations is in the poor category. Based on the polya indicators, the percentage of the ability to understand the problem is 8.64%, the ability to plan 10.19%, the ability to carry out the plan 9.45% and the ability to re-examine the answer 0.05%.

RECOMMENDATION

Important suggestions in this study are that further research needs to be done to see the extent of the effect of the form of problem representation on the ability of students to solve physics problems.

ACKNOWLEDGMENTS

Appreciation as much as possible the authors extend to both parents who support in all respects, colleagues and lecturers who always provide moral support, so that researchers can complete this research

REFERENCES

Ana, S., Andreja, B., Maja, P., Marko, M., & Marijan, P. (2019). Role of diagrams in problem solving: An evaluation of eye-tracking. *Physical Review Education Research*, *15*, 1-6.

Ana, S., Andreja, B., Petra, M., Maja, P., & Marijan, P. (2017). Graphical representations of data improve student understanding of measurement and uncertainty: An eye-tracking study. *Physical Review Education Research*, *13*(2), 1-20.

Ana, S., Andreja, B., Elizabeta, K., Maja P., & Marijan P. (2018). Student understanding of graph slope and area under a graph: A comparison of physics and nonphysics students. *Physical Review Education Research*, *14*, 1-15

Anton, S., Sunyoto, E., & Ian, Y. (2016). *A*nalisis kesulitan siswa dalam menyelesaikan masalah fisika berbentuk grafik. *Unnes Physics Education Journal*, *5*(3), 32-39.

Docktor, J. L., & Mastre, J. P. (2014). Synthesis of discipline-based education research in physics. *Phisical Review Special Topics -Physics Education Research*, *10*, 1-58.

Haratua, T., & Judyanto, S. (2016). Representations based physics instruction to enhance students' problem solving. *American Journal of Educational Research, 4*(1), 1-4.

Laras, W., Siswoyo, & Fauzi, B. (2015). Pendekatan multi representasi. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *1*(1), 31-38.

Mehmet, A. K., & Ayesegul, S. A. (2014). Effectiveness of multiple representations for learning energy. *Procedia - Social and Behavioral Sciences*, *116*, 627-632.

Nina, L., & Heru, K. (2018). Improving the competence of diagrammatic and argumentative representation in physics through android-based mobile learning application. *International Journal of Instruction*, 11(3), 106-122.

Polya, G., 1971. *How to solve It (Second Edition)*. New Jersey: Princeton University Press

Rismatul, A., Lia, Y., & Eni, L. (2015). The physic problem solving difficulties on high school student. J*urnal Penelitian Fisika dan Aplikasinya*, *5*(2), 44-50.

Suci, A., Yusuf, H., & Cecil, H. (2017). Kemampuan pemecahan masalah matematika siswa pada pembelajaran matematika menggunakan strategi abduktif-deduktif di SMA Negeri 1 Indralaya Utara. *Jurnal Elemen*, *3*(1), 25-34.

Suhandi, A., Wibowo, F. (2012). Pendekatan multi representasi dalam pembelajaran usaha-energi dan dampak terhadap pemahaman konsep mahasiswa. *Jurnal Pendidikan Fisika Indonesia*, *18,* 1-7.

Sujarwanto, E., Hidayat, A., & Wartono. (2014). Kemampuan memecahkan masalah fisika pada modeling instruction pada siswa SMA Kelas XI. *Jurnal Pendidikan IPA Indonesia*, *3*(1), 65-78.

Wahyuddin. (2016). Analisis kemampuan menyelesaikan soal cerita matematika ditinjau dari kemampuan verbal. *Jurnal Tadris Matematika*, *9*(2), 148-160.

Zhongzhou, C., Neset, D., Young Jeng, C., & David, E. (2017). To draw or not to draw? Examining the necessity of problem diagrams using massive open online course eksperiment. *Physical Review Physics Education Research*, *13*, 1-12.