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PBL : Improving Problem Solving Ability in Science Subject Materials

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Abstrak

Penelitian ini bertujuan untuk mengetahui peningkatan kemampuan pemecahan masalah siswa SMP dengan pembelajaran berbasis masalah pada materi cahaya dan optik. Jenis penelitian yang digunakan adalah deskriptif kuantitatif dengan desain penelitian one group pretest posttest design. Subjek dalam penelitian ini adalah siswa kelas VIII A dan VIII B SMP Negeri 14 Gresik yang masing-masing berjumlah 30 siswa. Teknik pengumpulan data yang digunakan adalah metode observasi, tes, dan angket dengan menggunakan instrumen lembar observasi, lembar tes (pretest dan posttest) dan lembar angket respon siswa. Teknik analisis dalam penelitian ini adalah analisis skor dan kriteria penilaian keterlaksanaan pembelajaran, analisis uji dengan uji normalitas, uji t tidak berpasangan, dan uji N-gain ternormalisasi, analisis skor dan kriteria penilaian respon siswa. Setelah diterapkan model pembelajaran berbasis masalah, kemampuan pemecahan masalah siswa menunjukkan peningkatan.

Kata Kunci: *Pembelajaran Berbasis Masalah, Kemampuan Pemecahan Masalah, Ringan dan Optik*.

Abstract

This study aims to determine the increase in problem-solving skills of junior high school students with problem-based learning on light and optic. The type of research used is descriptive quantitative research design with one group pretest posttest design. The subjects in this study were students of class VIII A and VIII B of SMP Negeri 14 Gresik, each of which consisted of 30 students. The data collection technique used is the method of observation, tests, and questionnaires using observation sheet instruments, test sheets (pretest and posttest) and student response questionnaire sheets. The analysis technique in this study was the analysis of scores and criteria for assessing the implementation of learning, analysis of tests with normality-test, unpaired t-test, and normalized N-gain test, analysis of scores and criteria for assessing student responses. After applying the problem-based learning model, students' problem-solving abilities showed an increase.

Keywords: *Problem based Learning, Problem solving Ability, Light and Optic.*

INTRODUCTION

Life is incomplete without a solid foundation in education. The aim of education is to improve the quality of a nation's human resources. As written in the Law (National Education System Number 20 of 2003 Article 3) which confirms that the purpose of national education is to educate the nation's life through developing skills and forming dignified national character and civilization (Hanifa et al., 2018).

In the 21st century, education requires mastery of hard skills and soft skills by every individual to prepare them for globalization and a career in the workplace (Nurjannah & Susiyawati, 2021).

The ability to think, act, and live in the world are three very important skills to have in the 21st century (Putriani & Hudaidah, 2021a). Thinking competence includes thinking creatively, critically, and solving problems. Communication, collaboration, digital literacy and technology literacy are all acting competencies. Despite the fact that initiative, self-direction, global awareness and social responsibility are components of competence to live in the world (Putriani & Hudaidah, 2021b). In the book 21st Century Skills, Trilling and Fadel (2009) it is stated, according to Learning for Life in Our Times, critical thinking and problem solving, communication, collaboration, and creativity are the four components that make up 21st century skills.

Based on these statements, the fact is obtained that one of the skills that must be possessed is problem solving skills. To be successful in school, the workplace, and other aspects of social life, the 21st century education industry is in dire need of problem-solving skills. In this case, students will be better able to deal with problems both inside and outside the classroom when they have problem solving skills (Saavedra & Opfer, 2012)

The results of the preliminary research using the observation method conducted in one of the junior high schools in Gresik Regency showed that currently students tend to lack understanding of the existing material, causing students to be less interested in learning natural sciences. In addition, students tend to have low solving abilities when facing problems that exist in science subjects. According to the findings of interviews with a number of teachers and science students, students tend to be passive learners who only listen to the teacher explain something. They also tend not to dare to ask questions or voice their opinions. In learning, educators are centered on educating towards information only, actual learning will generally be centered on teachers. Students who learn this way tend to only listen to the teacher's explanations rather than doing problems. Despite the fact that students are used to facing challenges as part of the classroom learning process, this prevents them from developing problem-solving skills (Ekasari et al., 2018, 2023; Iolanessa et al., 2020; Print, 2023).

In learning, educators are centered on educating towards information only, actual learning will generally be centered on the teacher. Students who study in this way tend to only listen to the teacher's explanation rather than do the problems. Despite the fact that students are used to facing challenges as part of the learning process in the classroom, this hinders them from developing problem-solving skills (Iolanessa et al., 2020). Students' capacity for problem solving can be increased when teacher centered learning is implemented. Giving questions that can stimulate higher-order thinking processes is one way to improve students' problem-solving abilities (Primayana, 2019).

Teachers are required to choose a learning model that is considered appropriate to the material being taught and the needs of students from the many

available options (Sumiantari et al., 2019). Light and optical devices are one of the material sub-chapters in learning natural sciences in junior high schools. The properties of light, mirrors, lenses, and optical devices that are often used in everyday life to help humans overcome the limitations of their optical abilities are contained in the material of light and optical devices. Students are faced with bona fide problems experienced by people to understand this material (Hidayat et al., 2013). Students can learn concepts related to problems and scientific methods to solve them through a problem-based learning model. In order for students to gain experience, a learning model is needed that can encourage students to have their own learning ideas and seek their own knowledge. The problem-based learning model is one of the learning models that can be used (Shofiyah & Wulandari, 2018).

Based on the problems that exist in this background, research is carried out to improve the existing problem-solving abilities of junior high school students, especially in science subjects with light and optical devices, because currently students' problem-solving abilities are still relatively low. The objectives that can be taken from this study to determine the improvement of the problem-solving ability of junior high school students with problem-based learning.

METHOD

The type of research used is descriptive quantitative research design with one group pretest posttest design. The subjects in this study were students of class VIII A and VIII B of SMP Negeri 14 Gresik, each of which consisted of 30 students. The data collection technique used is the method of observation, tests, and questionnaires using observation sheet instruments, test sheets (pretest and posttest) and student response questionnaire sheets. The analysis technique in this study is the analysis of scores and criteria for assessing the implementation of learning, analysis of tests with normality-test, unpaired t-test, and normalized N-gain test, analysis of scores and criteria for assessing student responses.

RESULTS AND DISCUSSION

The test given before the learning process (pretest) is used to determine students' initial abilities before receiving a problem-based learning model. The test given after the learning process (posttest) is used to determine the increase in students' problem-solving abilities after the application of problem-based learning models to lightweight materials and optical devices. It provides data about students' problem-solving abilities. The results of students' problem-solving abilities for each clue are determined to determine the attainment of each sign of problem-solving ability after learning is complete.

To find out whether the data is normally distributed or not, a normality test is used. SPSS is used to test the data. Further information will be provided as follows:

Table 1. Normality Test Results Data

	Pretest VIII-A	Posttest VIII-A	Pretest VIII-B	Posttest VIII-B
N (The number of students)	32	32	32	32
Mean	44,22	88,28	41,09	88,13
A	0,05	0,05	0,05	0,05
Asymp.Sig. (2-tailed)	.200	.123	.077	.096

The data used in table 1 is 32. Class VIII-A has an average pre-test of 44.22 and an average of 88.28 in the post-test, while class VIII-B has an average of 41.09 in pre-test and an average of 88 in the post-test. 13. The results of the pretest and posttest data in class VIII-A and VIII-B were normally distributed using the SPSS normality test. The data requirement is normally distributed if the significant count value is greater than 0.05, as evidenced by the pretest posttest significance of class VIII-A and VIII-B. The posttest scores for class VIII-A were 0.123 and 0.096 respectively, while the significance value for class VIII-A was 0.200>0.05 and class VIII-B 0.077>0.05. The normal distribution of the data is indicated by the value.

In a study that compared data between the two groups, an unpaired t test was used to analyze the data. There are two classes in this subject. H_0 and H_1 are the names of the two hypotheses. When making decisions, unpaired t-test analysis; otherwise, it can be done by comparing the probability value or significant value. H_0 indicates that there is no difference in the average GPA between classes VIII-A and VIII-B, and Ha indicates that there is a difference in the average GPA between classes VIII-A and VIII-B. Based on probability, H_0 is accepted if the probability is greater than 0.05, and H_1 is rejected if the probability is less than 0.05. The data will be presented as follows for additional information:

Table 2. T-Test Result Data - Unpaired

	Df	Sig. (2-tailed)
Posttest	62	.931
	61.649	.931

Unpaired data from the results of the t test in class VIII-A and VIII-B UPT SMP Negeri 14 Gresik are presented in Table 2. Either H_0 is accepted or H_0 is rejected are two possibilities. If the significance level is greater than 0.05, then H_0 is accepted and H1 is rejected. If the significance is less than 0.05 then H_0 is rejected and H1 is accepted. The same significance value of 0.931 can be seen in the table of unpaired t test results. Unpaired t-test shows that 0.931 is greater than 0.05. The results show that H_0 is accepted and H_1 is rejected, which indicates that the outcomes for class VIII-A and VIll-B after treatment are identical. The problem-based learning approach is the treatment in question.

Using a problem-based learning model, the pretest is given before the learning process. By using a problem-based learning model, the learning process is continued with a posttest. Each of the five questions on the pre-test and post-test measures students' ability to solve problems. 32 students were given questions for the pre-test and post-test. Then, the data from the pre and post test results were processed to see if there was an increase in problem solving skills. N-gain shows an increase in scores before and after the test.

Table 3. Result Data N – Gain VIII - A

No	Class	N-Gain category	The number of students	Percentage
1	VIII-A	High	23	71,87%
		Medium	9	28,12%
		Low	0	0%
		No increase	0	0%
		There was a decline	0	0%

Table 4. N-Gain VIII-B Result Data

No	Class	N-Gain category	The number of students	Percentage
1	VIII-B	High	25	78,12%
		Medium	7	21,87%
		Low	0	0%
		No increase	0	0%
		There was a decline	0	0%

There are five types of gain in N-Gain: high, medium, low, no increase, and decrease. Pre and post test results are reflected in this category. There are five ranges of N-Gain, with decrement determined by gain values below 0.0. There is no increase because the profit is zero. The low criterion is a profit of less than 0.3. With moderate criteria, the gain is worth more than 0.3. The high criterion is a gain greater than or equal to 0.7 (Nirmalasari, Santiani, 2016). Tables 3 and 4 show the Gain results based on the collected pre and posttest data. Based on the table, the high N-Gain category in class VIII-A has a percentage of 71.87 percent, the moderate category has a percentage of 28.18 percent, and the low category does not experience any increase or decrease at all. In class VIII-B, the high N-Gain category had a percentage of 78.12 percent, the medium category had a percentage of 21.87 percent, and the low category did not experience any increase—no increase or decrease at all. Of the four, the highest percentage is included in the high N-Gain category. This shows that the difference in scores between the pre and post tests is significant. The data in this table is presented in the form of a pie chart to make it easier to read:

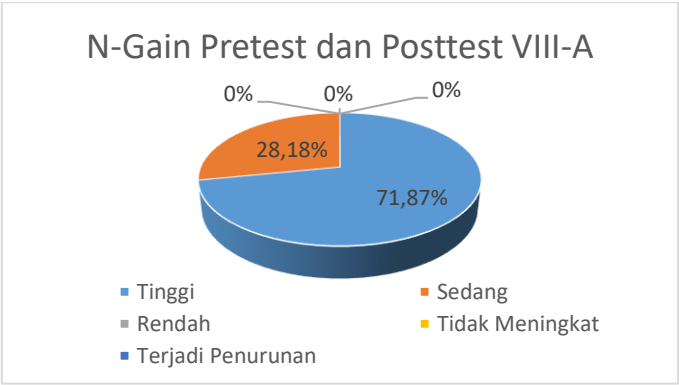

Figure 1. N-gain pie chart pretest and posttest VIII-A

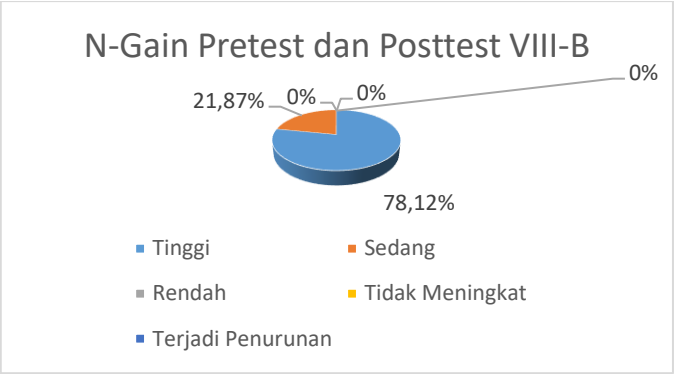

Figure 2. N-gain pie chart of VIII-B pretest and posttest

The five descriptive questions form the pretest and posttest questions. There are indicators of problem-solving ability in each question. Understanding casual relationships in problems, strategic questions that support problem solving, arguments for learning problem solving, and regulation of problem solving metacognition are all indicators of problem solving ability. The N-Gain for each indicator is sought to find out the increase in the problem solving abilities of class VIII UPT SMP Negeri 14 Gresik students. The data will be shown in tables 3 and 4 below:

Table 5. N-Gain Result Data for Each Indicator of Problem Solving Ability VIII-A

KPM indicator	Average Pretest Score	Average Posttest Score	N-Gain	Gains Category
Defining the problem Problem Schema	7,19	14,84	0,73	High
Understanding casual relationships in trouble	10,00	17,81	0,69	High
Strategic questions that support problem solving	8,59	17,66	0,72	High
Arguments for learning problem solving	10,78	18,28	0,84	High
Regulatory metacognition of problem solving	7,66	19,69	1,00	High

Table 6. N-Gain Result Data for Each Indicator of Problem Solving Ability VIII-B

KPM indicator	Average Pretest Score	Average Posttest Score	N-Gain	Gains Category
Defining the problem Problem Schema	7,34	16,88	0,85	High
Understanding casual relationships in trouble	9,53	17,34	0,84	High
Strategic questions that support problem solving	7,66	17,50	0,83	High
Arguments for learning problem solving	19,22	18,06	0,83	High
Regulatory metacognition of problem solving	7,34	18,44	0,90	High

Problem Schemes, understanding casual relationships in problems, strategic questions that support problem solving, arguments for learning problem solving, and regulation of problem solving metacognition get the highest score, namely 20. Obtained an average score on the pretest and posttest of 32 students

for each indicator problem solving skill. N-gain result data for each problem solving indicator VIII-A which defines the Problem Scheme problem is shown in table 5. This indicator has an average pretest value of 10.00 and a posttest value of 17.81 resulting in an N-gain of 0.73. The n-gain obtained for the indicator of understanding casual relationships in the problem is 0.69, with an average pre-test score of 7.19 and a post-test score of 14.84. The average pretest score for strategic question indicators that help solve problems is 8.59, and the posttest average score is 17.66, resulting in an N-gain of 0.72. The argumentation indicator for problem solving learning has an average score of 10.78 in the pretest and 18.28 in the posttest, resulting in an N-gain of 0.84. The regulatory indicator of problem solving metacognition has an N-gain of 1.00, with an average pretest score of 7.66 and a posttest score of 19.69. In contrast, the N-gain data shown in Table 4.10 for each indicator of problem solving VIII-B, namely the indicator that defines the problem, the Problem Scheme, shows that the N-gain obtained is 0.85 because the average score in the pretest is 7.34 and the average value in the posttest was 16.88. The calculated n-gain for the indicator of understanding casual relationships in the questions is 0.84, with an average pre-test score of 9.53 and a post-test score of 17.34. The pretest average score for strategic question indicators that help solve problems is 7.66, and the posttest average score is 17.50, resulting in an N-gain of 0.0.83. The argumentation indicator for problem solving learning has an N-gain of 0.83, with an average pretest score of 9.22 and a posttest score of 18.06. The regulatory indicator of problem solving metacognition has an N-gain of 0.90, with an average pretest score of 7.34 and a posttest score of 18.44.

Decline is defined as a gain of less than 0.0. There is no increase because the profit is zero. The low criterion is a profit of less than 0.3. With moderate criteria, the gain is worth more than 0.3. The high criterion is a gain of more than 0.7(Nirmalasari, Santiani, 2016). The indicators for defining problem schemas, understanding causal relationships in problems, strategic questions that support problem solving, problem solving learning arguments, and problem solving regulatory metacognition are included in the high gain category for N-gain VIII-A and VIII-B problem solving abilities. This finding indicates that all indicators of problem solving skills for class VIII-A and VIII-B fall into the same category, namely high. The N-Gain results for each indicator will be displayed in diagram form for easier reading:

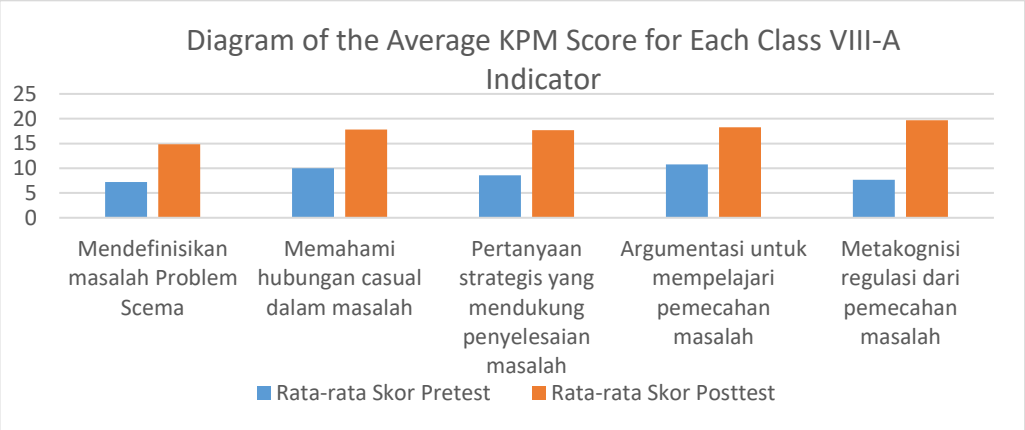

Figure 3. Diagram of the average problem-solving ability score for each class VIII-A indicator

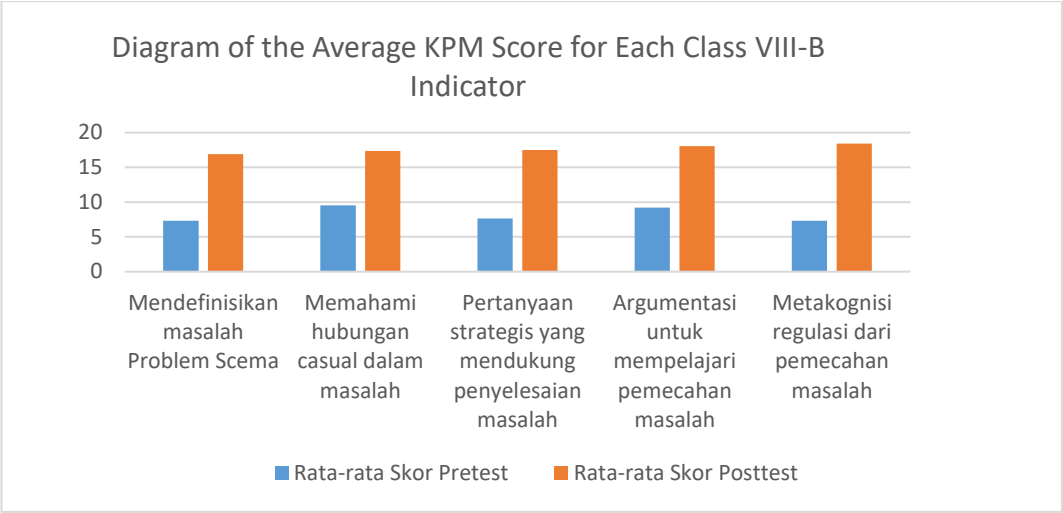

Figure 4. Diagram of the average problem-solving ability score for each class VIII-B indicator

Definition of problem schemas, understanding causal relationships in problems, strategic questions that support problem solving, arguments for learning problem solving, and regulation of problem solving metacognition are the five problem solving skills examined in this study. Scores on the pre- and post-tests showed an increase in students' problem-solving skills. There were five description questions in total on the pre-test and post-test. One indicator for solving the problem is included in each question. The normality test, unpaired t-test, and n-gain will later be used to evaluate the pretest and posttest results.

To find out whether the data is normally distributed or not, a normality test is used. Because it meets the requirements for a significant count greater than 0.05, it is known from the results of the SPSS test that the normality test results for class VIII-A and VIII-B pretest and posttest are normally distributed. The unpaired t-test, which is useful for determining whether the results after treatment are different, is the next step. The application of a problem-based learning model is the intended treatment. After being given the treatment, it was determined that there was no difference in the results of this test between class VIII-A and class VIII-B. The same significance level of 0.931, which is greater than 0.05, is evident. These results support the hypothesis that class VIII-A and VIII-B outcomes are not different after treatment, which means that H_0 is accepted and H_1 is rejected. The N-gain test was carried out by the researcher following the normality test and unpaired t test to see if there was an increase in problem solving ability. The results of the five questions on the pre-test and post-test will be evaluated using N-gain.

Class VIII-A and VIII-B scores on the pretest and posttest were compared using N-gain, and the results showed a significant increase between the pretest and posttest scores. The results of the pretest for class VIII-A and VIII-B show that students lack the ability to solve problems. Based on these findings, it appears that students' problem-solving skills are inadequate because they have not fully mastered the subject matter. Pre-research conducted at UPT SMP Negeri 14 Gresik corroborated this finding by showing that students were less interested in learning science due to their lack of understanding of the material. In addition, when faced with science-related problems, students often do not have the ability

to solve them. This is supported by the results of daily tests which show that there are still many students who have not met the Minimum Completeness Criteria (KKM) 75, which means that student learning outcomes have not been completed perfectly. According to the findings of interviews with a number of science teachers and students, students tend to be passive learners who only listen to the teacher explaining something. They also tend not to dare to ask questions or voice their opinions. Learning still tends to be centered on the teacher, but in learning the teacher only teaches knowledge.

The posttest was given after three meetings to apply the problem-based learning model in class VIII-A and VIII-B. The N-gain test used to determine the increase in each indicator of problem solving ability is also given to each indicator. There was an increase among the five indicators of problem-solving abilities that were taught as a whole, this indicated that students' problem-solving abilities began to increase in line with the habit of solving problems in the science class. This is also in line with research (Primayana, 2019) who found that the use of teacher-centered learning can help students become better at solving problems. Giving questions that can stimulate higher-order thinking processes is one way to improve students' problem-solving abilities.

By using n-gain, the results of the pretest and posttest are also calculated as a whole in addition to the calculation of each indicator. The ability of class VIII-A and VIII-B students in solving problems as a whole has increased. In class VIII-A there were 23 students who achieved high gains and 9 students who achieved moderate gains. In class VIII-B there were 25 students who scored high gains, and seven students got moderate gains. This study shows that students' problem-solving abilities have increased since the problem-based learning model was applied. This finding is in line with research (Waskita et al., 2022) who found that students gave a positive response to the use of problem-based learning models to improve students' problem solving abilities and that the application of learning models with problem-based learning models at each stage resulted in the percentage of students being in the very good category. In conclusion, student responses, problem-solving abilities, and implementation of learning are all interconnected. According to Burner's theory, students will learn to be active and productive by solving problems. This indicates that students will be more involved in solving a problem given by the teacher when learning according to the problem-based learning model, resulting in positive learning outcomes such as complete posttest scores and high n-gain categories.

CONCLUSION

At UPT SMP Negeri 14 Gresik, students' problem-solving skills increased after applying a problem-based learning model to light and optical devices. The n-gain results for class VIll-A and VIII-B which have the same category, namely height, show an increase in the two classes. The high N-gain category indicates that students' problem-solving abilities increase significantly when the problem-based learning model is used.

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