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The Effectiveness of Student Worksheet Based on Inquiry Learning to Improve Student Problem-Solving Skills on Factors that Affect the Reaction Rate Material

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Abstract: Problem-solving ability is one of the abilities that support the achievement of the Profil Pelajar Pancasila. In reality, problem-solving skills are still low and need to be improved. Based on the literature study, student worksheet learning tools using the inquiry model can train problem-solving skills. The research objective is expected to produce an effective student worksheet to improve problem-solving skills on the material of factors that affect the reaction rate. The student worksheet was developed following the ADDIE (Analyze, Design, Develop, Implement, Evaluate) stages, up to the develop and pilot implementation stage. The pilot implementation target was 28 students of class XI-3 SMA Negeri 7 Surabaya. Student worksheets in this study were developed referring to the indicators of problem-solving ability, namely recognising the problem, describing the problem, planning a solution, executing the plan, and evaluating the solution. The effectiveness of the student worksheets was determined based on the results of the problem-solving ability test. The effectiveness test design used was a one-group pretest-posttest Design. Pretest and posttest data were analyzed using a normality test and a paired t-test. The student worksheet developed was declared effective if there was an increase in students' problem-solving ability test scores between before and after the trial. The problem-solving ability test results were tested with the Shapiro-Wilk test. The prerequisite test results showed normal distribution because the p-value> 0.05. Followed by hypothesis testing using a paired t-test (one-tail). Data analysis using a paired t-test (one-tailed) resulted in a p-value of 0.000 <0.005, so there was a significant increase in the problem-solving score. Thus, student worksheets developed using the inquiry model are declared effective for improving students' problem-solving skills in the material of factors that affect the reaction rate.

Keywords: Effective; Pilot Implementation; Problem-Solving Skills; Student Worksheet.

Introduction

The curriculum is important in a country's education because it describes the vision, mission, and educational goals of the country [1]. The curriculum used by the State of Indonesia today is the Merdeka Curriculum. The Merdeka Curriculum focuses on achieving the Profil Pelajar Pancasila (P3). P3 consists of six main dimensions, namely faith, devotion to God Almighty, noble character, global diversity, mutual cooperation, independent, critical reasoning, and creative [2].

In the creative dimension, there are three elements for P3 achievement, namely producing original ideas, producing original works and actions, and having flexibility of thinking in finding alternative solutions [3]. The ability to find alternative solutions (problem solving). Problem-solving involves high-level thinking skills, activities carried out by a person to solve a problem. By utilizing the knowledge, skills, and understanding that have been acquired, so that when facing similar problems in the future, students no longer consider it a difficulty [4].

Problem-solving skills are important for students to have. Based on a field study of 21 students conducted by Nuralifah & Hidayah (2021), it was found that 86% of students had problem-solving skills in the very poor category with a score range of 21-40 [5]. Almost the same findings were also obtained by Devi & Ismono (2018) that students' achievements for each indicator of problem-solving ability were as follows (1) stating the problem (65.71%), (2) stating the hypothesis (34.28%), (3) organizing and collecting data (47.14%), and evaluating the hypothesis (27.86%) [6]. Other researchers stated that students' problem-solving skills were still lacking [7].

Based on research by Wulandari, Distrik, & Rosidi (2019), it shows that student worksheets are effective for practising problem-solving skills as indicated by the significant difference between the average n-gain score of solving skills between the experimental and control classes. [8]. Based on this, the research was conducted to develop student worksheet learning tools as a vehicle for practising students' problem-solving skills. In addition, an appropriate learning model is needed to support the implementation of the learning process. In the opinion of Simeru et al (2023), the inquiry learning method will train students to express opinions and solve problems [9]. This is in line with the results that the Guided Inquiry and Modified Free Inquiry learning models can improve problem-solving skills in students [10]. The stages of inquiry learning, according to Arens, are getting attention and explaining the inquiry process, presenting inquiry problems or inappropriate events, helping to formulate hypotheses to explain problem situations, encouraging students to collect data to test hypotheses, formulating explanations, reflecting on problem situations and thinking processes [11].

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In inquiry learning, the problems presented are problems in everyday life, and students are required to learn creatively and have broad insight [12]. One of the lessons that can apply the inquiry model is the reaction rate because the reaction rate material is close to everyday life [13]. One of the subtopics in the reaction rate is the factors that affect the reaction rate, which are also commonly found in life, so that it can be taught using inquiry learning.

The stages in the problem-solving indicator can be practised on the material of factors that affect the reaction rate to achieve the expected material-related concepts. The subject matter of factors affecting the reaction rate can potentially be used as a vehicle for practising problem-solving, so it still requires appropriate learning tools and models for practising reaction rate material.

Research conducted by Larosa (2023) shows that the development of student worksheets with a valid and practical inquiry learning model can be effective for improving students' mathematical problem-solving skills [14]. Based on this research, the development of student worksheets with inquiry models can improve problem-solving skills in certain materials.

Based on these problems, research was conducted related to "The Effectiveness of Student Worksheet to Improve Students' Problem-solving Skills on the Material of Factors that Affect the Reaction Rate through Inquiry-Based Learning". The purpose of this research is to produce student worksheets which is effective for improving students' problem-solving skills. Knowing the effectiveness of student worksheets is based on the problem-solving ability test carried out by students through a pretest and a posttest.

Research Methods

This study developed student worksheets to train problem-solving skills on the material of factors that affect the reaction rate using an inquiry learning model. The target of the pilot implementation of the use of student worksheets was 28 students of class XI SMA Negeri 7 Surabaya. The development of student worksheets uses the ADDIE model with the stages of Analysis, Design, Development, Implementation, and Evaluation [15].

The analysis stage is the process of collecting information that is used as a reference for making a product. At this stage, needs analysis, curriculum analysis, and evaluation of the analysis stage are carried out. The design stage is the process of verifying the author's wishes and the examiner's in accordance with the method so as to produce the desired design outline. At this stage, student worksheet design, supporting instrument design, evaluation, and revision are carried out. The development stage is the process of realizing the design into a real product. At this stage, student worksheet printing is carried out, development of development instruments, evaluation, and revision. The research conducted was limited to the development stage, pilot implementation. The student worksheet developed has been declared valid and practical based on previous research, so that pilot implementation can be carried out. The student worksheet has been validated based on content validity and construct validity by three expert validators, consisting of two chemistry education lecturers.

In the pilot implementation, learning was carried out using the student worksheets developed. Before learning using student worksheets, a pretest is carried out, and after learning using student worksheets, a posttest is carried out to test effectiveness. The effectiveness test design used is a one-group pretest-posttest Design. In this trial design, there is a pretest before treatment and a posttest after treatment so that it can compare the situation between before and after treatment [16].

The instrument used in the effectiveness test contains description questions based on problem-solving indicators, namely, recognize the problem, describe the problem, plan a solution, execute the plan, and evaluate the solution. The problem-solving indicators are represented by ten problem-solving test items that have been validated and declared valid by three chemistry education lecturers. The analysis of the test sheet was carried out with a preliminary test followed by a hypothesis test. The preliminary test used is the Shapiro-Wilk normality test. If the data obtained is normally distributed, the analysis of the results is continued with a parametric test, namely the correlated two-sample t-test (paired sample test).

Results and Discussion

In the pilot implementation stage, learning is carried out using student worksheets in groups. Learning in groups helps the learning process to occur efficiently and effectively when children learn cooperatively with other children in a supportive atmosphere and environment under the guidance of someone more capable [17]. Learners' activities begin with readings and pictures of events related to the material that can be found in everyday life. This event is used for learners to recognise and formulate problems. This activity shows that learners are able to set goals to be achieved. The problem recognition activity is shown in the following figure.

Figure 1. Recognize the problem

The problem description indicator is trained by conducting a theoretical study by observing theories related to the material and compiling hypotheses. Problem explanation enables learners to describe the problem by focusing on things that provide answers through the following activities.

Solution planning indicators are trained by conducting experiments related to the material studied.

Learners write down the experimental variables and experimental data. This activity shows that learners are able to apply special techniques in chemistry to connect situations with goals (Figure 2). The solution planning activity is shown in Figure 3.

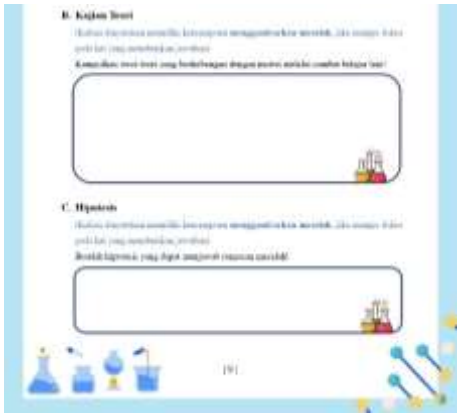

Figure 2. Describe the problem

Figure 3. Plan a solution

Indicators of plan implementation are trained by answering analysis questions and making conclusions (Figure 3). Analysis of experimental data shows that learners are able to focus on the main problem until they see the solution clearly. The solution obtained is the conclusion that answers the problem formulation as follows (Figure 4).

The solution evaluation indicator is practised by connecting the conclusions made with collision theory and events related to the material. This activity shows that learners are able to determine how appropriate the solution results are obtained with knowledge of similar behavior, using understood limiting behavior. The solution evaluation activity is shown in the Figure 5.

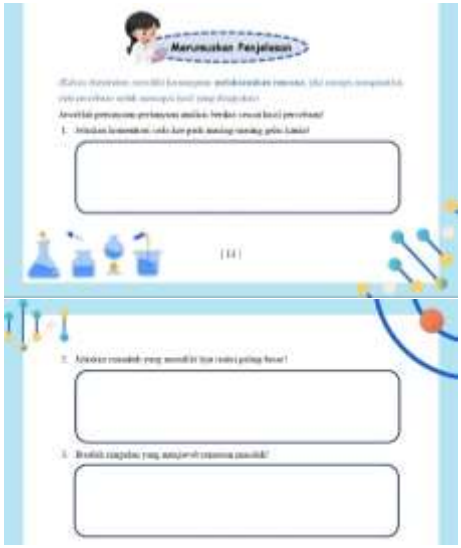

Figure 4. Execute the plan

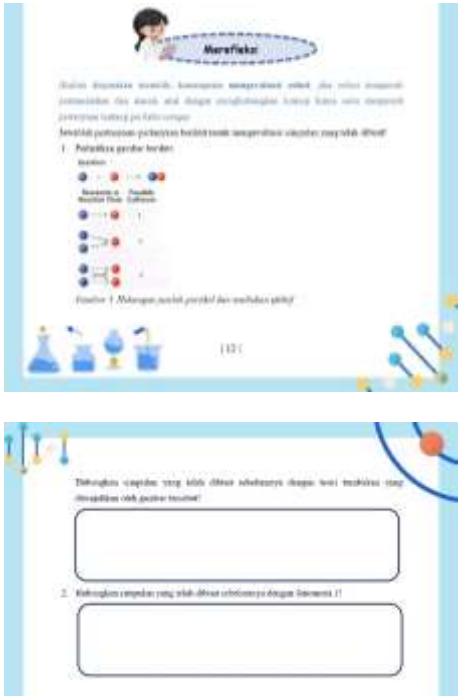

Figure 5. Evaluate the solution

After the pilot implementation, learners take a posttest whose results will be compared with the pretest. The effectiveness of the developed student worksheets is reviewed from the results of the test of students' problem-solving skills before and after learning using the developed student worksheets. This is in accordance with the opinion that learning effectiveness refers to the relationship between the results obtained and the goals set by indicating that effectiveness is an evaluation of how well it is to achieve predetermined goals, and learning can be said to be effective when students' problem-solving skills improve after using

student worksheets [18]. Table 1 shows the results of the recapitulation of students' pretests and posttests.

Table 1. Pretest and Posttest Results

Sample	Number	Average
Pretest	28	49.11
Posttest	28	83.84

Referring to Table 1, the average pretest score of students was low. This shows that there are still many students who have not mastered the material on factors that affect the reaction rate, even though students have studied the material before. Lack of mastery of the material is one of the causes of learning difficulties. External factors of learning difficulties owned by students include the wrong learning strategies used and the lack of learning activities that arouse student motivation [19].

In the posttest, the average posttest score of students was a high score. All students have problem-solving skills on the material of factors that affect the reaction rate after learning using the developed student worksheet. This is in line with the opinion that increasing the ability of students can be done with the appropriate learning model and learning tools, because it affects the ability of students [20].

The problem-solving ability test given to students was made based on problem-solving indicators according to Haller & Heller (2010). Indicators of problem-solving that show the achievement of a problem-solving process consist of five indicators, including recognize the problem, describing the problem, planning a solution, executing the plan, and evaluating the solution [21]. The results of the achievement of problem-solving indicators are shown in Figure 1.

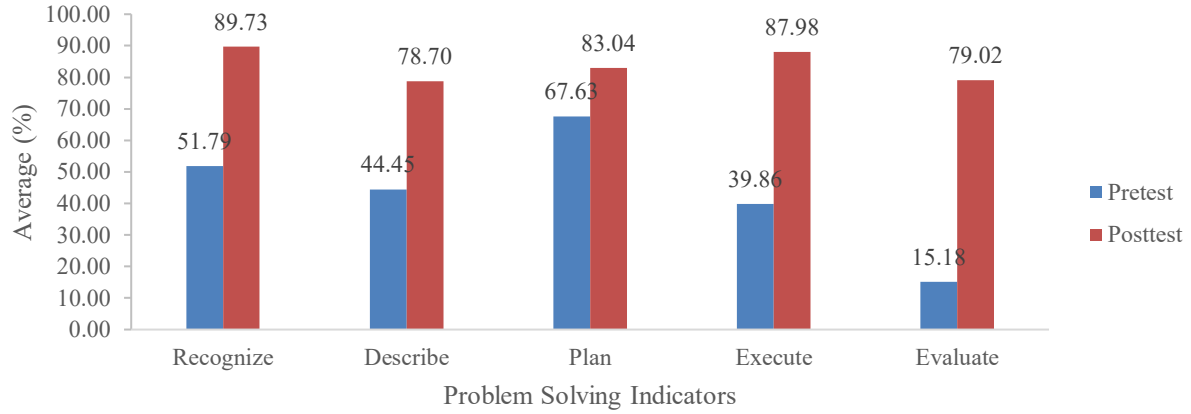

Figure 6. Achievement of problem-solving indicators

Based on Figure 1, it is known that there is an increase in students' problem-solving ability for each indicator. The first problem-solving indicator, recognising the problem presented in problem-solving test questions 1 and 2, has increased with an average percentage of 51.78% in the pretest to 89.73% in the posttest. In number 1, students are asked to formulate problems based on events, and in number 2, students are asked to find facts in events to help formulate hypotheses. In the pretest, students were less able to formulate problems and collect facts on events related to catalyst factors, as discussed in the topic of the material. After learning to use student worksheets, on the posttest, students can formulate problems and facts on events related to catalysts.

The second indicator, the description of the problem presented in number 3, has increased with an average percentage of 44.44% in the pretest to 78.69% in the posttest. In question number 3, students are asked to formulate a hypothesis that answers the problem formulation. In the pretest, students were less able to make hypotheses related to catalysts as the topic of material discussed in the event. In the posttest, students can formulate hypotheses that answer the problem formulation and are related to catalysts.

The third indicator is that planning the solution presented in question numbers 4, 5, and 6 has increased with an average percentage of 67.63% in the pretest to 83.69% in the posttest. In number 4, students are asked to write down the tools and materials, in number 5, write down the experimental procedure, and in number 6, write down the experimental variables according to the events displayed. In the pretest, students were less able to make an appropriate experimental design and were still wrong in determining the experimental variables. In the posttest, students were able to design experiments and determine the right variables in accordance with the event.

The fourth indicator, implementing the plan presented in questions 7 and 8, has increased with an average percentage of 39.85% in the pretest to 87.98% in the posttest. In question number 7, students are asked to write down the data from the experiment and in question 8, they are asked to analyze the data. In the pretest, students were less able to analyze data in accordance with the material and events. In the posttest, students can analyze data well and in accordance with the events and materials studied.

The fifth indicator is that the evaluation of the solution presented in questions 9 and 10 has increased with an average percentage of 15.18% in the pretest to 79.02% in the posttest. In question number 9, students are asked to write conclusions, and in question 10, they are asked to connect conclusions with events. In the pretest, the conclusions made by students were not connected to the collision theory, and they were less able to connect conclusions with events. In the posttest, the conclusions were connected to the collision theory and could connect the conclusions with events.

Based on this, there is an increase in the problem-solving ability score before learning using the student

worksheet. This is in line with the statement that if students experience an increase in learning outcomes, then the learning tools used are effective [22]. Data analysis through a t-test needs to be done to support these findings objectively and provide more accurate results.

The effect of student worksheets on students' problem-solving skills can be analyzed through the implementation of prerequisite tests and continued with hypothesis testing. The prerequisite test carried out in the study is the normality test. The normality test is carried out to determine whether the data obtained is normally or abnormally distributed. The normality test in this study used the Shapiro-Wilk method because the data used was less than 50. The resulting data is declared normally distributed, namely when the Sig.>0.05 value, otherwise, when the Sig.<0.05 value, the data obtained is declared to be abnormally distributed. The following is a table of the results of the Shapiro-Wilk test that has been carried out.

Table 2. Normality Test

Sample	Shapiro-Wilk				
	Mean	StDev	N	RJ	P-Value
Pretest	49.11	15.71	28	0.983	>0.100
Posttest	83.84	6.028	28	0.994	>0.100

Based on Table 2, data analysis using the Shapiro-Wilk test resulted in a p-value of 0.100 for the pretest and posttest, so that the data was normally distributed. Analysis of the results can be continued with a parametric test, namely a paired t-test (one-tailed). This test is used to determine whether there is a difference in the average value of two groups of paired data. Paired samples mean that one sample gets two different treatments [23]. The determination of the hypothesis conclusion is if Sig.< 0.05, then H_0 is rejected and H_1 is accepted, which means that the posttest score is greater than the pretest [24]. The following are the results of the one-party t-test that has been carried out using Minitab.

Table 3. Paired t-test

Descriptive Statistics				
Sample	N	Mean	StDev	SE Mean
Posttest	28	83.84	6.03	1.14
Pretest	28	49.11	15.71	2.97

Null hypothesis	H_0: μ_difference = 0
Alternative hypothesis	H_1: μ_difference > 0
t-value	p-value
1.72	0.000

Based on parametric tests, it is known that data analysis using a paired t-test (one-tail) resulted in a p-value of 0.000; there was a significant increase in problem-solving scores. Thus, the student worksheet developed is declared effective. Based on the results of the effectiveness test, the use of student worksheets with inquiry stages can support the achievement of problem-solving skills as the expected goal. This is in accordance with the opinion of Nieveen (2007), effectiveness refers to the use of products that are expected to produce the desired goals [25].

The results also show that the developed LAPD can fulfil the function of LAPD according to Prastowo (2011), namely, making students active during learning, facilitating students' understanding of the material on factors that affect the reaction rate through tasks and exercises, and as a tool to improve students' problem-solving skills [26]. The developed student worksheet acts as a container that supports learning activities, facilitates communication between teachers and students, and encourages students' interest in improving problem-solving skills in the material of factors that affect the reaction rate.

Conclusion

Paired sample test (one-tailed) resulted in a p-value of 0.000, below 0.05. This means that there is an increase in the problem-solving ability score obtained by students in the class using the student worksheet developed. The conclusion of the research has obtained LAPD, which is effectively used to improve problem-solving skills in the material of factors that affect the reaction rate. The application of student worksheets with an inquiry model can be used to support the achievement of the Profil Pelajar Pancasila. Problem-solving ability is part of high-level thinking skills (HOTS), so the development of similar student worksheets can be applied to other chemical materials in future research.

Author's Contribution

Riza Apriliane: contribution of studying conception and design, collecting data, analyzing data, writing draft articles; Suyono: contribution reviewed the results, provided input, approved the draft article. Antina Delhita: contribution reviewed the results, provided input, approved the draft article.

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