ANALYSIS OF THE PROFILE OF STUDENTS' PROBLEM SOLVING ABILITIES THROUGH THE APPLICATION OF THE STEM-INQUIRY LEARNING MODEL IN ENVIRONMENTAL POLLUTION MATERIALS

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Abstract

This research aims to assess the problem-solving abilities of seventh-grade students after instruction. The problem-solving indicators in this study include understanding the problem, devising a plan, solving the problem, and re-evaluating the solution. The research adopts an experimental approach. The study sample consists of two classes: the experimental group, class VII G with 30 students, engaged with the STEM-INQUIRY learning model assisted by E-LKPD, and the control group, class VII H, also with 30 students, utilizing the discovery learning model assisted by E-LKPD. Data collection involved a written test instrument for pretest and posttest evaluations, along with non-test instruments such as student response questionnaires, teaching modules, E-LKPD, and validation sheets. Data analysis was conducted using SPSS version 25 software. Results indicate that the problem-solving abilities of students following the STEM-INQUIRY model assisted by E-LKPD show that 64% of students fall into the "high" category, 33% into the "very high" category, and 3% into the "medium" category. Meanwhile, the problem solving ability profile based on the indicators of understanding the problem, formulating a plan, and checking again obtained an average percentage value in the experimental class that was greater than the control class, while the problem solving indicator obtained a percentage value in the control class that was higher than the experimental class.

Keywords: Problem Solving, E-LKPD, STEM, Discovery Learning.

1 INTRODUCTION

scientific disciplines such as biology, chemistry and geology. Uncontrolled human activities in exploiting natural resources trigger a decline in ecosystem quality. Destructive behavior and indifference to the environment threatens future survival [1]. Environmental pollution, such as water, air and land pollution, as well as impacts such as global climate change and ozone layer depletion, are serious problems that require collective problem-solving capabilities to find effective and sustainable solutions [2].

The ability to solve problems is a crucial competency that students need to have in today's modern era. In an educational context, this ability not only helps students understand and solve academic problems, but also prepares them to face complex and dynamic real-life challenges [3]. Therefore, it is important for the education system to implement effective learning strategies in developing these skills [4]. One model used to develop problem solving abilities is a learning-based model inquiry .

The inquiry model is a sequence of instructional activities that focus on critical and analytical thinking skills in investigating and finding solutions to given problems [5]. The inquiry model can help students to be more active in the learning process, encouraging them to think critically and creatively in solving problems [6]. The inquiry model creates a pleasant learning atmosphere and increases understanding of concepts [7]. Even though it has significant benefits, there are still many teachers who rarely use this model in their daily learning. Based on the results of interviews with Tegal City Middle School science teachers, it shows that the majority of teachers still use learning methods that are not yet integrated with technology and The problem-solving abilities of students in these schools remain inadequate. Therefore, an approach that integrates science and technology concepts, such as the STEM approach, is necessary to address this issue.

The science, technology, engineering and math (STEM) approach is an innovative educational approach that combines the fields of science, technology, engineering and math to help students solve everyday problems [8]. This approach invites students to design, develop, use and apply science and technology. The STEM (Science, Technology, Engineering, and Mathematics) approach significantly improves students' problem solving abilities [9].

Improving problem solving abilities is the main focus in the STEM-INQUIRY learning model, which combines Science, Technology, Engineering and Mathematics with inquiry methods [10]. This approach encourages students to actively observe, investigate, and formulate their own questions through real challenges or problems [11]. To measure problem-solving abilities, there are several indicators that can be used, including understanding the problem, preparing a plan, solving the problem, and checking again.

This research is expected to be a pioneer in integrating the STEM-INQUIRY learning model, providing an important contribution to the development of curriculum and learning strategies that are more effective in developing students' problem solving abilities. And this research is expected to provide in-depth insight into how the STEM-INQUIRY learning model influences the profile of students' problem solving abilities. This research focuses on analyzing the profile of students' problem solving abilities after they have participated in learning using the STEM-INQUIRY model. The primary objective of this research is to assess the impact of the STEM-INQUIRY approach on enhancing students' problem-solving skills. The study aims to identify the profile of students' problem-solving abilities following the implementation of the STEM-INQUIRY learning model.

2 METHODOLOGY

This study is categorized as quantitative research. The method employed is experimental, involving the division of research subjects into two groups: an experimental group and a control group. The population for this research consists of seventh-grade students from junior high schools in Tegal City for the 2023/2024 academic year, totaling 252 students across 8 classes, with an average of 32 students per class. Random sampling was used to select the sample classes, with class VII G (experimental) and class VII H (control), each comprising 30 students. The research design utilized is a pretest-posttest control group design.

Table 1. *Design Pretest-Posttest Control Group*

Group	*Pretest*	Treatment	*Posttest*
Experiment	Yb	X1	Of
Control	Yb	X2	Of

Source : [12]

Data collection methods in this research include written tests (pretest and posttest) and non-test instruments such as teaching modules, E-LKPD, and validation sheets. The experimental class uses the STEM-INQUIRY learning model with E-LKPD, while the control class uses the Discovery Learning learning model also with E-LKPD. Data analysis includes testing the test instrument which consists of empirical validity, reliability, item difficulty level and differentiability tests. As well as non-test instrument tests consisting of expert validity tests. Prerequisite analysis consisting of normality test and homogeneity test. Hypothesis analysis used in this research is a profile analysis of problem solving abilities.

Problem Solving Ability Profile Analysis

Profile analysis of problem solving abilities was tested using descriptive analysis methods. The analysis in this research includes a description of the student's ability profile in solving problems using problem solving data scores. The score is analyzed using the percentage formula below:

$$\text{Value} = \frac{Student\ Scores}{Shoes\ Ideal} \times 100\%$$

Source : [13]

Table 2. *Problem Solving Assessment Criteria*

Mark (%)	**Criteria**
$0 < x \leq 40$	Very Low

$40 < x \leq 50$	Low
$50 < x \leq 70$	Currently
$70 < x \leq 90$	High
$90 < x \leq 100$	Very high

Source : [13]

3 RESULTS

The profile analysis of problem solving abilities in this research was tested using a descriptive analysis method, the results of which came from the posttest scores carried out after using the STEM-IQUIRY learning model. The stages of this research are data description and initial data analysis, prerequisite data analysis, hypothesis testing analysis.

3.1 Data Description

This study was conducted in a seventh-grade class at a junior high school in Tegal City from April 27 to May 29, with the objective of identifying students' problem-solving abilities after applying the STEM-INQUIRY model. Prior to the study, interviews were conducted with science teachers, along with a review of documentation. The interviews revealed that the teaching methods used varied, ranging from traditional to modern, depending on the teacher. Additionally, some teachers had not yet implemented STEM-integrated teaching methods. The students' problem-solving abilities at this school were also found to be lacking, with no specific assessments in place to measure these skills. Furthermore, the documentation review indicated that the teaching model used had not yet adopted a STEM-based approach. Integration of STEM in daily learning activities was minimal, largely due to limited resources and teacher training, which contributed to the generally low problem-solving abilities among students.

The second step involved preparing the research instruments, such as grids, questions, teaching modules, and E-LKPD, which were validated by three experts. The third step included creating 40 multiple-choice questions, which were tested on 30 eighth-grade students. The results of validity, reliability, difficulty level, and discrimination power tests were analyzed. Out of the validity test results, 23 questions were deemed valid while 17 were invalid; however, only 20 questions were selected for the pretest and posttest as they met the problem-solving ability indicators. Subsequently, the sample was chosen using a random sampling method, consisting of two classes: class VII G (30 students) as the experimental group using the STEM-INQUIRY model with E-LKPD, and class VII H (30 students) as the control group using the discovery learning model with E-LKPD.

The data analysis method uses SPSS version 25 through three stages, namely initial, prerequisite and final data analysis. In the first stage, the validity and reliability of the test instrument was tested through a trial of 40 questions, resulting in a reliability value of 0.827 (very high category). The percentage of difficulty of the questions is 2.5% difficult, 45% medium, and 52.5% easy, with a difference of 12.5% fair, 37.5% good, and 50% very good. The validity of the non-test instrument was tested by a science teacher and two lecturers. The next stage included a normality test which obtained a pretest significance value of 0.470 for the experimental class and 0.263 for the control class. For the posttest, a value was obtained of 0.076 in the experimental class and 0.475 in the control class. Because all significance values are above 0.05, it is concluded that the data in both classes is normally distributed. After that, carry out a homogeneity test which obtained a pretest significance value of 0.064 and a posttest of 0.309, which shows that the data for all classes is homogeneously distributed.

3.2 Data Analysis

Analysis of the Problem Solving Ability Profile of class VII students after learning

Descriptive analysis of problem solving ability profiles shows that there are students in the very high, high and medium categories, with the respective percentages presented in figure 1.

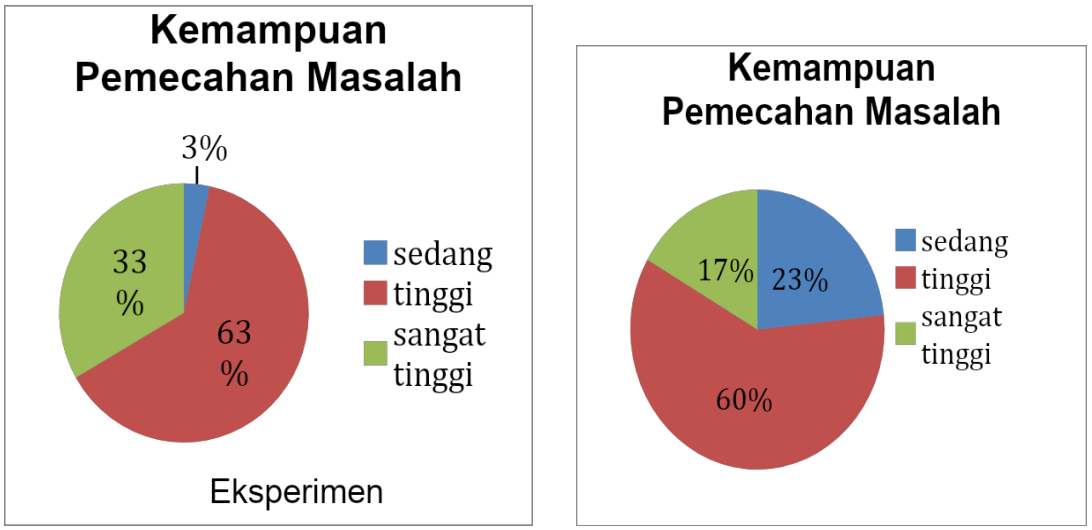

Figure 1. *Percentage of Problem Solving Ability Profile*

The analysis results of the problem-solving abilities profile of class VII students in one of Tegal City Middle Schools show that in the experimental class, 64% of students were in the high category, 33% were very high, and 3% were medium. In the control class, 60% were in the high category, 23% were very high, and 17% were medium. The majority of students show good abilities in solving problems. Students with very high problem-solving abilities are able to understand, plan, and implement solutions effectively. This finding is consistent with Smith et al. (2019), who found that the STEM-INQUIRY learning model significantly improved problem solving and critical thinking skills, especially with the help of digital tools such as E-LKPD.

There are still 3% of students in the experimental class and 23% in the control class who are in the medium category. This is caused by various factors such as differences in learning readiness, motivation, initial skills, and adaptation to new learning methods. Additionally, variations in understanding of the material, application of STEM concepts, and supportive learning environment also influence these outcomes. Panjaitan et al. (2020) stated that learning readiness and motivation greatly influence students' problem-solving abilities. Smith et al. (2019) added that adaptation to new methods, especially those involving technology such as E-LKPD, requires time and adequate support. Johnson and Johnson (2017) emphasize the importance of a supportive learning environment and interaction between students in improving problem-solving abilities.

According to the results of the descriptive analysis, the problem-solving indicators targeted in the research understanding the problem, planning a solution, solving the problem, and reviewing the solution revealed that the seventh-grade students at a junior high school in Tegal City fell into the high classification. These findings are illustrated in Figure 2.

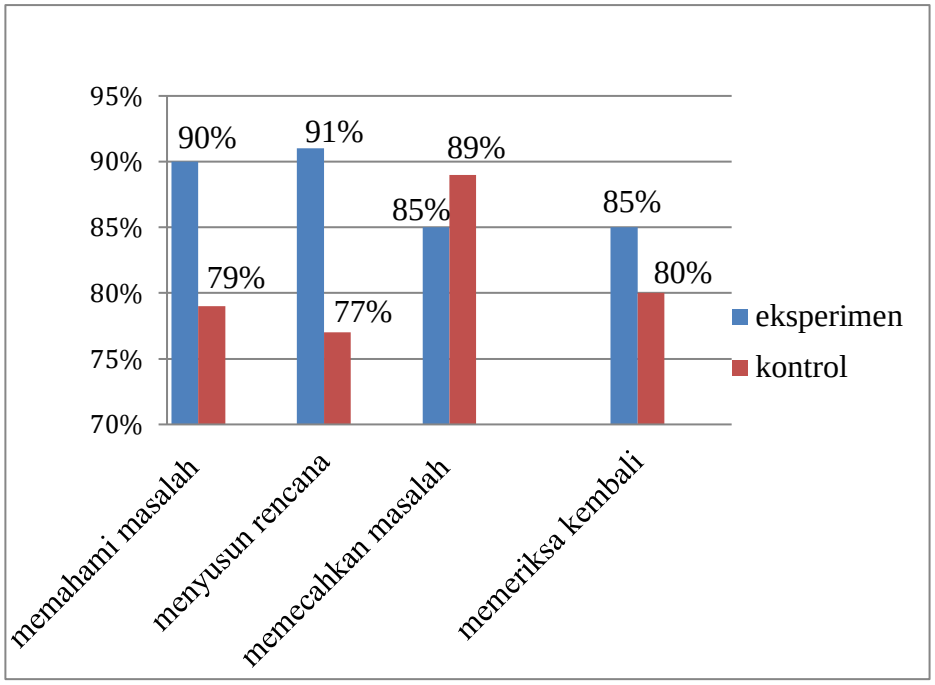

Figure 2. *Mean Percentage of Problem Solving Indicators*

The discussion regarding the achievement of students' problem solving abilities in each indicator will be explained below:

a. Understanding the Problem

Based on the analysis, the experimental class showed an average of 90% in the high category for the problem understanding indicator, while the control class had an average of 79%. The application of the STEM-INQUIRY approach in experimental classes may explain this advantage, as the method encourages students to think critically and analytically, allowing for a deeper understanding of the problem. These results are in line with research by Tsai et al. (2020), which shows that the inquiry-based STEM model can improve students' understanding and problem-solving abilities. Research by Chen et al. (2021) also support that STEM-INQUIRY encourages collaboration and hands-on experimentation, which has a positive impact on students' understanding of complex scientific topics.

These differences in results can be attributed to factors such as instructional strategies, student engagement, and teacher effectiveness in implementing the STEM-INQUIRY approach. In experimental classes, students work together more, experiment, and evaluate solutions, thereby increasing their understanding. In contrast, the control class with discovery learning tended to be less focused, which may have hindered their knowledge and engagement compared to the STEM-INQUIRY model. This finding is consistent with research by Chen et al. (2021), who show that STEM-INQUIRY encourages student participation and hands-on experimentation, increasing their understanding of complex scientific topics.

b. Make a plan

Based on the analysis, the experimental class achieved an average of 91% in the very high category for the planning indicator, while the control class had an average of 77% in the high category. The advantage of the STEM-INQUIRY model lies in its holistic approach, which encourages exploration and research in solving real problems. This model strengthens students' ability to plan through active involvement and collaboration. This finding is in line with research by Kelley & Knowles (2016), which shows that an inquiry-based STEM approach increases student collaboration and active involvement.

This difference in results can be attributed to the STEM-INQUIRY approach which is more interactive and structured compared to discovery learning which is less structured. The experimental class demonstrated higher levels of student enthusiasm and engagement, which enhanced their ability to plan. These findings are consistent with Molfino's research *et al.* (2021), which shows that

the STEM-INQUIRY model improves students' critical thinking and planning skills, especially in science and technology, with a structured and interactive approach.

c. Solve the problem

The results of the analysis show that the experimental class has an average of 85% in the high category for problem solving indicators, while the control class reaches 89% in the same category. This difference in results may be caused by students in the control class who are more familiar with discovery learning methods, so they adapt more easily and achieve higher results. The complexity of STEM-INQUIRY, which requires the integration of scientific disciplines and intensive inquiry, can slow down student understanding compared to more direct approaches to discovery learning. Hmelo-Silver's (2020) research also supports that the complexity of STEM-INQUIRY can take longer for students to understand than direct methods such as discovery learning.

d. Regroup

The results of the analysis showed that the experimental class had an average of 85% in the high category for the re-checking indicator, while the control class achieved 80% in the same category. This difference may be due to the more targeted learning structure in the STEM-INQUIRY model, which supports the development of students' skills in effectively reviewing data. In contrast, discovery learning models, although they encourage exploration and independent learning, tend to be less structured. Research by Smith et al. (2019) also showed that the STEM-INQUIRY model improved conceptual understanding and analytical skills, including re-examining data.

The four indicators show high results, indicating that students have excellent abilities in understanding and solving problems. This high percentage reflects strong analytical skills, the ability to plan effective strategies, and the ability to find the right solutions. The ability to double-check their work also shows students' thoroughness in ensuring accurate results. This finding is in line with research by Johnson and Smith (2022), which shows that problem-solving-based learning significantly improves students' analytical abilities and technical skills.

4 CONCLUSIONS

After implementing the STEM-INQUIRY model with the help of E-LKPD, the profile of students' problem solving abilities showed that 64% of students were in the high category, 33% in the very high category, and 3% in the medium category. Meanwhile, The problem solving ability profile based on the indicators of understanding the problem, formulating a plan, and checking again obtained an average percentage value in the experimental class that was greater than the control class, while the problem solving indicator obtained a percentage value in the control class that was higher than the experimental class.

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