The Effect of a Scientific Approach Based on Problem Based Learning Models on Students Science Problem Solving Skills at Madrasah Ibtidaiyah

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Abstract. The ability to solve problems shows a person’s ability to think critically by using the reasoning and knowledge they have. The purpose of this study was to determine the effect of a scientific approach based on problem based learning on students’ science problem solving skills at Madrasah Ibtidaiyah Negeri 2 Aceh Tamiang. This research is quantitative research with an experimental method. The population is all students of class V MIN 2 Aceh Tamiang, totaling 60 people and the sample used is VA class as the control class and VB class as the experimental class. Each class consists of 30 people. The research instrument was a test in the form of an essay totaling 3 questions of indicators of problem solving skills namely identifying problems, describing various strategies, solving problems, and solving problems systematically. From the results of the data analysis, the class average value was obtained. The experiment was higher than the control class with a difference of 54.67 and an increase of 63.87%. The findings from the hypothesis testing indicate a significance level of 5%. The calculated t-value 18.41 exceeds the critical t-value 2.41 for the shown degrees of freedom 18.41 or the two-tailed significance value 0.00 is less than 0.05. Consequently, the alternative hypothesis (Ha) is accepted. The conclusion is an effect of a scientific approach based on problem learning on students’ science problem solving skills at Madrasah Ibtidaiyah Negeri 2 Aceh Tamiang and this approach is good for learning science.

Keywords: Scientific Approach, Problem Based Learning, Problem Solving Skills, Science

Introduction

The government has made various efforts to prepare a quality learning process to achieve educational goals in Indonesia. Curriculum changes, improvements to facilities and infrastructure, using media, and innovative learning models are steps towards a higher quality Indonesian education. The development of science and technology has an impact in all fields, where effects occur to increase success in the learning process (Maulidiya & Mercuriani, 2023). Three aspects are essential points in this curriculum, namely aspects of attitude (affective), skills (psychomotor), and knowledge (cognitive), which are the main reference points in the assessment. In the learning process, the K13 makes the learning process more meaningful by inviting students to conduct scientific research (Nugraha & Suherdi, 2017). Ethnic background, as a demographic component integrated inside a socio-cultural milieu, can potentially impact the learning process. The
field of science and science education encompasses not only the acquisition of knowledge and critical thinking skills but also emphasizes several aspects, including the learning process. The abilities demonstrated while participating in activities rooted in scientific principles are commonly referred to as science process skills (Duda et al., 2019).

The National Research Council (USA) established a definition for 21st-century skills in the year 2012, recognizing their essential role in learning. Problem-solving is a fundamental component of executive function skills, encompassing the cognitive process of problem identification, solution exploration, and optimal implementation within novel contexts (Araiza-Alba et al., 2021). A scientific approach is a method that uses a scientific framework in the learning process. This scientific approach relates to real life, which expects students to be more creative, innovative, and able to issue brilliant ideas in solving the problems (Nahdliyati et al., 2016). This is expected to stimulate student motivation and interest in learning because it can positively influence teachers and students in finding a lesson (Wahyono et al., 2017). Through a scientific approach, we can create a conducive atmosphere to change a person's way of thinking and character to become more creative with their various ideas. This approach can also change a monotonous atmosphere into a pleasant learning atmosphere, where students are given material and facts found around their lives to increase their motivation for further curiosity (Nagl et al., 2015).

The application of a scientific approach to students is expected to make learning active, innovative, creative, and productive so that it can form students' hard skills and soft skills by referring to three aspects, namely affective, cognitive, and psychomotor. This approach has five stages: observing, asking, collecting information or conducting experiments, associating, and communicating (Atmarizon & Zaim, 2016). Apart from having steps, the scientific approach has the following characteristics: student-centered, involving skills and concept assignments, cognitive processes, and developing student character (Maryani et al., 2020). In the teaching and learning process, the scientific approach is closely related to problem-solving skills as a cognitive process to find ways to achieve a goal. It depends on organizing and processing information (Gunawan et al., 2020). Apart from cognitive aspects, an affective component is needed to measure students' active in the learning process (Purwasih et al., 2018).

Therefore, the conventional approach is less effective in developing students' problem-solving abilities. This ability is essential in understanding concepts and principles, analyzing procedures, and evaluating and interpreting results. The existence of this problem-solving stage can increase students' ability to explore the knowledge they have (Gok, 2014). These skills require students to connect their knowledge, skills, and understanding to finding solutions to specific problems (Batolona et al., 2018). Four steps or stages can be used to develop this skill: understanding the problem, planning, project implementation, and reflection (Purwasih et al., 2018). This skill has high relevance in everyday life and can be obtained through science learning, where students can apply this skill through the steps or stages involved in this method. Students will be trained to face various problems and formulate solutions more effectively through a scientific approach to learning science.

Science learning is inseparable from the process of observation and investigation, which can make students able to solve a problem. This is because learning science is a learning that requires students to think at a higher level (Jelita et al., 2020). Science learning by using problem solving skills is believed to be able to broaden students' insights. The students experience challenges when attempting to acquire problem solving skills. In this manner, individuals cannot cultivate any systematic approaches to problem solving. Consequently, the kids need to demonstrate their achievements (Gok, 2014).
However, the reality in the field is that students find it difficult to understand science material, and it becomes one of the terrifying lessons. This is due to students' lack of interest in learning science, causing students to pay less attention to the teacher when learning takes place. So far, students have only recorded natural science material without understanding the intent of the recorded material. When students are given science questions, they want to work on them, but students get bored quickly in working on these problems due to the lack of motivation provided by the teacher. This is in line with (Azizah et al., 2022) which states that the learning activities carried out by students are based on the desires of the student's souls and the lack of encouragement from the teacher to be active in science learning. This is because teacher motivation is needed to move the learning power contained in students so that they direct students to achieving learning goals (Widjaya et al., 2023). In addition, students' self-confidence makes it easier to understand science learning material and makes it easier for students to ask questions and express their opinions (Azizah et al., 2022).

Readiness for student learning is also the basis for carrying out activities so that students will more easily understand the science material provided, easily accept explanations of the science learning material provided by the teacher and can make students more quickly adjust their minds to the science learning material to be discussed. As well as the need for precise methods and approaches used by teachers in teaching, students are less interested in understanding and influencing their ability to solve problems. The students' comprehension of several elements of the explanation of scientific phenomena, evaluation and design of scientific research, and interpretation of evidence and scientific data needs to be improved. The outcomes of this study are deplorable, considering the significance of scientific literacy skills in the context of the current century. Accordingly, there is a pressing need to enhance the advancement of scientific literacy (Hestiana & Rosana, 2020). Educators have the potential to enhance student's abilities by implementing learning activities that promote the development of higher-order thinking skills. Additionally, curriculum designers should evaluate the degree to which the curriculum has successfully attained its goals and devise strategies to enhance higher-order thinking skills. Therefore, the educator's selection of instructional methods will impact the development of higher-order abilities in learners. This statement emphasizes the importance of acquiring knowledge, as it can positively impact the development of higher-order thinking skills in learners (Saido et al., 2015).

Based on the results of PISA in 2018 it was found that the problem-solving abilities of students in Indonesia still needed to improve. This is evident from the 79 participating countries of PISA, ndonesian students' problem-solving skills need to reach level 2 (OECD, 2019). In addition, the low ability of Indonesian students to solve problems can affect science learning outcomes (Dharma, 2008). According to Sumartini (2018) students' problem-solving abilities still need to be improved, evaluations are rarely carried out in the learning process, and they still adhere to conventional methods. The cause of these low skills is that students need more critical thinking skills in solving problems to apply previously acquired knowledge to new situations, such as analyzing, considering, and making the right decisions (Zunanda & Sinulingga, 2015). Therefore, students’ critical thinking skills are needed to increase creativity, develop inner character, and be able to solve problems faced in science learning. This can be achieved through a scientific approach that connects theoretical knowledge with real-world situations, increasing their understanding of scientific concepts. According to science process skills can be improved by using the problem
based learning (PBL) model. In addition, stated that to increase scientific creativity, students need higher-order thinking skills, especially synthesis and evaluation skills (Saido et al., 2015).

Methods

This research employs a quantitative research design utilizing experimental approaches. The variables examined in this study encompass the scientific approach (X) and problem-solving ability (Y). The scientific approach is executed through five processes: observation, inquiry, data collection, logical reasoning, and dissemination of findings. The research design employed in this study was the posttest-only control group design. The study sample comprised two classes, VA and VB, from class V MIN 2 Karang Baru Aceh Tamiang, with 60 individuals. The study utilized two distinct courses as samples: the VA class, which served as the control group and employed traditional lecture-based instruction, and the VB class, which served as the experimental group and implemented a scientific approach to learning. Every class is comprised of a total of 30 individuals. The sampling procedure employed in this study involved using a simple random sampling strategy, namely utilizing a lottery method. The assessment tool employed in this study was an essay test consisting of three questions, each designed to assess the participant's ability to identify difficulties, describe different options, and methodically solve problems. Table 1 displays the grid for the problem-solving skills test.

Table 1. Problem solving skills grid

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Indicator</th>
<th>Sub Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving Skills</td>
<td>Identify the problem</td>
<td>Presenting problems in the form of pictures and story questions</td>
</tr>
<tr>
<td></td>
<td>Describe various strategies</td>
<td>Use various ways to solve problems</td>
</tr>
<tr>
<td></td>
<td>Problem solving</td>
<td>Answer questions</td>
</tr>
<tr>
<td></td>
<td>Problem solving systematic</td>
<td>Giving various reasons</td>
</tr>
</tbody>
</table>

In advance of implementing the essay exam, a preliminary evaluation is conducted on a sample of students from the sixth grade. This evaluation aims to assess the instrument's validity, reliability, level of difficulty and discriminating power. The evaluation is carried out using the IBM SPSS version 23 software. The obtained $r_{count}$ is derived from the study of the validity value at a significance level of 5%. Suppose the significance level (p-value) is less than 0.05, and the Pearson correlation coefficient is positive. In that case, the item is considered genuine, which is more important than the
reliability coefficient \((r\text{-table})\) (Sujarweni, 2014). Based on the results of the data analysis a reliability value is considered satisfactory if Cronbach's alpha coefficient above 0.6 indicates a reliable measure. Conversely, the measure is deemed unreliable if the coefficient falls below this threshold. The data analysis reveals that Cronbach’s alpha value is 0.711, indicating a high level of reliability for all items. The resultant findings indicate based on the outcomes derived from the analysis of question difficulty levels and their distinguishing power, as measured by the corrected item-total correlation.

Question 1 contains an adequate number of objects, question 2 exhibits a satisfactory selection of items, and question 3 showcases an exemplary assortment. In general, the instrument can serve as a valuable tool for data collecting in research endeavors. In order to examine the research hypothesis, the distribution test \((t\text{-table})\) will be employed to analyze the two samples. This analysis will be conducted using the IBM SPSS version 23 software. The decision-making criteria for this analysis are as follows: if the significance value (two-tailed) is less than 0.05, then it is stated that there is an influence. The alternative hypothesis \((H_a)\) will be accepted. If the significance value (two-sided) is greater than 0.05, there is no statistically significant effect, and the null hypothesis \((H)\) is accepted.

**Result and Discussion**

After getting the results of the instrument trials, before learning began, a pre-test was first carried out in both VA and VB classes to see students' initial ability to problem solving skills in science learning with material on organs of movement in animals and organs of movement in humans. The test results for the average pre-test scores of MIN 2 Aceh Tamiang students can be seen in Table 2.

**Table 2.** The average value pretest of the experimental and control classes

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Maximum</th>
<th>Minimum</th>
<th>X (Average)</th>
<th>Standard Deviation (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>30</td>
<td>28</td>
<td>0</td>
<td>10.53</td>
<td>7.93</td>
</tr>
<tr>
<td>Experiment</td>
<td>30</td>
<td>60</td>
<td>0</td>
<td>27.93</td>
<td>14.48</td>
</tr>
</tbody>
</table>

Based on Table 2, the VA and VB classes' initial ability has an average value more significant than the standard deviation value. This shows that the data from the pre-test results of the two classes are homogeneous. However, the value of the two classes' problem-solving skills is still in the low category, namely below a passing grade of 75, especially on the theme of locomotor organs in animals and locomotor organs in humans. After carrying out the learning process in the experimental class (VB) and the control class (VA) it is continued by giving the final test (post-test) to both classes at the same time, which is 60 minutes. The results of the post-test in both classes can be seen in Table 3.
Table 3. The average value posttest of the experimental and control classes

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Maximum</th>
<th>Minimum</th>
<th>X (Average)</th>
<th>Standard Deviation (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>30</td>
<td>72</td>
<td>12</td>
<td>30.93</td>
<td>14.36</td>
</tr>
<tr>
<td>Experiment</td>
<td>30</td>
<td>100</td>
<td>76</td>
<td>85.60</td>
<td>6.96</td>
</tr>
</tbody>
</table>

The post-test results in Table 3 show that after learning using a scientific approach based on the PBL model, the problem-solving skills of the experimental class had a minor standard deviation compared to the average post-test score for the control class. This shows that the score distribution from the experimental class provides a more significant gap between students' maximum and minimum scores. This means that the treatment given to experimental class students was successful because the students focused on the learning activities presented. Meanwhile, the standard deviation value in the control class is quite significant, so the distribution of values is uneven, and the average value is smaller than the experimental class. Therefore, a scientific approach with the PBL model can improve students' problem-solving abilities in science material.

Figure 1. Profile students' skills in science learning

In addition, the average value of the experimental class is higher than the control class with a difference of 54.67 and an increase of 63.87%. Regarding the average value, the problem-solving skills of the experimental class are better than the control class. Thus, the experimental class shows the significant value of providing PBL with a scientific approach. A hypothesis test was carried out to see the significant influence of the scientific approach. Before testing the hypothesis, the normality and homogeneity tests were carried out first. The results of the normality test analysis using the IBM SPSS version 23 application are normally distributed data because the sig value > 0.05 equals 0.172 for the post-test value in the experimental class and 0.176 for the post-test value in the experimental and control class. Then the homogeneity test analysis results using
the IBM SPSS application version 23 data are distributed homogeneously, because the sig value > 0.05 equals 0.367. After carrying out normality and homogeneity tests in the experimental and control classes, the researchers conducted a hypothesis test. This is done to find out whether there is an effect of the scientific approach to problem solving skills in science learning achieved in the experimental class.

Based on the results of hypothesis testing using the t-test (independent sample t-test) with the help of the IBM SPSS Version 23 application, the equal variances assumed sig (2-tailed) value is 0.000. This means that the value of sig (2-tailed) < 0.05 or \( t_{\text{count}}>t_{\text{table}} \) (18.41 > 2.41) so that \( H_a \) is accepted. Consequently, there is a significant influence of using a scientific approach based on problem based learning models on PBL. This is following the results of the study (Erny et al., 2017) which says that there is a positive effect from using PBL with a scientific approach to problem solving skills in learning mathematics. Usually, students choose to utilize solved issues as a means to address both qualitative and quantitative problem-solving tasks. Their attention is solely directed toward the accurate outcomes of the issues. Typically, individuals do not employ structured PBL methodologies to resolve a given issue (Gok, 2014).

This is because the scientific approach combined with the PBL model can help children to contribute to their learning. After all, children directly deal with the natural world so that they can relate the material being taught to the problems they face. The application of scientific approach-based learning can improve students' skills because it is focused on process skills (Setiawan & Wilujeng, 2016). These activities are scientific approaches such as observing, asking questions, collecting information or data, associating information, and communication skills, which are implementing the process itself. Learning that focuses on process skills can help students to improve learning outcomes (Aktamiş et al, 2016).

In terms of student problem-solving in each experimental and control class, it can be seen from the percentage of achievement of each indicator in Table 4.

**Table 4.** Percentage of problem solving skill indicators of the experimental and control classes

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Experiment (%)</th>
<th>Control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the problem</td>
<td>78</td>
<td>60</td>
</tr>
<tr>
<td>Describe various strategies</td>
<td>75</td>
<td>58</td>
</tr>
<tr>
<td>Solution</td>
<td>80</td>
<td>68</td>
</tr>
<tr>
<td>Decision making systematic</td>
<td>83</td>
<td>67</td>
</tr>
</tbody>
</table>

Based on Table 4 shows that the problem-solving skill indicators of the experimental class students are better than the control class. In the experimental class, students' decision making systematic has the highest rating (83%) and the lowest on describing questions using various strategies (75%). However, overall, all indicators of PBL exceeded the specified completeness value (75). Regarding the control class, the highest score of solution abilities (68%), and the lowest is at the second indicator of 58%. As a whole, it is stated that it has yet to reach completeness. It is because the
experimental class students have been trained in solving problems given through storytelling problems in which there are problems in everyday life. In addition, with a scientific approach, it trains students to observe, ask questions, collect information, associate, and communicate the material displayed through YouTube videos so that students can directly see the process of learning activities and become interested in the images and sounds displayed. The existence of this display causes students to be motivated to think about finding the solution. However, in the control class, students were not used to identification from the material presented. The teacher only transferred their knowledge to students without being accompanied by problem-solving skills around them, so they did not invite students to think about solving the problems they faced in learning. It is because the teacher rarely invites students to observe the material using engaging learning media following the learning material. Thus, the PBL model effectively applies during the student learning process with a scientific approach, making students more active and critical in finding a solution. It is because while employing PBL as an instructional approach, students are directed to independently discover solutions by following the logical phases of the PBL model.

The material applied by researchers uses a scientific approach that refers to standard indicators of problem-solving skills, namely identification, describing various strategies, solution, and decision making systematically. So that students are very enthusiastic about participating in the learning process. The instructional process has been designed with stages that make it easier for students to understand the themes presented. The existence of solving skills that have been designed makes learning more manageable, more focused, interesting, and makes students more active in ongoing learning. The study's findings provide evidence that the PBL technique employed in the research has demonstrated effectiveness in improving the students' problem-solving abilities. Furthermore, research suggests that PBL is more efficacious than non-PBL approaches when improving students' ability (Valdez & Bungihan, 2019). Based on the results of data analysis, it can be explained as follows.

**Identify The Problem**

The learning process in the first stage, students are directed to understand problems or questions regarding animal motion. At this stage, students are stimulated to find out what is a problem that must be solved so that they can present questions to students to find answers. Students must identify the values related to the problem being observed, so that it can assist students in solving a problem in the first stage. As well as connecting similar problems, so that you can explain the problems you are experiencing using your own language (Cahyani & Setyawati, 2016).

Identifying problems can improve students' ability to think critically in solving problems contained in science learning and requires students to stimulate their knowledge in finding out the issues they want to solve, consequently raising questions appropriate to the problems they face. This is appropriate (Zunanda & Sinulingga, 2015) that problem solving is an effort to find a way out of learning difficulties to achieve learning objectives. Identifying problems can make it easier to solve or solve problems that occur in science learning with learning activities through observing, asking, collecting (trying), associating, and communicating the science learning information that has been obtained (Erny et al., 2017).
Describe various strategies

In this activity, students are stimulated to look for and recall problems that have been solved and then try to make connections with current problems. In this activity, students are required to compile the steps or strategies needed to make it easier for students to solve the problems given (Sumartini, 2018).

Compiling the steps or strategies used can shape students' thinking patterns critically in solving problems contained in science learning. The process contained in the scientific approach is that students are required to observe activities carried out by reading, listening, and seeing without using additional tools. This process can train students to be serious in reading, listening, and so on, and can form accuracy in using various strategies (Erny et al., 2017).

Find solutions

After compiling the steps for finding solutions, students carry out the steps prepared with the help of the teacher's role as a facilitator. Gather various information and conduct experiments to get explanations and solve problems (Sumartini, 2018). Through experiments, students will remember what they did and the results they obtained so that students have the skills to solve problems following the ideas contained in them. When students compile steps in compiling problem solving, students look for sources with different opinions by collecting all the problems obtained. They are required to reason about the various information obtained. When students solve problems, a pattern of critical thinking is needed through reasoning from the results that have been observed. In addition, problem solving skills foster an honest and conscientious attitude.

Decition making systematic

Activities at this stage are the core activities of problem solving skills. The draft strategy or steps prepared in the previous stage will be carried out at this stage systematically. The role of the teacher as a facilitator is significant, because the active part of students is very dependent on how the teacher manages the class. Considering from the study results, students were very enthusiastic when they succeeded in solving the problem. After successfully it, the thing that must be considered is looking back at the steps previously involved in this skill and then being questioned again whether the questions that arose in the first stage got the answer following the procedure that had been carried out (Cahyani & Setyawati, 2016). At this stage, students and their groups exchange ideas and equate the perceptions of their different opinions to find a decision to solve the problem. This is appropriate (Samani, 2012) that exchanging ideas will result in correct it together.

Thus, problem solving skills can be grown if in learning the teacher provides several problems that students must solve. This learning can be done through video shows offered by the teacher so that students can find solutions with their friends through the learning resources obtained to solve existing problems. Using a scientific approach combined with PBL makes children critical in thinking so that children can construct their knowledge through the questions they ask. This is following research conducted by (Fusaro & Smith, 2018) that children's ability to solve scientific problems influences cognitive skills and tends to ask questions in developing their ideas. The various solutions obtained by students can improve different cognitive skills. This skill must be following the child's ability so that later he can act according to his thoughts which can influence his behavior in the future.
Conclusion

The results of the study revealed that students' problem-solving abilities in the context of learning natural sciences managed to reach the category considered good on all indicators, which included the ability to identification, overcome various problems, resolve strategies, solution, and achieving a predetermined level of learning completeness. In addition, a scientific approach based on problem-oriented learning models significantly improves students' ability to find a solution during the science learning process. Even though, in practice, some students still need help identifying it in storytelling questions. Therefore, it is necessary to carry out further research that integrates this approach into science education to effectively stimulate students' depth of understanding and critical thinking skills through storytelling questions.

References


