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The Influence of The Problem-Based Learning with Radical Constructivism Module on Students' Problem-Solving Skills

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Abstract. Problem solving skills (PSS) are one of the high-level thinking skills that must be possessed by students. This skill will help students apply scientific content to solve problems in real life. The purpose of this study was to determine the effect of problem based learning (PBL) models with a radical construktivism module on PSS. Data were collected in February to March 2022. The method in this study used an experimental method with nonrandomized post test only control-group design. This research was conducted in two classes: the experimental class using PBL model learning with radical constructivism module and the control class that only using PBL model learning. The samples were 160 students. The instrument was tests to assess PSS. Data analysis used independent sample t-test to determine effect of PBL model learning with radical constructivism module on PSS. T-test results showed that value sig > 0,05. The result showed that students who received PBL model learning and the radical constructivism module obtained significantly better PSS compared to students who only received PBL model learning.

Keywords: Problem-based learning module, radical constructivism, problem-solving skills.

Introduction

Current learning emphasizes students being able to understand scientific concepts and apply them in real situations through problem-solving. These skills must be provided early to prepare students for global competition. Students must be taught and trained in problem-solving processes related to everyday life, applying scientific content learned in class to solve problems (Ling & Mahmud, 2023; Zhao & Allen, 2023). These problem-solving skills (PSS) are very necessary in environmentally based learning, such as in learning about environmental pollution.

Environmental pollution material is studied in class VII MTs/SMP in the even semester. This learning aims to enable students to analyze and solve environmental problems. The results of the initial study of learning environmental pollution material at MTs in Banda Aceh City showed that learning had not yet trained contextual PSS, so students had difficulty solving questions that presented ecological problems, such as identifying issues, hypothesizing, investigating, and applying scientific content to find solutions to problem-solving. They were Related to everyday life. The results of the interviews stated that students needed help in solving environmental pollution case

questions and planning solutions. Students are not used to solving questions that require reasoning by linking various lesson concepts they have studied.

The low PSS of MTs Banda Aceh City students can also be traced from the national exam scores (UNBK). The average biology score on environmental pollution is still low, whereas UNBK questions require analysis and reasoning (Ulhaq et al., 2020). The low average score of students who answered correctly shows students' difficulty in answering questions that require logic and creative thinking. Therefore, PSS must be improved to build knowledge and creativity. Students need to be involved in situations and tasks related to problem-solving. One effort can be made by implementing the problem-based learning (PBL) learning model.

The PBL model involves students in problem-solving activities through reasoning, investigation, expressing ideas, finding answers and imagining in solving problems so that they become students who think critically (Alt et al., 2023; Hu et al., 2023; Özdeniz et al., 2023). Providing problems in PBL learning can stimulate students to find ideas and decide the most appropriate ideas for solving problems (Mustofa & Hidayah, 2020; Sumarni & Kadarwati, 2020; Beneroso & Robinson, 2022). The characteristics of PBL learning make students more active and independent in discovering knowledge concepts and linking this knowledge to real problems presented in learning.

A radical constructivism module will assist the application of PBL to environmental pollution material. The radical constructivism module is a learning module developed based on the revolutionary constructivism approach, which provides continuous learning experiences ranging from simple to complex problems. Radical constructivism views knowledge construction as found on previous experience and knowledge and students' interactions with environments that contain various realities. In its presentation, the module displays facts and reality around students to activate the senses and imagination (Walshe, 2020; Jayasinghe, 2021; Ali & Dini, 2022; Arney et al., 2023). These realities and facts are the main components in analyzing problems critically, logically, broadly and deeply. Radical constructivist learning prioritizes providing reality to shape students' knowledge. These realities will be presented in the module. By understanding reality, students will indirectly cognize knowledge into their cognitive structure.

The PBL learning model with the radical constructivism module is a suitable combination, which prioritizes students' thinking with diverse reasoning abilities, thinking complexly based on the information received. This learning will develop critical thinking skills in problem-solving. Students' knowledge is built based on their thoughts, and the teacher plays a role in reflecting on the students' thoughts. A more in-depth study needs to be carried out looking at the combination of these two learning approaches (Yakar et al., 2020; Epp et al., 2021; Meng et al., 2023). Several previous studies have shown the success of the PBL model in improving students' PSS through active involvement in learning (Aslan, 2021; Chen et al., 2021; Sari et al., 2021; Kim et al., 2022; Manuaba et al., 2022; Ichsan et al., 2023), As well as the success of the radical constructivism module in forming understanding constructions towards the reality and facts around students (Walshe, 2020; Hill, 2022; Knoblauch & Pfadenhauer, 2023; Marnewick, 2023). However, research must combine the PBL model and radical constructivism modules. This research must be carried out to see the impact on students' problem-solving abilities.

Methods

This research approach was quantitative and experimental, with a randomized post-test and only a control-group design (Stratton, 2019; Rogers & Revesz, 2020; Krishnan, 2023). The research was carried out at Madrasah MTsN 1 and MTs Darul Ulum Banda Aceh in the even semester of the 2021-2022 academic year.

Table 1. Randomized post test only control group design

Kelas	Independent Variable	Pos-test
Experiment	X	Y_2
control	-	Y_2

Information:
Y2: Post-test Experimental class
Y2: Control class post-test
X: PBL with radical constructivism module

The population of this study was 493 students. The sample was chosen randomly, taking into account the representation of students as experimental and control classes, resulting in a sample of 160 students consisting of 90 experimental class students and 70 control class students. PSS are obtained through subjective test instruments i.e. analysis, evaluation and creation skills. This instrumental test was designed based on indicators of PSS, including: 1). understanding the problem, 2). preparing a plan, 3). solving the problem, and 4). Evaluating (Exintaris et al., 2023; Ulhaq et al., 2023). An initial ability test (pre-test) was also carried out on the two sample classes, using the independent sample t-test formula to obtain sig> 0.05 (0.188> 0.05), which means that students in these two classes have the same abilities.

Data analysis of students' PSS based on an assessment rubric that has been prepared with scores of 0, 1, 2, 3 and 4. The scores are tabulated in a table to determine the score obtained for each question item. Decision-making regarding the level of students' PSS is based on the criteria in Table 2. Next, to determine students' PSS as a group, the student scores will be analyzed using a percentage formula (Valdez & Bungihan, 2019).

Table 2. Problem-solving skills score criteria

Problem-solving skills score	Criteria
81- 100	Very high
61-80	High
41-60	Enough
21- 40	Low
0 – 20	Very low

Results and Discussion

Data Problem-solving skills on environmental pollution material were measured using a description test of 10 questions guided by a predetermined assessment rubric. The average score of PSS for the experimental class and control class can be seen in Figure 1.

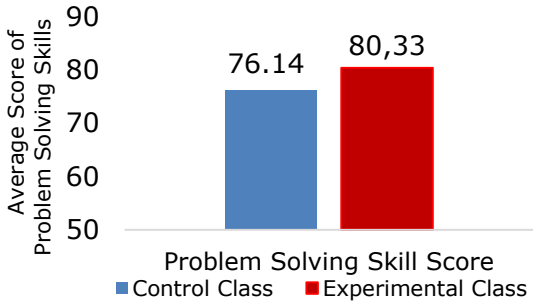

Figure 1. Average score of problem-solving skills

Based on Figure 1, the average score for PSS for the experimental class was 80.33, and the average for the control class was 76.14. Data on PSS were analyzed using the independent sample t-test formula to see the effect of treatment on PSS. The t-test results and data normality can be seen in Tabel 3.

Table 3. Independent sample t-test data on problem solving skills

Class	Average Post test	Normality*	Homogeneity **	Significance***
Experiment	80.3	Normal Sig : 0.087	Homogen Sig : 0.207	Significan $t_{count} > t_{table}$ 3.033 >1.975 Sig (2-tailed) 0.003
control	76.1			

Infromation :
*) = One Sample Kolmogorov-Smirnov (Normal, Sig > 0.05)
**) = Levene test (Homogen, Sig > 0.05))
***) = Independent sample t test (Sig < 0.05, t count> t table)

Based on the hypothesis testing table, the Sig value is 0.003 < 0.05, t_{count} (3.033)> t_{table} (1.975), meaning the hypothesis is accepted. Students who learn from the PBL model with a radical constructivism module gain significantly better PSS than those who only learn from the PBL model. Data on the PSS of experimental class and control class students varies greatly. The experimental class has a higher average value compared to the control class. Data on students' problem-solving skills is then analyzed using a percentage formula to see the percentage of students' PSS achieved in the categories very high, high, enough, low and very low.

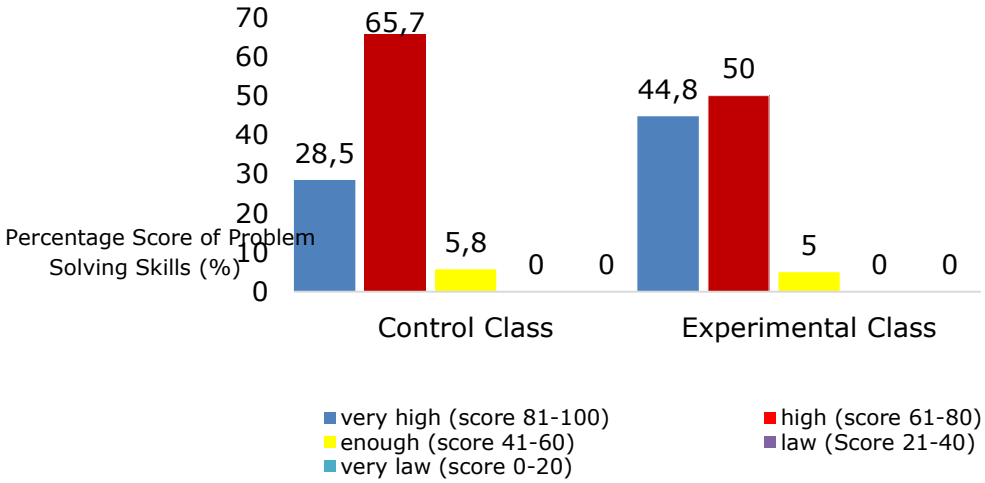

Figure 2. Percentage of students' problem-solving skills scores

Figure 2, shows the percentage of PSS categories. In the experimental class, there were 44.8% of students in the very high PSS category, 50% in the high category, 5% in the moderate category, 0% in the low category, and 0% of students in the very low category, while in the control class, there were 28.5% of students are in the very high category and 65.7% are in the high category, 5.8% of students are in the moderate category, 0% are in the low category and 0% are in the very low category. The experimental class had better PSS compared to the control class. The difference in the percentage of achieving PSS is because the PBL model learning process can train PSS such as identifying and investigating through scientific activities. The radical constructivism module contains learning material that is well presented and contains facts and realities that increase knowledge and develop students' PSS.

Students PSS consist of several indicators: 1) understanding the problem, 2) preparing a plan, 3) solving the problem, and 4) evaluating. Each test item is arranged to represent each indicator. Furthermore, the PSS data is analyzed to determine the average score for each indicator.

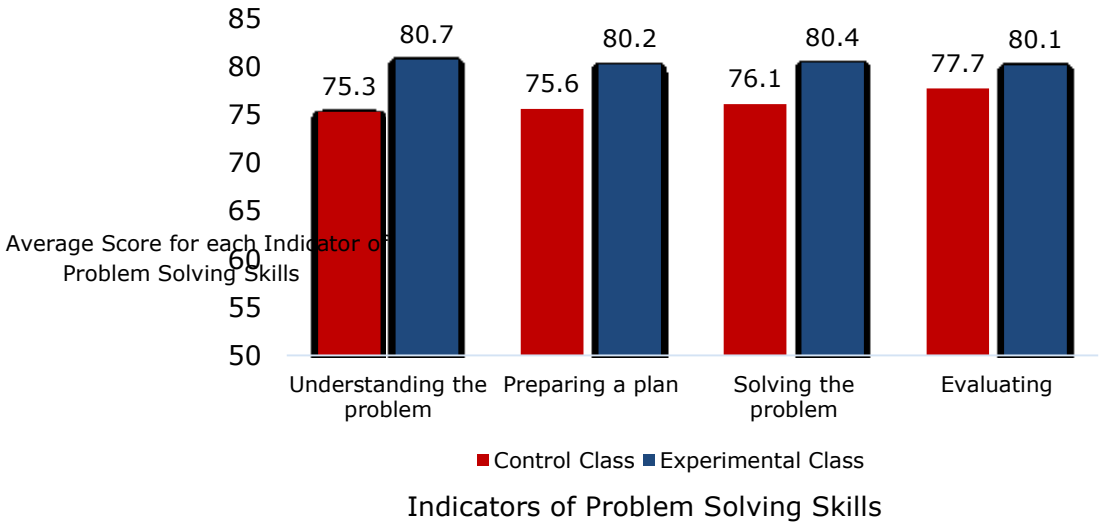

Figure 3. Score achievement for each indicator of problem-solving skills

In formulating a problem, students are asked to understand an environmental case in the student worksheet. Students must truly understand the problem before determining a resolution strategy that can be used to solve the problem. In planning a solution, students create a strategy that can be carried out using the issues given through environmental pollution cases in the LKPD. In the problem-solving indicator, students apply problem-solving techniques that are most appropriate and easy to apply in solving problems. In the evaluating indicator, students are asked whether the problem-solving strategy is suitable for solving the problem or not.

The analysis results show that the experimental class achieved higher scores on each PSS indicator than the control class. This difference in scores shows the same pattern for each indicator of PSS, which include formulating problems, formulating plans, solving problems and evaluating. The high average score of PSS in the experimental class is because this class has learning resources for radical constructivism modules, which can support students understanding in following the stages of the PBL learning model. Students actively construct their knowledge so that they can solve and find solutions to the problems in the student worksheet (Srikan et al., 2021; Almulla, 2023). Problem-solving requires knowledge and understanding of concepts to make the solutions presented precise and scientific. Understanding concepts for students is very important for solving problems in learning. The knowledge gained will help students understand issues and find solutions to solve problems by applying the scientific content they have learned. This is the opinion of experts, who say that students who already understand the concepts of the subject matter will find it easier to solve problems. On the other hand, if students have poor understanding, they will have difficulty to solve problems (Daryanes et al., 2023; Rini and Aldila, 2023).

The PBL model learning process and radical constructivism module effectively improve PSS. Providing issues in the form of phenomena that occur in everyday life will stimulate students to think creatively to find solutions. The radical constructivism module systematically presents concepts to build a fundamental construction of understanding through the information presented (Walshe, 2020). The module contains subject matter, the reality of environmental pollution, and solutions that solve problems. Obtaining concepts in phenomena and reality makes it easier for students to solve problems in the student worksheet given. This is the opinion of Hill (2022) and Jayasinghe (2021), who state that the radical constructivism module contains realities that will help students understand problems and solve problems.

PSS are one of the highest cognitive levels by maximising students reasoning power to find the right solution by involving the senses in understanding problems, making plans, solving problems, and evaluating ideas. Based on the findings, researchers can assume that students' PSS are very dependent on the initial knowledge that students have obtained. Developing PSS can optimise high-level cognitive abilities, especially applying, analysing and evaluating. As cognitive skills increase, this will indirectly affect thinking abilities.

The radical constructivism learning module was developed using constructivist learning theory, providing students with sustainable learning experiences. This learning experience begins with understanding simple phenomena and more complex problems. The radical constructivism module contains information in the form of reality, facts and events regarding phenomena, increasing students' insight and knowledge in analyzing problems critically, logically, broadly and deeply. The learning experiences that students have gone through will make it easier for them to construct an understanding of their cognitive structures actively. This is the opinion of Ulhaq et al. (Ulhaq et al.,2020), who state that knowledge results from cognition of reality and experience.

The radical constructivism module, in its application, includes 3 phases of learning experiences: cognitive, assimilation, and accommodation. In the cognitive phase, the

module will display subject matter so that students can construct their understanding by displaying scientific concepts of the studied material. In the assimilation phase, the module will display new knowledge in the form of problem-solving, students can connect the subject matter studied in the cognitive phase. The problems that arise in this phase are simple. Meanwhile, in the accommodation phase, the module will present problem-solving on a broader scope, in the form of real problems around students. The problem presented is a more complex problem that requires in-depth analysis to find solutions to the problem.

The success of implementing the PBL model and radical constructivism module in improving PSS can be seen in the activeness and enthusiasm of students in participating in the learning process. Students become independent students in solving problems on LKPD. The problems given are real problems that exist in the students' environment. This is the opinion of Yuan et al., (2020) and Seibert (2021) that the PBL model can increase students' interest in active learning. Apart from that, Valdez & Bungihan (2019) stated that using modules can create fun learning, encouraging total student involvement in education.

Conclusion

Applying the PBL model with a radical constructivism module affects PSS. The findings consistently show that students can analyze problems critically, logically, broadly and deeply by understanding facts and reality. Combining the PBL model and radical constructivism module can help students become students who can construct knowledge so that their problem-solving abilities increase. In the PBL model, students go through a series of scientific activities such as identifying, investigating, and solving real problems presented in learning. The radical constructivism module plays a role in systematically strengthening the material concepts presented in the module. Understanding scientific concepts as a basis for problem-solving.

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