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The Influence of PjBL-Based STEAM Approach on Students' High Order Thinking Skills

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Abstract: The focus of the research investigated the influence of the PjBL-based STEAM approach on the high order thinking skills of students in science learning on sound and light wave materials. The research conducted was a quantitative research using a quasi-experimental design involving two groups, namely the control group using conventional methods and the experimental group using the PjBL-based STEAM approach. The results showed that the experimental group that applied the PjBL-based STEAM approach experienced a significant improvement compared to the control group that used conventional learning. The increase in high order thinking skills in the experimental group was 67.32%. In contrast, the control group also showed an improvement, but in a low percentage of 28.43%. The t-test showed a significant difference (p = 0.000), and the N-gain analysis showed that the experimental group had a higher N-gain (69.3%) compared to the control group (29.3%). So that the application of the PjBL-based STEAM approach is more effective in improving high order thinking skills compared to conventional learning methods.

Keywords: High order thinking skills; Science learning; STEAM-PjBL

Introduction

Education is a planned and systematic process to optimally develop students' potential through meaningful and contextual learning experiences (Hidayat & Abdillah, 2019; Pristiwanti et al., 2022). In an effort to improve the quality of education, the curriculum plays an essential role so that the development of students' potential is measurable and relevant (Zumrotun et al., 2024). The curriculum that is currently being implemented is the Independent Curriculum. Indonesia began to implement the Independent Curriculum in line with the industrial revolution 4.0 towards society 5.0 which requires teachers to be more responsive, creative, and innovative in carrying out learning (Indarta et al., 2022; Langoday et al., 2024).

The Merdeka Curriculum is designed to emphasize the mastery of learners' skills that are relevant to 21st century skills. The goal is to prepare learners to face real-world challenges that are increasingly complex and dynamic (Jufriadi et al., 2022; Widiansyah et al., 2024; Zakso, 2022). The learning concept in the Independent Curriculum is implemented through student-centered learning, competency-based learning, contextual and relevant learning, and holistic learning as a form of adaptive to 21st century developments (Cholilah et al., 2023).

One of the learning contents in the Merdeka Curriculum is the science learning content. Science learning does not only focus on mastering the material, but emphasizes more on the process of systematically searching for information about nature. So, students need to be given direct experience so that they can develop their potential, understand the concepts and processes of science and be able to explore the surrounding environment naturally (Efendi et al., 2019; Fitria, 2017). Ideally, science learning is not only oriented

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to memorization, but encourages students to understand phenomena through observation, experimentation, and data collection that can improve high order thinking skills (Tulljanah & Amini, 2021). So, learning innovations are needed that allow students to explore the material more deeply.

High order thinking skills are very important to equip students to be able to adapt and play an active role in the 21st century (Rahmi & Azrul, 2022). In the context of learning, the learning process is not only limited to remembering and understanding information, but encourages learners to develop the skills of analyzing, evaluating, and creating something new (Desyandri et al., 2019; Handayani & Muhammadi, 2020). The high order thinking skills of students are still low in science learning, especially in sound and light wave materials. The low level of high order thinking skills is because students assume that science learning is a learning that requires memorization because of the wide content of the material so that the learning process still focuses on memorization and repetition of the material.

High Order Thinking Skills are greatly influenced by the quality of the questions given (Yuliandini et al., 2019). The right questions can help develop students' high order thinking skills which include the ability to analyze, evaluate, and create, while memorization-based questions do not train the high order thinking skills of students because they only require students to remember and repeat the information obtained (Handayani & Muhammadi, 2020).

The results of observations on September 2-6, 2024 showed that students had difficulty in working on problems that varied from the examples given previously that demanded the application of knowledge in a new context. This causes students to have difficulty in recognizing the relevance of the concepts needed to solve the problem. In addition, students tend to focus more on memorization. This causes students to only remember and repeat the information obtained without expressing opinions, asking questions, and constructing knowledge. So that students tend to have difficulty doing problems when teachers give questions that are designed to measure high order thinking skills. The learning innovation that can be carried out is the use of a Science, Technology, Engineering, Arts, and Mathematics (STEAM) approach based on Project Based Learning (PjBL).

The PjBL-based STEAM approach is a learning innovation by integrating STEAM components, namely science, technology, engineering, art, and mathematics in the implementation of project-based learning (Ramadhan, 2023; Triprani et al., 2023). The application of the PjBL-based STEAM approach encourages active participation of students in project activities that can increase curiosity, develop critical thinking skills, problem solving, collaboration, and opinion skills which are indicators of high order thinking skills (Fitriyah & Ramadani, 2021; Harahap et al., 2021; Sulastri & Cahyani, 2021).

Method

The research carried out is a quantitative research by testing between variables analyzed using statistical data. The research method used is experimental research. This research was carried out in grade V of SDN 11 Kurao Pagang, Padang City which was registered in the even semester of the 2024/2025 school year. This study requires 2 samples, namely the experimental class sample and the control class sample. Sample withdrawal is carried out using probability sampling techniques, which are sampling techniques that provide equal opportunities for each member of the population to be selected as a sample member (Hermawan, 2019; Sugiyono, 2017). Instruments are variable measuring tools in research that are used to test hypotheses proposed in research (Sugiyono, 2017). The variable in this study is high order thinking skills.

The instrument used in this study is a test sheet. Tests are instruments used to measure a person's abilities, knowledge, and skills in a systematic and objective way (Sudaryono, 2021). The data collection techniques in this study are observation, interviews, tests, and documentation. To collect initial data, the researcher used data collection techniques through observation, interviews, and documentation activities. The data analysis technique in this study is a t-test which is carried out after the prerequisite test of t-test analysis is met.

Results and Discussion

Information about students' high order thinking skills was collected through pretest and posttest data in the form of multiple-choice objective test questions arranged based on a question grid with a total of 10 test questions with a difficulty level of C4-C6. Test scoring in this study was carried out by giving a score of one (1) to each question item that was answered correctly and to giving a score of zero (0) to each wrong question item (Sudijono, 2015). Indicators to measure students' high order thinking skills include analyzing, evaluating, and creating (Ahmad et al., 2017).

Table 1. High order thinking skills data for students

Information	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
Minimum Score	30	60	20	30
Maximum Score	80	100	80	100
Standard Deviation	13.22	11.01	14.30	17.05
Mean	49.52	82.86	49.55	63.64

Table 1 shows that both the experimental group and the control group experienced different high order thinking skills improvements. The experimental group obtained an average pretest of 49.52 and a posttest of 82.86. The average increase in the high order thinking skills of the experimental group was 67.32%, from 49.52 to 82.86. The average high order thinking skills of students have increased after the application of the STEAM approach based on PjBL in the learning process. The table also shows the average high order thinking skills of the control group students. The average pretest and posttest of the control group were 49.55 and 63.64, respectively. The average increase in the control group's high order thinking skills increased by 28.43%, from 49.55 to 63.64.

The hypothesis test uses the Independent Sample t-Test to find out whether or not there is a difference in the high order thinking skills of students in science learning between the control group and the experimental group. The Independent Sample t-Test uses significance values to make decisions. If the significance value is less than 0.05 then, H_0 rejected and H_a accepted.

Table 2. Independent sample t-test high order thinking skills

	Sig. (2-tailed)
High Order Thinking Skills	0.000

Table 2 shows the results of hypothesis testing using the Independent Sample t-Test which shows a significance value (2-tailed) of 0.000, which means it is smaller than 0.05. So that the zero hypothesis (H_0) was rejected and the alternative hypothesis (H_a) was accepted which showed a significant difference between the high order thinking skills of students in the control group and the experiment. These results are in line with the research of Fitriyah & Ramadani (2021) which states that learning using a STEAM approach based on PjBL can improve students' critical and creative thinking skills which are the main aspects of high order thinking skills.

The N-gain test was performed to determine the extent of improvement between before and after treatment between the two sample groups. Table 3 shows the results of the percentage of N-gain high order thinking skills of students as follows.

Table 3. N-gain test results

	Group	Mean	Std. Error
N-gain Percentage	Control	0.293	0.03
	Experiment	0.693	0.02

Table 3 shows the results of the N-gain percentage test with an average percentage of N-gain for the experimental group of 69.3% that is included in the medium category, while the average percentage of N-gain for the control group is 29.3% that is included in the low category.

The use of the PjBL-based STEAM approach in the learning process is considered important because it can achieve the learning goals that have been set. The PjBL-based STEAM approach has several advantages as one of the learning innovations in science learning, including improving the high order thinking skills of students. The results of the study show that the application of the PjBL-based STEAM approach in science learning can improve the high order thinking skills of students.

Overall, this research makes a significant contribution to the educational literature, particularly in learning innovation. The results of this study show that the PjBL-based STEAM approach not only improves students' high order thinking skills but can also increase curiosity, develop critical thinking skills, problem solving, collaboration, and opinion skills. For further development, it is recommended that further research be conducted on other subjects and on a larger scale to test the sustainability of the influence of the PjBL-based STEAM approach in various fields.

Conclusion

Based on the research that has been conducted, it can be concluded that the use of the PjBL-based STEAM approach has an effect on the high order thinking skills of students. This is evidenced by an increase in the average score of high order thinking skills of students in the experimental group. The results of the hypothesis test showed that there was a difference in the high order thinking skills of students between the experimental group and the control group. Therefore, the use of the PjBL-based STEAM approach can be an innovative alternative in education to create a learning environment that can encourage students to learn through the active involvement of students in working on projects that are relevant to students' daily lives by applying knowledge from the components contained in the STEAM approach. The limitations of this study are its limited scope of science learning and the relatively small scale of research. Therefore, further research is recommended to expand the use of the PjBL-based STEAM approach in other subjects.

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