e-ISSN 2716-0327
doi: 10.23917/bkkndik.v6i1.23664

Increasing Critical Thinking Abilities and Skills through Problem Based Learning for Elementary School Students

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ARTICLE INFORMATION

Article History:
Submit: April 28th, 2024
Revision: June 8th, 2024
Accepted: June 11st, 2024
Available Online: June 26th, 2024
Period: June 2024

Keywords:
critical thinking,
natural and social sciences,
problem based learning model

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ABSTRACT

The study aimed to evaluate the effectiveness of problem-based learning in enhancing critical thinking skills in Natural and Social Sciences. It utilized a quasi-experimental design with pretest-posttest randomized control groups. Data analysis involved t-tests to determine group differences and N-gain to measure improvement. Results showed significant enhancement in critical thinking abilities with problem-based learning. The t-test indicated a significant difference between groups, with t count (5.949) exceeding the t table value (2.018) and p-value (0.000) below 0.05. N-Gain scores showed a higher improvement in the experimental group (48.65%) compared to the control (29.46%). These findings highlight the effectiveness of problem-based learning in fostering critical thinking.

Introduction

Education curriculum's growth in Indonesia line with the continuing growth of the times. One of the latest curriculum evolutions is the Natural and Social Sciences (IPAS) approach. This approach integrates the natural sciences (IPA) and social sciences (IPS) into one lesson. This combination occurs because students at the basic education level are in a comprehensive, complete, and concrete thinking phase (Nur et al., 2023). Natural and Social Sciences (IPAS) is a realm of study that investigates living and non-living things in the universe and the interactions between the two. In addition, IPAS carefully explores the dimensions of human life, making humans both individual entities and integral parts of social complexity that interact with their environment (Sagendra, 2022). The application of science and technology in the learning process not only brings benefits to developing students' critical thinking skills but also stimulates high levels of curiosity. Through the basic principles of scientific methodology, IPAS creates an environment that stimulates students' critical thinking abilities, analytical skills, and the ability to draw appropriate conclusions (Suhelayanti et al., 2023).

Natural and Social Science, especially science, is closely related to critical thinking because, when studying, students will often be invited to dig deeper by analyzing, evaluating carefully, and then concluding with a sharp view. The essence of science learning is to provide problems related to everyday life, so it requires an active role and high motivation from students (Rediani, 2022). The objective of science education is to instruct students in the application of scientific knowledge, the identification of inquiries, and concluding based on the facts at hand, with the purpose of comprehending and making informed judgments in alignment with natural phenomena and daily fluctuations. Science education enables individuals to comprehend both their own nature and the surrounding world, hence facilitating practical application in daily life (Aiman et al., 2020). Students must possess an active, imaginative, analytical, and articulate disposition in order to engage in scientific study in the 21st century (Minsih, 2022) Critical thinking skills are one of the main benefits for science students, so the learning process using critical thinking skills can be applied to science subjects. Students' analytical reasoning in science learning is very important to connect and understand the microscopic and abstract contents of scientific material. For this reason, it is necessary to analyze, evaluate, and interpret students' thinking well (Ningsih et al., 2022)

Critical thinking in elementary school students is something that must be developed. In order to enhance students' ability to acquire 21st century abilities, it is essential to design educational activities in schools that foster creativity and critical thinking (Anazifa & Djukri, 2017). Critical thinking skills can upgrade learners independence and self-confidence in learning (Kurniawan et al., 2022; Minsih, 2022). This is due to the advantages of analytical reasoning skills such as guides that guide students in observing, analyzing, and evaluating information or views with accuracy, forming a solid foundation before they decide anything (Firdausi & Yermiandhoko, 2021; Novia Saputri et al., 2022). It is important to tell, implant, and cultivate analytical reasoning abilities in schools. This will enable kids to effectively and adeptly tackle the many difficulties they encounter in their surroundings. Learning encompasses not only the transmission of theoretical knowledge, but also the acquisition of practical skills that enable the application of theory to real-world issues. Therefore, it is possible to establish an environment conducive to learning and foster meaningful educational experiences (Rahmawati, 2022). Therefore, developing critical thinking skills has become a crucial focus for education, a long with the natural sciences.

The results of observations at Muhammadiyah 16 Elementary School in Surakarta show that students' critical thinking competence in the context of science and science learning still shows a relatively low level. Only a small number of students are able to provide the right answer, while critical thinking indicators or parameters include the skills of producing short explanations, fostering fundamental abilities, drawing logical conclusions, delivering comprehensive elucidations, and formulating methodologies and approaches that can be measured (Khoiriyah et al., 2018). These indicators have not yet reached optimal levels. The cause of low critical thinking skills is thought to be related to the application of conventional learning models, which produce boredom and loss of interest in students.

e-ISSN 2716-0327
doi: 10.23917/bkkndik.v6i1.23664

It is important to realize that every material in Natural Sciences subjects refers to the reality of the world as a basis for learning. Therefore, it is essential to use a pedagogical framework that is not only engaging and enjoyable but also directly applicable to students' comprehension. Contemporary educators do not only provide knowledge or merely assist in the learning process. Education should extend beyond the confines of the classroom, and teachers must take on the role of designing learning environments (Tan, 2003). Teachers really determine the success of a lesson because the teacher is the spearhead of the lesson. Teachers are learning resources, facilitators, mentors, motivators, and evaluators. If the teacher carries out this role well, it will have an influence on learning, and learning will become more meaningful (Rahmawati, 2022). In order to optimize the quality of teaching in science and science subjects, the innovative approach implemented is to emphasize a student-centered learning model, known as student-centered. In this context, students are invited to participate actively and proactively in the entire learning process, providing a dynamic dimension to their learning experience (Trimaheri & Chairiyah, 2023). The problem-based learning model has an effect on activeness and increases students' critical thinking in thematic learning by creating an active atmosphere for students (Sasmita & Harjono, 2021).

PBL is a teaching model that starts with a concrete case and is then analyzed in depth to identify the problems contained therein. PBL stands out as an innovative learning approach that creates a dynamic learning environment and involves active student participation (Mayasari et al., 2022). The primary objective of problem-based learning is not to impart extensive information not to only instruct kids, but rather to foster their capacity for critical thinking and problem-solving capabilities, while simultaneously fostering their capacity to actively construct their own knowledge (Saputra, 2013). Problem-Based Learning is an educational method that promotes the development of lifelong learning abilities via a process of open, reflective, critical, and active thinking. This model enhances students' abilities to solve problems, communicate effectively, collaborate in groups, and develop interpersonal skills more effectively than other instructional models (Hidayati, 2022). The problem-based learning paradigm comprises the following steps: The students prioritize the learning goals, actively engage with issues, carry out investigations, evaluate data, generate reports, and reflect on the inquiry (Desstya, 2023).

Prior research has consistently shown that The use of problem-based learning (PBL) has a positive consequences on improving pupils' critical thinking abilities. For example, research by (Cahyaningsih & Ghufron, 2016; Gumartifa et al., 2023; Setyaningsih et al., 2022) noted that PBL was able to increase aspects of students' creativity and critical thought processes abilities in the realm of mathematics learning. Other findings from research by Misla & Mawardi (2020) show that the deployment of problem-based learning (PBL) results in an increase in elementary school students' ability to address challenges and improve analytical reasoning abilities. Meanwhile, the results of research by fahrurrozi et al. (2022) emphasized that the implementation of PBL was successful in improving elementary school students' critical thinking skills, especially in the context of citizenship education learning.

It is hoped that this research will be able to provide a valuable contribution regarding the

effectiveness of PBL in advancing elementary school students' critical thinking skills. The target is to evaluate to what extent the implementation of PBL can improve students' critical thought processes at the elementary school level.

Method

This research utilized a quasi-experimental approach by applying a control group and an experimental group design. Through this design process, samples are selected randomly and separated into two distinct categories, namely the control group and the experimental group involved in learning (Budiyono, 2017). In this research, the quasi-experimental method was used because of its practicality and ethical suitability. They offer a compromise between the rigor of true experiments and the need for naturalistic study conditions (Budiyono, 2017). The advantages of this method include the ability to conduct research in actual educational settings and to overcome ethical dilemmas that may arise from random assignment. However, disadvantages include reduced control over variables, which can affect the precision of causality assessments, and possible selection bias, as subjects are not randomly assigned. This approach is particularly useful in education, where real-world applications and ethical considerations take precedence. These two groups of research subjects will undergo a series of tests before and after the learning series. By investigating the test results from both groups, the effectiveness of the problem-based learning model (PBL) will be analyzed in forming and improving the critical thought processes of elementary school students.

The research was carried out at SD Muhammadiyah 16 Karangasem, with the research subjects being fifth-grade students for the 2023–2024 academic year. who are aged 10-11 years. The number of participants in this study was 30 students, divided into two classes, namely classes fifth-grade 1 and fifth-grade 3. Fifth-grade 1 was determined as the experimental group with a total of 15 students, while fifth-grade 3 was determined as the control class with a total of 15 students. To obtain the expected data, researchers collected data through test techniques. The data collection method used is a test. The test method is one of the methods used to indirectly determine an individual's level of ability, which is done through responding by the individual to a number of stimuli or questions given (Rediani, 2022). The research test was looking by giving a test with indicators of critical thinking. The instrument used was essay questions.

The research hypothesis is H0: There is a lack of statistical significance between the employment of the problem-based learning framework and the upgrading of students' critical thought processes. The deployment of the problem-based learning method significantly impacts the enhancement of students' conceptualization abilities. Next, the data from the learning process skills test results were analyzed quantitatively using SPSS 25 for Windows. The data tested were pretest and posttest data using the t test and N-gain critical thinking skills. N-gain testing was carried out to determine the improvement that occurred after being given the action and whether Compared to the control group, the experimental group's growth in critical thinking abilities was superior.

Result and Discussion

Data was obtained using tests that were distributed to 30 class V students of SD Muhammadiyah 16 Karangasem who were divided into

e-ISSN 2716-0327
doi: 10.23917/bkkndik.v6i1.23664

two groups, namely the control class and the experimental class. Respondent data indicators are name, class, gender and several questions that have been created according to the indicators of the research variables as shown in the table below.

Table 1. Control Class Pre-Test Results

Name	Question Item Score					Total Score
	1	2	3	4	5	
AA	5	5	10	10	10	40
AS	5	5	15	10	10	45
AF	10	10	10	0	0	30
AN	10	5	5	0	5	25
AK	5	5	5	5	5	25
AP	15	10	10	10	10	55
AR	10	10	15	5	10	50
AI	10	10	10	5	5	40
BA	10	10	15	0	0	35
BP	15	5	10	10	10	50
DA	10	15	15	5	10	55
EN	15	10	15	5	10	55
IN	15	5	15	5	5	45
JA	15	15	15	5	5	55
ML	5	5	10	5	10	35

Table 2. Control class post-test results

Name	Question Item Score					Total Score
	1	2	3	4	5	
AA	10	5	10	10	10	45
AS	5	5	15	15	10	50
AF	10	10	5	5	10	40
AN	10	5	10	5	10	40
AK	5	5	5	5	15	35
AP	15	10	10	15	15	65
AR	5	5	15	10	15	50
AI	10	5	10	10	5	40
BA	5	5	5	10	10	35
BP	10	5	10	15	15	55
DA	10	10	15	10	15	60
EN	20	10	15	15	15	75
IN	10	5	15	10	15	55
JA	5	15	20	10	10	60
ML	15	5	10	10	10	50

Table 3. Experimental Class Pre-Test Results

Name	Question Item Score					Total Score
	1	2	3	4	5	
AC	20	5	10	5	5	45
AA	5	5	10	5	5	30
AN	5	5	10	5	5	30
DA	15	10	10	0	15	50
EN	5	5	10	5	5	30
GF	10	5	15	5	15	50

Name	Question Item Score					Total Score
	1	2	3	4	5	
IW	15	5	15	10	15	60
MA	20	20	15	10	10	75
MB	15	10	10	10	5	50
MD	10	5	5	5	5	30
MG	15	5	0	5	5	30
MR	15	10	10	5	0	40
MU	15	5	10	15	15	60
SH	15	10	10	10	5	50
VA	10	10	0	10	10	40

Table 4. Experimental Class Post-Test Results

Name	Question Item Score					Total Score
	1	2	3	4	5	
AC	15	15	10	20	20	80
AA	15	10	20	20	20	85
AN	15	10	15	5	15	60
DA	15	10	5	20	20	70
EN	15	10	10	20	10	65
GF	15	10	20	20	20	85
IW	15	10	10	20	20	75
MA	15	15	15	20	15	80
MB	15	5	15	5	20	60
MD	15	5	10	20	20	70
MG	10	5	5	20	10	50
MR	15	10	10	20	20	75
MU	15	10	20	20	20	85
SH	15	10	10	5	20	60
VA	15	10	20	20	20	85

Comparative data on pretest and posttest scores on critical thinking skills for experimental class and control class students are depicted in the following table.

Table 5. Comparison of Average Pretest and Posttest Scores

Class	*Pretest*	*Posttest*
Experiment	47,5	76,25
Control	42,6	50,3

Based on Table 5. there are disparities in the mean pre-test score for thinking critically abilities between students in the experimental class and those in the control class. This demonstrates the kids' first aptitude for critical thinking before the learning treatment were almost the same. After giving problem-based learning treatment to the experimental class, the post-test scores in both the experimental class and control class showed differences in quantity.

Table 6. Normality Test Results

Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experiment	.131	15	.200*	.936	15	**.330**
Control	.145	15	.200*	.884	15	**.054**

e-ISSN 2716-0327
doi: 10.23917/bkkndik.v6i1.23664

Based on Table 6, the outcome of the normality test in the experimental class and control class observable. The normality test uses the Shapiro Wilk technique with SPSS 25 for Windows; if the significance value is >0.05, then the data is normally distributed. Based on the data above, it shows a figure of 0.330 for the experimental class and 0.054 for the control class, meaning the data is normally distributed.

Table 7. Independent Sample Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence. Interval of the Difference	
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Differene	Lower	Upper
Critical Thinking Ability	Equal variances assumed	7.330	.011	5.949	28	**.000**	35.07097	5.89518	22.99524	47.14669
	Equal variances not assumed			5.494	22.310	**.000**	35.07097	5.89518	22.85496	47.28697

The T test findings in Table 7 indicate a tcount of 5,949, with a significance level (2-tailed) of 0.00 in the Sig column. Findings from the examination of the Independent Sample T-Test Subsequently, the study hypothesis was subjected to testing. Hypothesis testing is a crucial process used to ascertain if a hypothesis should be accepted or rejected. The hypothesis suggested in this study is. H0: There does not exist a clear and statistically significant relationship regarding the use of problem-based learning and the improvement of students' critical thought processes. Undoubtedly, there exists a discernible association between the adoption of the problem-based learning methodology and the improvement of students' aptitude for critical thought. The efficacy of problem-based learning approach and critical thought skill development varies significantly. The hypothesis is tested using the output results processed by SPSS 25 for Windows. Test criteria:

a. Using the Sig coefficient. under the condition

1. If the sig value is 0.05, then H0 is accepted.
2. If the sig value is >0.05, then H0 is accepted.

b. Using the calculated t coefficient with conditions

1. If the calculated t coefficient> t table, then reject H0.
2. If the calculated t coefficient < t table, then accept H0.

The hypothesis test calculations use the independent sample test (t). According to the data in table 3, the significance value is 0.000, means

that it is less than 0.05. This implies that the value of 0.00 in table 5.494 is more than 2.018, and the significance value of 0.000 is less than 0.05. Therefore, we may conclude that the null hypothesis (H0) is rejected. Ha has been approved. This demonstrates a significant correlation between the adoption of the problem-based learning approach and the enhancement of students' critical thought processes.

The N-Gain test is used to assess the efficacy of implementing the two learning models. The normalized average gain method is used to enhance the average pretest and posttest scores. This formula contrasts the highest possible average gain alongside the observed average gain. The current mean N-Gain is calculated as the disparity between the average posttest score and the average pretest score. The formula for normalized gain is often referred to as the g factor or Hake factor (Wiyanto, 2008).

$$\langle g \rangle = \frac{\langle \bar{S}_{post} \rangle - \langle \bar{S}_{pre} \rangle}{100\% - \langle \bar{S}_{pre} \rangle}$$

Information:

g = g factor (Hake factor) or normalized score gain value.
Height = $g \geq 0.7$ or expressed in percent $g \geq 70$
Medium = $0.3 \leq g < 0.7$ or expressed in percent $30 \leq g < 70$
Low = $g < 0.3$ or expressed in percent $g < 30$

The N-Gain score test calculation reveals that the experimental class has an average N-Gain score of 48.75%, falling within the medium category. Conversely, the control class has an average N-Gain score of 13.67%, falling within the low category. The data analysis findings indicate that the application rate in the experimental class is superior to that in the control class.

The results of research on the effectiveness of using the problem-based learning model in developing critical thought processes showed that the outcomes were significantly different from the sig value of > 0.05. By applying this model to learning, it has had different levels of success. In the analysis that has been conducted according to the results and conclusions, the application of the problem-based learning model has more effective effectiveness when used to upgrading students' critical thought processes. Thus, from the results that have been tested, it can be seen in the mean different test of the model that has been carried out that the outcomes show that the posttest scores in the experimental class have a higher-level value compared to the results of the posttest scores in the control class. In the initial provisions, if the research uses a homogeneity test, it has certain requirements, such as if the significant value is > 0.05, then it is declared homogeneous; conversely, if the significant value is < 0.05, then the data is declared not homogeneous. So, from the statement above, it can be concluded from the non-homogeneous data that Ho is rejected while Ha is accepted. The output results of the Independent Sample T-Test show tcount > t table, namely 5.949 > 2.018 and a significant 0.000 < 0.05, which means H0 is rejected and Ha is accepted, meaning there is a significant difference regarding the effectiveness of using the problem-based learning model in developing critical thinking skills. The success of the problem-based learning model, which is effective in improving students' critical thinking skills, is because it is influenced by the learning activity steps implemented by orienting students towards problems so that the problems given can be solved. Familiarize students with learning using the problem-based learning model so as to

e-ISSN 2716-0327
doi: 10.23917/bkkndik.v6i1.23664

improve students' critical thinking skills effectively (Sukmawati et al., 2020).

In the problem-based learning (PBL) learning model, the main attention is given to solving problems that arise in everyday life. PBL emphasizes developing students' critical thinking skills through an active process of solving concrete problems. This approach creates a learning environment where students are encouraged to participate actively, analyze situations, and seek relevant solutions (Krismayanti & Mansurdin, 2020). According to Evi and Indriani, quoted from Fahrurrozi et al. (2022), in the problem-based learning approach, everyday problems are raised as the core of teaching. This model stimulates students to develop critical thinking skills and skills for solving life's challenges. As a learning concept, problem-based learning (PBL) brings real-world situations into the classroom, giving students the opportunity to explore complex ideas and innovative solutions through problem solving. In this way, learning becomes more lively, contextual, and has a positive impact on the development of students' intellectual skills. In a problem-based approach, complex problems that exist in The actual world is used as a means to inspire students to recognize and investigate the ideas and principles necessary for solving the challenges given to them (Davidson & Major, 2014). PBL illustrates the blending of information and skills rather than the incremental acquisition of individual components. For instance, engaging in a collective discussion on the discoveries made in literature will result in an answer to the question The learning problem is illuminated from a different angle; since the individual study period is independent, the student has—to a certain extent and within the limits of the topic of the problem—the freedom to choose and study literary sources themselves (Dolmans & Loyens, 2016).

Increasing learning outcomes in students' critical thinking abilities using the problem-based learning model is influenced by the development of ideas in every aspect of problem-solving abilities (F. A. Setiawan et al., 2020). Problem solving is a thinking process to solve problems. Apart from that, problem solving is the use of methods in learning activities by giving students the knowledge to accept a problem, whether an individual problem or a group problem, to be solved individually or together (Handayani & Hidayati, 2020). Problem-solving abilities are very important for students to develop the potential that exists within them. This is because students will ultimately face various problems within themselves, and they cannot depend on anyone other than themselves. Students will try themselves to solve problems and understand and interpret the importance of the knowledge they gain before and after solving the problem (Utomo et al., 2020). This research conducted a pretest and posttest to determine whether there was an increase in the scores achieved by students. The value of each class before and after receiving treatment with various learning models also had a significant impact on the research's success. Therefore, an analysis was carried out to find out that the problem-based learning model had experienced higher improvements.

The implementation of Problem-Based Learning (PBL) has far-reaching implications for education and can have a positive impact on educational outcomes as well as prepare students for future challenges. Among them is the development of critical thinking skills: Problem-based learning is a teaching model characterised by real problems as a context for learning so that students

can learn to think critically and improve problem-solving skills while gaining knowledge (Nafiah & Suyanto, 2014). PBL is a constructivist approach that emphasises learning through problem-solving experiences. Furthermore, it has been described as a teaching method that develops learners, knowledge and problem-solving skills through real-world problems (Retno Winarti & Waluya, 2018). Meaningful and Sustainable Learning: PBL allows students to engage in more meaningful and sustainable learning as they learn through hands-on experience in solving relevant and real problems. It helps students see the connection between theory and practice, which deepens their understanding of the subject matter and motivates them to learn further (I. Setiawan, 2022). High Engagement and Motivation: The implementation of innovative learning with PBL (Problem Based Learning) learning model with demonstration method in the classroom, there is a fairly good increase in motivation in students. This learning model can improve students' motivation and learning outcomes, as well as develop creativity and problem-solving skills (Irawati, 2020). The PBL approach that emphasises students' involvement in their own learning can increase students' motivation level (Ramlawati et al., 2017). Development of Collaboration and Communication Skills: This learning model can develop learners' collaboration and communication skills, which are important 21st century skills to face future challenges Collaboration skills are skills that build good relationships with others to achieve the same goals in a group (Dhitasarifa et al., 2023). Collaboration skills refer to the ability to communicate dialogically to exchange opinions, ideas, or ideas (Hastawan et al., 2023). Preparation for Future Challenges: 21st century education emphasises students' process discovery, as well as collaborating in solving problems. In accordance with Zivkovil's (2016) statement that learning in the 21st century has been oriented towards emphasising meaningful learning (Dopo, 2022). In this changing world, PBL is a relevant learning model to prepare students for future challenges. Through PBL, students are trained to think critically, solve complex problems, and work collaboratively. In addition, students are also invited to understand their role in society and actively participate in improving the quality of life (Haryati & Wangid, 2023). Thus, the implementation of PBL can have a significant impact on educational outcomes by developing critical thinking skills, increasing student motivation and engagement, strengthening collaboration and communication skills, and preparing students to face future challenges.

These results strengthen the research conducted by Cahyaningsih & Ghufron (2016). The results of this research state that the use of the problem-based learning (PBL) learning model is able to improve students' creative nature and critical thinking abilities in learning mathematics. The research results show that PBL is more successful than traditional learning methods in increasing students' levels of creativity and critical thinking abilities. Misla & Mawardi (2020) confirmed in this research that the problem-based learning (PBL) learning model was more successful in improving students' critical thinking skills when solving mathematics problems compared to the problem solving learning model. The t test analysis showed significantly that PBL was more successful than problem solving in improving students' critical thinking skills. Fahrurrozi et al. (2022) The findings from this research present an interesting highlight, showing that the problem-based learning (PBL) learning model is not just

e-ISSN 2716-0327
doi: 10.23917/bkkndik.v6i1.23664

encouragement but a catalyst that stimulates students' critical thinking abilities in citizenship education subjects. PBL is not only a guide but also creates a learning journey that invites students to be actively involved in every stage of learning, creating an arena where creativity and exploration can develop freely. Thus, this research confirms that PBL not only teaches but also forms a learning stage that allows students to dance in the rhythm of discovery and understanding. Kartikasari et al. (2021) highlight the success of using the problem-based learning (PBL) learning model in developing students' critical thinking skills. The improvement depicted through the jump in average grades and satisfactory levels of learning achievement confirms that PBL is not just a learning method but an effective tool for stimulating students' critical growth. Thus, this research provides a positive picture regarding the good impact of PBL on upgrading the quality of study and student academic achievement.

Conclusion

Enhancing critical thinking abilities in learners that use the method known as problem-based learning is superior and efficient in enhancing students' critical thinking capabilities. The posttest findings indicated that the mean level in the experimental group was 76.5. In addition, the control class achieved an average posttest score of 50.3. Then the results of this research, namely t count > t table, show a result of 5,949 > 2.016 and a significance (2-tailed) of 0.000, because the Sig value (2-tailed) is not greater than 0.05 (0.000<0.05). The next step is a different test (t-test) on the posttest results using the Independent Sample T-Test. The difference test (t-test) shows that the sig (2-tailed) value is 0.000 because the sig (2-tailed) value is not greater than 0.05 (0.000<0.05).

The implementation of PBL can have a significant impact on educational outcomes by developing critical thinking skills, increasing student motivation and engagement, strengthening collaboration and communication skills, and preparing students to face future challenges. Furthermore, schools are advised to integrate the PBL model into their curriculum to facilitate the development of students' critical thinking skills, especially in natural and social science subjects. And further researchers can explore the effectiveness of the PBL model in different contexts or by using larger samples to obtain more generalized results.

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