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Outdoor Problem-Based Learning; Enhancing Critical Thinking with Real World Experiential in Science Learning

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Abstract: Students in junior high school continue to encounter obstacles in learning critical thinking, an indispensable cognitive ability. This investigation investigates the impact of a problem-based learning paradigm that is implemented outside of the classroom on the development of critical thinking skills in the context of elementary school science education. The investigation was conducted using a quasi-experimental design and a quantitative approach. The experimental and control groups were composed of fourth-grade students from SDN Ditotrunan 01 Lumajang, East Java. The experimental group received problem-based learning model learning treatment outside the classroom, while the control group received conventional learning. The research instruments consisted of an observation sheet to monitor student activities during the learning process and a description test to assess critical thinking skills. A gain score and a t-test were implemented to analyze the data. The experimental and control groups exhibited a substantial disparity in critical thinking abilities, as indicated by the analysis. In the experimental class, the average critical thinking skills score was 86.76, while in the control class, it was 68.56. The t-test results indicate a substantial disparity in critical thinking skills between students in the experimental class and the control class, as evidenced by a significance value of 0.000 <0.05. The experimental class's gain score is 0.63, indicating a rise in critical thinking abilities in the medium category. Conversely, the control class's gain score is 0.12 in the low category. Conventional learning was found to be less effective in enhancing critical thinking skills than learning with a problem-based learning model outside the classroom.

Keywords: problem-based learning, outdoor learning, critical thinking, science learning.

▪ INTRODUCTION

Critical thinking is one of the competencies that pupils must acquire in the 21st century. Critical thinking is a fundamental cognitive skill that students must possess, requiring the evaluation of information, rigorous reasoning, and a viewpoint in order to reach independent and competent conclusions (Vincent-Lancrin, 2023). Primary school pupils engage in critical thinking by comprehending, evaluating, and interpreting information. Through observation, inquiry, generalization of data, reasoning, and the formulation of conclusions, it enhances their cognitive abilities (Kirk et al., 2023; Muhasabah et al., 2025). Students who possess critical thinking abilities will be capable of resolving issues, fostering creativity, and preparing them to confront practical challenges in a variety of life domains (Sari & Nuha, 2023; Tasgin & Dilek, 2023). Critical thinking can also be advantageous to students by enhancing their abilities to analyze information, evaluate arguments, and make substantial contributions to academic discussions and knowledge (Chukwuere, 2024). The capacity to analyze, evaluate, and integrate information can be enhanced through the acquisition of critical thinking skills. Various thinking skills, such as critical thinking, must be directed by the scientific learning process.

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Students frequently encounter obstacles in their efforts to enhance their critical thinking abilities, despite the fundamental importance of this skill. A lack of conceptual understanding, low participation in the learning process, and difficulty implementing concepts learned creatively when confronted with problems are all contributing factors to the difficulty students experience in developing essential thinking skills (G. Smith et al., 2023). Conventional learning strategies also result in students experiencing limitations in their critical thinking abilities. Additionally, students encounter challenges in the development of critical thinking skills as a result of educators' lack of expertise, their disregard for the significance of critical thinking, and an educational system that fails to prioritize these abilities (Franklin et al., 2022).

In order to cultivate critical thinking abilities, numerous investigations have been implemented. The development of critical thinking skills in elementary institutions has been the focus of previous research, but it has not been associated with fundamental societal issues (Puyol-Cortez, 2023). Limited innovation and dependence on conventional learning implementation are among the challenges identified in prior research (Ferrary & Kawuryan, 2023; Munawaroh, 2018). The development of critical thinking was also impeded by the teacher-centered learning procedure that was implemented by previous researchers. The implementation of a problem-based learning model is a widely used innovative learning alternative. The problem-based learning model has the potential to foster critical thinking by promoting the active participation of elementary school students in problem-solving and the application of this skill in daily life (Smith et al., 2023; Fadilah et al., 2024). According to additional research, the integration of innovative learning can enhance critical thinking skills by enabling students to make informed decisions, resolve issues, and advocate for innovative pedagogical strategies in education (Affandy et al., 2024; Nasihah et al., 2020). According to Sulistiyani et al. (2025) and Haniko et al. (2023), the problem-based learning model enables students to examine and challenge their critical thinking abilities. The learning process offers students the chance to make more informed decisions, overcome problems, and adapt to a world that is constantly changing (Smith et al., 2022). The problem-based learning model also offers a perspective on the promotion of critical thinking skills to enhance student learning outcomes and equip students with the ability to solve complex problems in a variety of academic and professional settings (Anggraeni et al., 2023). Furthermore, the problem-based learning model fosters a more authentic and challenging learning experience for primary school students by increasing student participation, promoting independent learning, fostering the development of problem-solving skills that are relevant to real-world situations, and promoting cooperation through mutually contributing activities (Maher & Yoo, 2017).

The implementation of problem-based learning models in classroom learning frequently encounters obstacles. The challenges encountered during the implementation of the problem-based learning model, as per Nurlaily et al. (2019), include inadequate preparation during lesson planning, limited time to conduct activities, challenges in assisting students in resolving problems, and difficulties in promoting active participation and student feedback. According to certain research findings, teachers encounter challenges during the planning phase when they must meticulously prepare lesson plans and identify issues at the outset of the learning process (Aidoo, 2023; Magaji et al., 2024). Additionally, educators encounter challenges when developing contextual learning resources that are pertinent to the issues at hand (Situmorang et al., 2019). The obstacle during the implementation phase is the insufficient time to optimize activities in all phases (Jailani et al., 2017). Teachers require an adequate amount of time to coordinate students in group activities. It is challenging for educators to guide students toward issues that necessitate resolutions (Lim, 2023). Students still wait for the teacher to explain things to the group without doing so, and they struggle to divide time when guiding groups.

In order to surmount the challenges encountered in this investigation, it is recommended that the problem-based learning paradigm be implemented beyond the confines of the classroom. This learning approach integrates a variety of learning activities that take place outside of the classroom in order to foster student collaboration and creativity. One of the qualities of problem-based learning is that it necessitates students to engage in genuine investigations by defining problems, formulating predictions and hypotheses, accumulating and analyzing data, and formulating conclusions (Arends, 2014). Real objects can be investigated outside of the classroom to facilitate these activities. By involving students in learning experiences through adventures, investigations, and discussions outside of the classroom environment, this strategy can also address the challenges in the problem-based learning model. Students derive numerous advantages from learning outside of the classroom. Students have the ability to engage in the scientific process in order to enhance their learning outcomes (Wahyuni et al., 2017). In order to enhance learning outcomes (Ayotte-Beaudet et al., 2025) and curiosity (Sekarini & Arty, 2019), students will be encouraged to participate in the learning process by learning outside the classroom (Soh & Meerah, 2013). Problem-based learning, which is implemented outside of the classroom, has the potential to enhance learning outcomes by fostering active engagement, fostering a deeper understanding, and facilitating the application of knowledge to real-world problems (Nofriadi, 2024). Due to this, the research must determine whether the critical thinking skills of elementary school students in science learning are positively influenced by the implementation of the problem-based learning model outside the classroom. The results of this study are anticipated to serve as a reference for the enhancement of innovative science learning strategies that foster high-level thinking skills. According to the research background, the research questions in this investigation are as follows:

1. How does problem-based learning outside the classroom affect students' critical thinking skills in science learning?
2. How is the improvement of students' critical thinking skills after participating in learning with problem-based learning outside the classroom?

▪ METHOD

Participant

Fourth-grade pupils from SD Negeri Ditotrunan 01 in Lumajang district comprised the population of this investigation. Two study groups, class IVA and class IVB, were composed of Grade IV students. The samples were allocated to purposively selected groups through random assignment. The control class, which consisted of 30 students, was the IVA class, while the experimental class, which consisted of 30 students, was the IVB class. Table 1 displays the number and gender of students in the experimental and control categories. The critical thinking skills of the experimental and control groups were assessed through pre- and post-tests that contained identical questions.

Table 1. Number of students by group and gender

		Gender		Total
		Male	Female	
Group	Control	16	14	30
	Experiment	17	13	30
Total		30	30	60

Research Design and Procedures

This study employs a quasi-experimental research method and a quantitative approach to investigate the influence of problem-based learning outside the classroom on critical thinking skills in science education. The experimental research design was employed to compare one experimental group with one control group, as well as a pre-test and post-test control group design. A pre-test was administered to both groups prior to treatment, followed by the learning process, and a post-test was administered to both groups. The problem-based learning model was implemented outside of the classroom in the experimental class to facilitate learning. Conversely, the control group's educator implemented the standard instructional methodology. The learning process in the experimental group was conducted in accordance with the phases of the problem-based learning model, as illustrated in Table 2. These phases include the orientation of students to the problem, the organization of students for study, independent and group investigation, the development and presentation of artifacts and exhibits, and the analysis and evaluation of the problem-solving process. The control and experimental groups underwent a post-test subsequent to the completion of the three-lesson learning process.

Table 2. Teaching and learning activities during the three learning sessions

Phase	Lesson 1	Lesson 2	Lesson 3
Orient students to the problem	Why can humans hear loud sounds and weak sounds? Why does the sound heard by the ear vary when there are various kinds of obstructions?	Why do balls bounce to different heights when dropped in different places? Why does the ball bounce lower and lower?	Will a simple swing with different lengths of rope swing the same number of times? Will simple swings with different weights swing the same number of times?
Organize students for study	Students are divided into small groups. Students receive student worksheets and pay attention to the learning instructions.	Students are divided into small groups. Students answer questions initiated by the teacher. Students receive student worksheets and pay attention to the learning instructions.	Students are divided into small groups. Students answer the provocative questions from the teacher. Students receive student worksheets and pay attention to the learning instructions.
Independent and group investigation	Students investigate drums being hit with varying strengths. Students observe and record the sounds produced.	Students investigate by dropping balls from various heights, observing and recording the results.	Students conduct direct investigations into city parks and record their results.

Develop and Present artifacts and exhibits	Students make observation reports and simple presentations	Students make reports on the results of experiments and simple presentations.	Students create reports, motion diagrams, and straightforward explanations about the energy that causes motion.
Analyze and evaluate the problem-solving process	Students present their results in class discussions, teachers give feedback, and conclude.	Students present their results in class discussions, teachers give feedback, and conclude.	Students present their results in class discussions, teachers give feedback, and conclude.

Research Instrument

Written assessments and observation sheets of student learning activities were employed to gather data. The critical thinking skills required to comprehend the scientific subject matter of energy transformation are assessed through written examinations. Critical thinking skills, such as the capacity to analyze, evaluate, interpret, explain, and conclude, are the focus of questions (Facione, 2011). The test's validity was evaluated by three experts: a junior high school supervisor, an elementary school supervisor with expertise in elementary science, and an expert lecturer in educational evaluation. The specialists were requested to evaluate the items' suitability in relation to the cognitive depth and critical thinking skills indicators. The inter-rater reliability of the test was calculated and produced a reliability coefficient value ranging from 88.75% to 100.00%. This indicates that all written test items are reliable (Miles, 1994). Students in the control and experimental groups are administered assessments that evaluate their critical reasoning abilities. Before the learning process, critical thinking skills exams are administered as a pre-test, and as a post-test after the learning process.

Data Analysis

Descriptive and inferential statistical analyses were implemented. An overview of student critical thinking skills data was obtained by conducting a descriptive statistical analysis based on pre-test and post-test results. The data analyzed comprises the maximum and minimum values that illustrate the score achievement mean data. The mean data is a measure of the size of data concentration, calculated by summing all values and dividing by the number of values. The standard deviation depicts the distribution of data from the norm. A significant difference between critical thinking skills in experimental and control classes is determined through inferential statistical analysis. A series of statistical tests, such as normality, homogeneity, and parametric tests, are employed to conduct inferential statistical analysis. The data normality test is designed to demonstrate whether the data is normally distributed. Before conducting parametric tests, it is imperative to conduct data normality tests. The Shapiro-Wilk test is implemented, which stipulates that the data is normally distributed if the p-value exceeds 0.05. The homogeneity test is employed to ascertain whether the data has a homogeneous variance, particularly when comparing data from experimental and control classes. The Levene test is implemented with the following criteria: a p-value greater than 0.05 indicates that the data exhibits homogeneous variance. In order to ascertain whether the data satisfies the criteria of normality and homogeneity and to resolve significant discrepancies, parametric tests are implemented. Independent t-tests were implemented for two distinct classes.

▪ RESULT AND DISSCUSSION

The implementation of this study began with a pre-test to obtain data on critical thinking skills. Furthermore, teaching and learning activities were carried out by applying the problem-based learning model outside the classroom in the experimental class. The problem-based learning model effectively encourages students to develop critical thinking skills through a contextual and collaborative problem-solving process. Learning activities are carried out in an open and honest environment, where students are faced with problems that are close to everyday life so that they can actively construct knowledge through direct observation, reflection, and group discussions. The teacher acts as a facilitator who facilitates the thinking process and exploration of ideas without providing direct answers. After the whole learning series, critical thinking skills were measured through a critical thinking skills test instrument. The data obtained from both classes were then analyzed to determine the impact of applying the problem-based learning model outside the classroom on improving critical thinking skills.

A descriptive statistical analysis was conducted to provide an overview of the achievement of critical thinking skills in the experimental and control classes. This analysis includes data on the highest score, the lowest score, the average score, and the standard deviation, both in the pre-test and post-test results. The results of the descriptive statistical analysis are presented in Table 3.

Table 3. Critical thinking

Thinking Skills	**Control Group**				**Experiment Group**			
	Pre-Test		**Post-Test**		**Pre-Test**		**Post-Test**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Interpretation	61.5	8.17	66.5	8.37	61.5	6.89	86.3	9.63
Analysis	57.3	8.43	61.1	10.11	59.2	10.51	78.1	9.45
Evaluation	69.4	11.65	70.7	9.22	67.0	6.51	92.0	8.21
Inference	67.2	9.49	74.1	8.55	60.2	8.39	94.6	7.07
Explanation	81.1	20.04	84.6	16.36	87.8	17.10	95.0	7.20
Critical Thinking	64.4	4.65	68.7	4.71	64.7	4.03	86.8	5.19

The data showed that the experimental group experienced a significant increase in scores on all aspects of thinking skills after the treatment was given. Meanwhile, the control group only showed a relatively small increase and tended to be stable from pre-test to post-test. The most striking improvement in the experimental group was seen in the aspects of inference, evaluation, and overall critical thinking. The average post-test score of the experimental group was much higher than the control group on all indicators. The relatively small standard deviation in the experimental group's post-test showed that the results of the improvement were quite evenly distributed among students. Overall, this data indicates that the treatment or learning model applied to the experimental group is effective in improving students' thinking skills. This finding shows that teaching and learning activities by applying the problem-based learning model outside the classroom contribute positively to developing critical thinking skills. These results align with the research findings by Mutiara et al. (2024), which states that the problem-based learning model can improve critical thinking skills because it requires students to analyze, evaluate, and conclude information in depth through direct learning experiences in the surrounding environment.

To gain a deeper understanding of improving critical thinking skills before and after treatment, the analysis was carried out using the n-gain calculation. The results of the n-gain calculation in the experimental and control groups are shown in Figure 1. The n-gain calculation is used to measure the effectiveness of the learning treatment based on the increase in pre-test and post-test scores. Based on the average post-test score in the experimental group of 86.76, it is higher than the control group of 68.56. In addition, the difference in the highest and lowest scores shows the superiority of the experimental group. Calculating n-gain is vital to see how much the critical thinking skills have increased proportionally. This supports the interpretation that the improvement results are evenly distributed among students in one class. Therefore, n-gain analysis was used to provide a quantitative picture of the effectiveness of the treatment applied to the experimental group compared to the control group.

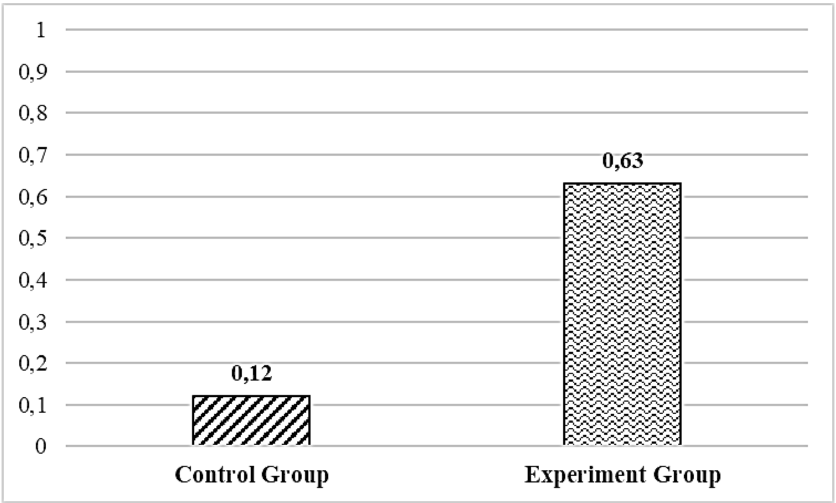

Figure 1. N-Gain analysis

To determine the effect of the problem-based learning model outside the classroom on critical thinking skills, an independent sample t-test was conducted. Before the statistical test, a data normality test was conducted to determine whether the data was normally distributed. The normality test is crucial because it determines the type of statistical test used next, whether parametric test (if the data is normally distributed) or non-parametric test (if the data is not normally distributed). Thus, the normality test is a crucial first step to ensure the validity of the statistical analysis results. The results of the normality test of critical thinking skills data are shown in Table 4.

Table 4. Normality test

	Shapiro-Wilk		
	Statistic	**Df**	**Sig.**
Experiment Pre-test	0.945	30	0.124
Experiment Post-test	0.953	30	0.199
Control Pre-test	0.959	30	0.285
Control Post-test	0.939	30	0.088

Based on the data in Table 4, it can be interpreted that all significance values are greater than 0.05 so that all data are declared normally distributed. Thus, it can be concluded that the critical thinking skills data from the pre-test and post-test in the experimental group and control group are normal. Therefore, the subsequent statistical analysis uses a parametric test, the independent sample t-test. The Shapiro-Wilk test results show that the significance value in all classes is greater than 0.05, so the data does not deviate significantly from the normal distribution. These results show that the distribution of critical thinking skills scores in each class is not to one side and follows a familiar pattern in the population.

The homogeneity test is crucial because it is one of the basic assumptions in the independent sample t-test. If the data from both groups have the same variance (homogeneous), then the t-test can be done with the correct assumptions. Conversely, adjusting or using an alternative test is necessary if the data is not homogeneous. Thus, the homogeneity test aims to ensure that the comparison between two groups is done fairly, without any significant differences in variation between groups that could affect the statistical analysis results.

Table 5. Homogeneity test

Homogeneity Test of Variance					
		Levene Statistic	**df1**	**df2**	**Sig.**
Experiment and Control Pre-test	Based on Mean	0.506	3	116	0.679
		0.418	3	116	0.740
Experiment and Control Post-test	Based on Mean	0.418	3	110.692	0.740
		0.477	3	116	0.699

In Table 5, the significance value in both classes is greater than 0.05, so it can be concluded that the data has a homogeneous variance. The significance value indicates no significant difference in variance between the experimental and control groups from the pre-test and post-test data. In other words, the data from both groups have a relatively equal distribution, although the average value or final score can be different. Thus, the level of diversity or difference between individuals in each group is comparable. This means the conditions for conducting an independent sample t-test have been met. Thus, statistical analysis can be continued using an independent sample t-test to determine whether there is a significant difference in critical thinking skills between the experimental and control groups.

After knowing that the data is normally distributed and has a homogeneous variance, an independent sample t-test is conducted to determine whether there is a significant difference in critical thinking skills between students in the experimental class who use the problem-based learning model outside the classroom and students in the control group whose activities are listening to the explanation of the material, working on sample problems and exercises, then together with the teacher summarize the content of the material that has been learned. This test aims to test the hypothesis of whether the treatment given to the experimental group has a real effect on improving critical thinking skills. The results of the independent sample t-test are shown in Table 6.

Table 6. Independent sample t-test

	F	Sig.	T	df	Sig. (2-tailed)
Equal variances assumed	1.412	0.240	-18.572	58	0.000
Equal variances not assumed			-18.572	55.141	0.000

The variances of the two groups are equivalent, as the significance value of Levene's Test is 0.240, which is greater than 0.05, as shown in Table 6. The t-test results utilized are located on the "Equal variances assumed" line. The t-test yields a value of Sig. (2-tailed) = 0.000, which is less than the significance level of 0.05. This demonstrates a substantial disparity in critical thinking abilities between the experimental and control groups. The results of the independent sample t-test indicate that there is a statistically significant difference between the group of students who were treated with the problem-based learning model outside the classroom and the group of students who followed conventional learning protocols. The application of problem-based learning outside of the classroom was found to have a more significant positive effect on the development of critical thinking abilities. Contextual learning that is problem-based and conducted outside of the classroom can motivate students to participate, be active, and be engaged in the learning process. The problem-based learning model's influence on the development of critical thinking skills outside the classroom is suggested by the extremely low significance value of 0.000.

If the significant value is greater than 0.05, it can be inferred that the independent and dependent variables do not have a significant impact on the data analysis. In contrast, a significant influence between the independent and dependent variables can be inferred if the significant value is less than 0.05. The significance (2-tailed) value in Table 6 is 0.000, which is less than the threshold of 0.05. The critical thinking skills on the subject of evolving energy forms are influenced by the problem-based learning model outside the classroom, as indicated by these results. This implies that the experimental and control groups exhibit disparities in their critical thinking abilities. Consequently, it is possible to infer that the critical thinking abilities of fourth-grade students at SDN Ditotrunan 01, Lumajang district, East Java, are substantially influenced by the problem-based learning model that is implemented outside of the classroom.

The experimental group students exhibit a greater improvement in critical thinking abilities than the control group students. Critical thinking abilities and an active interest in the learning process can be fostered by the application of a problem-based learning model outside of the classroom. This discovery further supports the notion that the out-of-class environment is not only a valuable pedagogical component in contextualized learning, but also a viable alternative location. The capacity to present genuine issues is one of the primary benefits of outdoor learning. Students are able to directly observe real-world phenomena that are pertinent to the lesson topic of environmental change, energy, and force. In addition, the outdoor environment offers multisensory learning experiences that are associated with sound, visuals, texture, and temperature. These experiences enhance the observation process and promote more analytical thinking. Students are encouraged to employ a variety of senses in order to comprehend problems, formulate inquiries, and challenge hypotheses. Students are more likely to acquire knowledge about potential and kinetic energy through problem-based learning that is conducted outside of the classroom. Students have the ability to observe swing movements in actual objects and directly connect them to changes in energy forms. These findings are consistent with the problem-based learning model proposed by Syed et al. (2023), which posits that critical thinking skills surpass traditional learning methods and foster reflective thinking, cooperation, efficient decision-making, and creativity. Encouraging students to engage in more profound cognitive processes, these abilities enhance academic performance. Critical thinking skills are effectively developed through the application of the problem-based learning model, as it motivates students to address real and intricate problems that necessitate in-depth analysis and reasoning (Mahardika et al.,2022). The energy transformation phenomenon in the environment around students is observed, collected data, and analyzed through activities outside the classroom, as the problem-based learning model encourages students to solve actual problems or problem simulations.

Critical thinking skills can be developed through activities that students engage in outside of the classroom. For the initial activity, students are grouped together to observe the diverse energy sources that surround them outside of the classroom. The phenomenon of vegetation exposed to sunlight is used to analyze the energy source we have observed, which is solar energy. In the event that the leaves are in motion as a result of the wind, wind energy is observed. Additionally, students evaluate the electrical energy of the illuminated lighting. Students are instructed to document the energy sources and the forms of energy they encounter, including heating, mechanical, and electrical energy. In groups, students compile a list of the types of energy that are present outside of the classroom. In the second activity, students engage in activities in the schoolyard with their groups to directly observe examples of potential and kinetic energy in the environment. Students were divided into three groups, and each group conducted distinct experiments to comprehend the concept of potential and kinetic energy. The experience enhances students' comprehension and application of their critical thinking abilities.

Students are taught to collaborate, communicate, and share responsibilities in order to accomplish shared objectives through group activities. There are numerous advantages to conducting educational activities outside of the classroom; however, educators encounter numerous challenges when conducting such activities. Distractions, such as sights, sounds, and other individuals, are abundant in the environment beyond the classroom, which hinders students' ability to concentrate on their studies. Supervising and preserving the discipline of numerous students in an open space can be more difficult to manage in classroom management than in a classroom that is more manageable. Students are more likely to be able to move around outside the classroom when they are learning outside of it, which can make it challenging for instructors to ensure that they remain in their groups and follow instructions. Despite the numerous challenges that students encounter, learning outside of the classroom continues to offer significant advantages in terms of facilitating authentic and increasingly authentic experiences.

▪ CONCLUSION

The results suggest that the critical thinking skills are influenced by the problem-based learning model in the setting outside of the classroom. The control class employed the traditional learning model that the teacher could employ, while the experimental group employed the problem-based learning model. According to the independent t-test analysis, the learning outcomes of students are influenced by the application of the problem-based learning model. The reason for this is that the t-test results on the learning outcome data indicate a very small p-value, indicating that there is a statistically significant difference between the learning outcomes of students in the experimental and control classes. This verifies that the academic performance of the experimental groups is enhanced by the implementation of specific learning strategies. Outside of the classroom, the problem-based learning model has an impact on critical thinking abilities. The control group employs the conventional learning model, while the experimental group employs the problem-based learning model. The independent t-test analysis demonstrates that the critical thinking abilities are influenced by the application of the problem-based learning model. This conclusion is based on the fact that the t-test on the essential skills of thinking data yielded significant results. Consequently, the applied learning substantially enhanced critical thinking skills in comparison to conventional methods in the control group.

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