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The Influence of Project Based Learning Model on Students' Learning Outcome and Critical Thinking

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Abstract: Project-based learning (PjBL) is a learning model in which students are actively involved in solving a problem by applying the skills of researching, analysing, producing and presenting learning products based on real experiences. This study aims to determine the influence of the PjBL model on students' learning outcomes and critical thinking in Natural and Social Sciences (IPAS in the Indonesian context) Class IV subjects. This research adopts a quantitative approach using the quasi-experimental method. The sample consisted of students from Darussalam Natural School Islamic Integrated Elementary School in Musi Rawas, which had just implemented the independent curriculum using the PjBL model as the applied model, while the control class received the conventional treatment. In collecting data, the techniques used are written tests in the form of description questions carried out twice (pre-test and post-test) and observation. Data analysis, data processing and analysis are carried out by determining question scores, descriptive analysis, prerequisite test analysis, and inferential analysis. The research design used was a pure experimental design with two groups, the control and experimental groups. The results of this study showed that the PjBL model significantly influenced students' learning outcomes and critical thinking skills in IPAS. The findings contribute to the existing literature on PjBL and its impact on students' learning outcomes and critical thinking skills in IPAS learning.

Keywords: critical thinking, learning outcome, project based learning

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Introduction

The ability of learners to think can be developed by improving critical thinking skills so that students can be more active in understanding, analyzing and examining the opinions of others with confidence, being able to cooperate with other students so that they can judge a problem is true or false based on scientific truth and knowledge. Learning in the 21st century involves critical thinking, problem solving, communication, collaboration, creativity, and innovation (Alliance for Excellent Education, 2011; Kassim & Ali, 2010; Satria et al., 2024). Learners' thinking skills can be developed by improving their critical thinking skills so that they can more actively and confidently understand, analyse and test the opinions of others, and work with other learners to judge whether a problem is true or false based on scientific truth and knowledge. Learning in the 21st century involves critical thinking, problem-solving, communication, collaboration, creativity, and innovation.

A teacher or lecturer has long experienced the change in values. Learning with textual skills has given way to problem-solving skills (Damayanti & Mawardi, 2018; Meijer et al., 2006). The role of

learning is to be mediator of concepts to improve students' ability to solve problems (Dumeedae & Haryadi, 2013; Handika & Wangid, 2013). Problem-solving skills can be developed through learning steps that guide students to think critically, find solutions, and select, evaluate, and integrate information from different sources about a problem (Moore, 1995). Problem-solving is an important part of the curriculum and a prerequisite for learning (Nayazik, 2017)

Critical thinking skills are a must in learning today. The rapid development of science and technology has made critical thinking a major concern in learning. (Anindyta & Suwarjo, 2014; Darmawati & Mustadi, 2023; Luthvitasari, Navies & Linuwih, 2012). Critical thinking is the ability to analyse and evaluate existing information on a subject (Baker, 2020). Ideally, education aims to develop critical thinking, communication and other skills that strengthen the mind. When teachers, students and the wider community clearly understand the true purpose of education, students' daily experiencewill change for the better (Berger & Starbird, 2012). If a person lacks critical thinking skills, they will find it difficult to compete in a globalised world (Fell & Lukianova, 2015; Frijters et al., 2008; Sellars et al., 2018).

Educators in the millennial era aim for problem-solving skills to create a good learning atmosphere and increase students' interest in learning (Primadiati & Djukri, 2017). In addition to problem-based learning models, project-based learning is a solution for students to enjoy and support the process of interest and critical thinking in the learning process. Especially in the face of learning in the independent curriculum, teachers and students are challenged to learn with projects. Project-based learning can maximise the learning process so that students enjoy the learning process and are not only result-oriented (Mustadi et al., 2024; Wangid et al., 2014). For this reason, teachers need to be innovative in the way they deliver content so that students enjoy learning. Teachers are advised to use appropriate learning media combined with learning models.

The Socialisation of Curriculum Development issued by the Ministry of Education and Culture of the Republic of Indonesia has a gap in classroom learning, which is abstract and rote and does not accustom critical thinking. Teachers' and student manuals sometimes contain inappropriate content for children at the primary school level. Textbooks focus more on material and practice questions, resulting in more teacher-centred learning. If teachers do not improvise and evolve in the learning process, this will affect the students' activity in the learning process. Students will be more passive, receiving and following the flow and rules rather than experimental projects and finding their answers or solutions as part of the experience (Bergström et al., 2023; Serin, 2018).

One of the efforts that can be made is to create active learning through teaching materials. One challenging task for teachers is creating their own teaching materials to give to their students (Alberola-Mulet et al., 2021). These materials are an important part of the learning process. Teaching materials serve as a guide for teachers and students in learning activities. Learning programs can be implemented more regularly by using teaching material because teachers, as implementers of education, are given clear material guidelines (Hasanah et al., 2021; Maslahah et al., 2019). The Appendix to Permendiknas No. 16 of 2007 on Academic Qualification Standards and Competencies states that teachers, as professional educators, are expected to have the ability to develop teaching materials in line with existing mechanisms, taking into account the characteristics and social environment of students. One of the teaching materials developed according to the independent curriculum is a module.

Modules are subject matter compiled and presented in written form so that readers can absorb the material themselves. In addition to the subject matter, the module also contains questions to measure the student's understanding of the material. Electronic modules or modules are learning resources that can be created by adapting the conditions of the students. Modules are electronic and can be accessed anytime, anywhere, using electronic devices. The module has successfully improved critical thinking skills in several lessons (Fadieny & Fauzi, 2021; Perwitasari & Djukri, 2018).

The use of modules in learning is very appropriate. Teachers can determine the module's composition, design and concept per the applicable curriculum. The independent curriculum prescribes teaching and learning activities based on student-centred learning. Research shows that learning with modules allows students to learn independently and freely according to their conditions (Somantri & Winataputra, 2017). In line with this, the research found that modules can improve learning outcomes. Online modules make learning more interesting (Pradana et al., 2022). The module can be interspersed with pictures and video links to engage students more and make them think critically about the social studies material they are studying. After using the module, all children performed better overall in each

sub-subject. This means that modules can be effective and productive in learning (Chantarasombat et al., 2022; Delita et al., 2022).

Students identified that low learning outcomes resulted from insufficient engagement with critical thinking in everyday life (Ingwarni, 2018; Mursid et al., 2021; Supena et al., 2021). In the family environment, children who are found to be critical are seen as disruptive, which destroys this ability. On the other hand, the availability of reading material at school, at home and even in the community is very limited, and when it is found, the books presented are unattractive, old, and few. The problems identified do not stop there, because the capacity of teachers and institutions to develop the ability to create and develop modules is not maximised, and time is limited because teachers are busy with a lot of administrative work at school. The use of modules can lead to independent / student-centred learning (Logan et al., 2021), can change the way students read and consume interactively and make them feel comfortable where the printed module has pictures, narratives and graphics (Sulistyaningrum et al., 2021; Triwahyuningtyas et al., 2020).

Given the phenomenon and the diversity of research findings, there is scope for the researcher to develop a social studies module based on the project-based learning model to improve students' critical thinking skills. Specifically, the researcher will design a social studies module based on the project-based learning model to improve students' critical thinking skills. This module will be accessible to teachers and students through a variety of platform services. Teachers and students will easily download and access the module and then use it to improve students' face-to-face and online critical thinking skills.

The outcomes of PjBL research are based on learner-centred learning activities and real-life tasks, providing students with everyday challenges to solve and meaningful learning experiences for learners (Farrow et al., 2024; Muhajir et al., 2024). Students' learning experiences and concepts are based on the products created in the process of project-based learning. PjBL is an effective way to develop 21st-century skills by fostering critical thinking and problem-solving, interpersonal communication, information and media literacy, collaboration, leadership and teamwork, innovation and creativity (Baran et al., 2021; Zayyinah et al., 2022).

The creation of a social studies module based on the project-based learning model developed by researchers is a way of proving the theory about the impact of the project-based learning model on improving students' critical thinking skills (Chua & Islam, 2021; Pantiwati et al., 2023). The creation of a social studies module based on the project-based learning model developed by researchers is a way of proving the theory about the impact of the project-based learning model on improving students' critical thinking skills. The PjBL model applied by researchers is a form of proving the theory related to the impact of the PjBL model to improve student’s learning outcomes and critical thinking skills. Of course, suppose we correlate it with the purpose of education itself, which is to humanize humans. In that case, implementing the PjBL model in IPAS subjects is expected to contribute to the noble ideals of education.

Methods

This research is experimental, quantitative research and uses quasi-experimental methods, and given the research conditions that do not allow for strict control, the research design used is a pretest-posttest group design (Cheston et al., 2016). The study involved the formation of two groups, namely the control group and the experimental group. The research was conducted in Darussalam Natural School Islamic Musi Rawas Integrated Elementary School. Class IVA of Darussalam Natural School Islamic Musi Rawas Integrated Elementary School was assigned as the experimental group and Class IVB of Darussalam Natural School Islamic Musi Rawas Integrated Elementary School was assigned as the control class. The independent variable in this study is the effect of PjBL, while the dependent variables include students' learning outcomes and critical thinking skills. The data collection technique consists of pre-test and post-test. The research instruments used include observation sheets to assess the application of the PjBL model, pre-test and post-test sheets to measure student learning outcomes and critical thinking skills.

The research instrument used in this study was an objective test of 10 questions given during the pre-test and post-test with the same instrument. The pre-test was carried out before teaching with treatment, namely one meeting before, while the post-test was carried out after six learning activities were completed, namely one meeting after. To determine whether the questions to be given for the pre-

test and post-test are feasible, the questions need to be tested first in a class that is not a sample class (trial class). The test results were then analyzed to determine the questions' validity, reliability, difficulty level and differentiation.

In collecting data, the techniques used are written tests in the form of description questions carried out twice (pre-test and post-test) and observation. Data analysis, data processing and analysis are carried out by determining question scores, descriptive analysis, prerequisite test analysis, and inferential analysis. The hypotheses of this study are

H0 = There is a significant effect of the PjBL model on student's learning outcomes and critical thinking skills in primary school IPAS learning.

Ha = There is no significant effect of the PjBL model on student's learning outcomes and critical thinking skills in primary school IPAS learning.

Results and Discussion

Results

Student Learning Outcomes

This research was conducted at Darussalam Natural School Islamic Integrated Elementary School students, with 18 students in class A and 15 in class B. The data on student learning outcomes that are considered and processed are student learning outcomes in IPAS subjects in the cognitive aspect domain, which are obtained through the pre-test and post-test results. Data on student learning outcomes that are considered and processed are student learning outcomes in cognitive aspects of IPAS subjects, obtained through pre-test and post-test results. The results of the research data processing that has been carried out are described as follows.

Table 1. Learning Outcome of the Pre-Test and the Post-Test for Scores Compare

No.	Learning Outcome Indicator	Experiment Class		Control Class	
		Score average pre-test	Score average post-test	Score average pre-test	Score average post-test
1	Identify spatial characteristics and the use of natural resources for the community's welfare.	55.8	71.5	53.6	67.5
2	Identify social, economic, cultural, ethnic, and religious diversity as the identity of the Indonesian nation.	48.4	72.7	43.5	61.7
3	Identify Hindu and/or Buddhist and/or Islamic kingdoms in the local environment and their influence on today's life.	56.5	75.4	51.8	62.4
4	Identify economic activities and their relationship with various fields of work and social and cultural life in the surrounding environment.	59.2	77.3	57.4	67.3

Pre-test

The pre-test was given before the treatment in the experimental class and control class, the pre-test was conducted to determine the initial ability of students in each class. Pre-test is important to do to obtain data on the magnitude of the effect of different treatments between experimental and control classes. The average data of student pre-test results in both sample classes obtained was 54.98 in the experimental class and in the control class the result was 51.58. Furthermore, hypothesis testing was carried out using the t-test, with the calculation of homogeneity and normality tests preceding. The results of the calculation of the normality test of the pre-test scores in Clas IVA as an experiment and in Class IVB as a control, it was found that the value of the pre-test scores in Clas IVA as an experiment and in Class IVB as a control χ^2_{count} in grade IVA by 7.56 and grade IVB value χ^2_{count} by 3,68. Value χ^2_{table} at the significant level 5% by 7.81, this shows the status of the variants of the experimental class and control class is homogeneous and normally distributed with $\chi^2_{count} < \chi^2_{table}$.

This shows the variant status of the experimental class and control class is homogeneous and normally distributed with F_{count} by 1.155 smaller than F_{table} by 1.929 at the significant level 5%. This

means that the variant status of the experimental class and control class comes from a homogeneous variant. After the normality and homogeneity tests are carried out, the next hypothesis test is carried out from the data from the t-test calculation results, it is found that the value of the experimental class and the control class is homogeneous by 1.57 < t_{table} by 2.00. for t_{count} is in the rejection area H_0 and acceptance H_1. This means there is no significant difference between the initial abilities of students in the experimental and control classes.

Post-test

After the treatment in each class was carried out, namely as many as 6 meetings, students in each class were given post-test questions to see student learning outcomes in understanding the learning that had been carried out in the experimental and control classes. The average student post-test results in both sample classes are with details that 74.23 in the experimental class and 64.73 in the control class, the data on student post-test results were analysed using the normality test. The results of the calculation of the normality test in the experimental and control classes obtained a value of χ^2_{count} in the VA grade as an experiment is 1.57, and the value of the χ^2_{count} VB as a control is equal to 7.56. Value χ^2_{tabel} at the significant level 5% by 7.81, means that the variant status of the experimental class and control class is homogeneous normally distributed with $\chi^2_{count} < \chi^2_{table}$. Furthermore, the homogeneity test was carried out on the data from the calculation of the value of the F_{count} by 1.22 smaller than F_{table} by 1.92 at the significant level 5%. This means that the variant status of the experimental class and control class is homogeneous. The next stage is hypothesis testing of student observation data in the experimental and control classes to see if there is a significant difference between the experimental and control class group learning outcomes data. The results of hypothesis testing on the experimental and control class learning outcomes data obtained the value of t_{count} by 11.84 is greater than the value of t_{table} by 2,006. for t_{count} is in the reception area H_1 and rejectionn H_0. This means that there is a significant difference in learning outcomes between the experimental class and the control class.

Critical Thinking Skills

The ability of learners to think can be developed by improving critical thinking skills so that students can be more active in understanding, analyzing and examining the opinions of others with confidence, being able to cooperate with other students so that they can judge a problem is true or false based on scientific truth and knowledge. Learning in the 21st century involves critical thinking, problem solving, communication, collaboration, creativity, and innovation.

Based on the pre-test and post-test data obtained, student's critical thinking ability was analyzed using specific indicators, as outlined in Table 2 and Table 3. These indicators provide a detailed assessment of the improvements in student's critical thinking skills before and after the treatment. The comparison highlights the effectiveness of the intervention in fostering students' critical abilities and demonstrating measurable growth through project-based learning modules.

Table 2. Percentage of Pre-Test and Post-Test Critical Thinking in the Experimental Class

No.	Critical Thinking Indicator	Pre-test Average	Criteria	Post-test Average	Criteria
1	Elementary clarification	46.80	Low	73.60	High
2	Basic support	45.50	Low	79.45	High
3	Inference	42.16	Very low	74.80	High
4	Advance clarification	56.20	Low	75.40	High
5	Strategy and tactic	51.65	Low	70.50	Medium

Critical thinking was measured by essay test questions. For the elementary clarification indicator, the pre-test average was 46.80 (Low), which increased to 73.60 (High) in the post-test. For the basic support indicator, the pre-test average was 45.50 (Low), which increased to 79.45 (High) in the post-test. For the Inference indicator, the pre-test average was 51.65 (Low), which increased to 74.80 (High) in the post-test. For the advance clarification indicator, the pre-test average was 56.20 (Low), which increased to 75.40 (High) in the post-test. Finally, for the strategy and tactics indicator, the pre-test average was 42.16 (Very Low), which increased to 70.50 (Medium) in the post-test. As shown in Table

2, the post-test results show that the basic support indicator achieved the highest average, while the Inference indicator had the lowest average.

Students' critical thinking skills were also assessed based on the mean scores of the pre-test and post-test. The pre-test results showed an average score of 48.46. Based on these data, it can be concluded that the critical thinking skills of the students in class IVA (experimental class) in learning social studies can be classified as "low", with an average score of $0 < x \leq 43.75$.

The post-test results of the students' learning outcomes showed an average score of 74.75. Based on these results, it can be concluded that the critical thinking skills of the students in class IVA (experimental class) in social studies are categorised as 'high', with an average score of $71.5 < x \leq 81.25$, which meets the criteria for achieving the learning objectives. A comparison of the pre-test and post-test scores showed an increase, with a score difference of 26.29. This result shows that the project-based learning model is effective in improving students' critical thinking skills.

Table 3. Percentage of Pre-Test and Post-Test Critical Thinking in the Control Class

No.	Critical Thinking Indicator	Pre-test Average	Criteria	Post-test Average	Criteria
1	Elementary clarification	43.50	Low	66.50	Medium
2	Basic support	44.70	Low	68.50	Medim
3	Inference	41.25	Very low	64.50	Medium
4	Advance clarification	51.30	Low	72.80	High
5	Strategy and tactic	49.50	Low	65.50	Medium

Critical thinking was measured by essay test questions. For the elementary clarification indicator, the pre-test average was 43.50 (Low), which increased to 66.50 (Medium) in the post-test. For the basic support indicator, the pre-test average was 44.70 (Low), which increased to 68.50 (Medium) in the post-test. For the inference indicator, the pre-test average was 41.25 (Very Low), which increased to 64.50 (Medium) in the post-test. The pre-test average for the advance clarification indicator was 51.30 (Low), which increased to 72.80 (High) in the post-test. Finally, for the strategy and tactics indicator, the pre-test average was 49.50 (Low), which increased to 65.50 (Medium) in the post-test. As can be seen in Table 3, the post-test results show that the advance clarification indicator achieved the highest average, while the inference indicator had the lowest average.

Student’s critical thinking skills were also assessed based on the mean scores of the pre-test and post-test. The pre-test results showed an average score of 46.05. Based on these data, it can be concluded that the students' critical thinking skills in class IVB (control class) in learning social studies can be classified as 'low' with an average score of $0 < x$ (43.75).

The post-test results of the students' learning outcomes showed an average score of 67.56. On the basis of these results, it can be concluded that the critical thinking skills of the students in class IVB (control class) in the social studies subjects can be categorised as 'medium', with an average score of $62.5 < x \leq 71.5$ which is an average score that meets the criteria for achieving the learning objectives. The comparison of the pre-test and post-test scores showed an increase, with a score difference of 21.51.

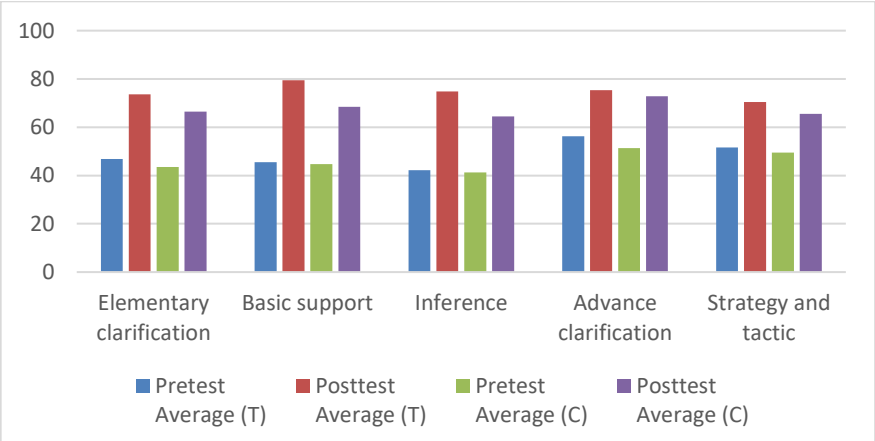

Figure 1. Comparison of Improvement in Pre- and Post-Test Scores in Critical Thinking Skills

Discussion

The Effect of PjBL Implementation on Learning Outcomes

To see if there is a difference in student learning outcomes between the experimental and control classes, we first look to see if there is a similarity in students' initial ability in the experimental and control classes. This is to determine whether the results obtained are purely differences in results due to the different treatments given to the experimental and control classes. The test of the students' initial ability is based on the calculation of the pre-test results, which were given before the learning treatment was carried out. The pre-test was given before the treatment in the experimental class and the control class, the pre-test was done to determine the initial ability of the students in each class. The pre-test is important to obtain data on the magnitude of the effect of different treatments between experimental and control classes. The average data of students' pre-test scores in both sample classes obtained was 54.98 in the experimental and control classes; the result was 51.58. The average data of the students' post-test results in both sample classes obtained was 74.23 in the experimental class and in the control class the result was 64.73.

Table 4. Comparison Table of Pre-Test and Post-Test Results on Learning Outcomes

	Average score of the experimental class	Average score of the control class
Pre-test	54.98	51.58
Post tes	74.23	64.73
Difference	19.25	13.15

The difference in learning outcomes between the experimental and control classes can be seen from the difference in improvement between the two classes. The experimental class that was treated with the PjBL model had an increase of 19.25, while the control class that was not treated also had an increase of 13.15. This is certainly due to many factors, such as the behaviour of the students in the experimental class, who are more active when treated with the PjBL model (Juuti et al., 2021; Umar & Ko, 2022) compared to the students in the control class, whicpassive students dominated during the treatment. Students in the experimental class looked more focused and ready to follow any treatment given in learning (Duke et al., 2021; Lin et al., 2021), Although some students were seen chatting when the treatment was given with an insignificant or small amount. Pupils follow the learning by listening to every instruction of the teacher when explaining the material to be learnt.

When project learning is conducted in groups, if it appears that the pupils' behaviour is orderly and they do not make any noise unrelated to learning, the teacher can carry out all the steps of the model smoothly without pupils refusing to be divided into groups. When students are given worksheets, all members are actively involved in the group according to their respective tasks. Students became more excited and enthusiastic in discussing the project.

Natural and Social Sciences (NSP) focuses on social studies in the first semester as the integrated study of the social sciences and humanities to promote social competence, adding that its main aim is to help young people (in this case elementary school students) develop the ability to make informed and reasoned decisions for good citizenship in a culturally diverse and democratic society in an interdependent world (Resti & Wibowo, 2024; Efendi et al., 2024; Brilatin & Wibowo, 2024). IPAS, focusing on social studies, provides students with the basic skills to develop themselves according to their talents, abilities and future needs (Adelina, 2015; Dewi & Mukminan, 2016; Fanny & Suardiman, 2013).

Developing Critical Thinking Skills

The pre-test results show that the critical thinking skills of students in the experimental class and control class are not much different or can be said to be the same. The research continued by giving treatment to the experimental class using the PjBL model, while the control class used the conventional learning model that is usually done in class.

Table 5. Comparison Table of Critical Thinking Scores of the Experimental and Control Class

	Score critical thinking of the experimental class	Score critical thinking of the control class
Pre-test	48.46	46.05
Post test	74.75	67.56
Difference	26.29	21.51

Students' critical thinking skills were also assessed based on the mean scores of the pre-test and post-test. The pre-test results (experimental class) showed an average 48.46 (low) score. The post-test results (experimental class) showed an average score of 74.75 (high). The comparison of the pre-test and post-test scores showed an increase, with a score difference of 26.29. This result shows that the project-based learning model improves students' critical thinking skills. While the critical thinking skills of the students in the control class showed an average score of 46.05 (low) in the pre-test. The post-test results (control class) showed an average score of 67.56 (medium). The comparison of the pre-test and post-test scores showed an increase, with a score difference of 21.51.

The test results showed that both experimental and control classes showed the same increase in scores from pre-test to post-test. In the experimental class, the most significant increase was in the basic support indicator, which reached the highest average, while the inference indicator had the lowest average. The reasoning indicator reached the highest average in the control class while the inference indicator had the lowest average (Sianipar, 2020). The expression of unfamiliarity in writing conclusions is why students do not carry out the inference process.

The thing that causes the difference in the development of student's critical thinking skills in the experimental class and in the control class in this study is because, during the learning process in the experimental class is dominated by teaching using concrete objects as learning support. This causes students to be more interested and active during the learning process, which is reflected through students' enthusiasm in learning. Learning using the PjBL model using realistic problems and concrete objects will produce meaningfulness in social studies learning (Fauzia & Kelana, 2021; Toding & Wibowo, 2024; Molstad & Karseth, 2016).

Critical thinking has benefits in learning, such as encouraging students to take risks, encouraging students' ability to innovate in dealing with the ambiguity of a problem, helping students appreciate different perspectives, and training independence (Wibowo, 2024; Mustadi et al., 2024; Harokah et al., 2024). Enabling children to master a broader and deeper range of material, especially in subjects such as social studies. Teachers who facilitate student's critical thinking will show benefits in terms of personality when teaching: a) being well-prepared and knowledgeable; b) having a high interest in disciplining students; c) having a talent for encouraging students to generate ideas and seek new knowledge; d) respecting student's personalities; e) being able to use a variety of teaching techniques; f) being flexible and open to criticism and suggestions from students; and g) believing in student's ideas (Kampylis et al., 2011).

Conclusion

The results of the study on the effect of the PjBL model in IPAS subjects for Grade IV students on learning outcomes and critical thinking skills showed an improvement in both learning outcomes and critical thinking skills. The effect of using a project-based learning model on students' learning outcomes is indicated by an increase in the average post-test scores over the pre-test scores in the experimental class, which is greater than in the control class. The effect of using a project-based learning model on students' critical thinking skills is indicated by an increase in the average post-test scores over the pre-test scores in the experimental class compared to the control class. The results of this study indicate that the PjBL model used in the implementation of the independent curriculum has proven to be the right choice for implementation. The PjBL model, with its indicators and steps, is able to improve the quality of learning outcomes and critical thinking skills, which is one of the profiles in the independent curriculum.

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