

## Improving students' critical thinking through Project-Based Learning (PBL)

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### Abstract

*The fourth industrial revolution impacts the education system and student learning. Education must be capable of developing and designing 21st-century life skills learning, one of which is critical thinking abilities. The PBL model is used to guide efforts. This research aims to improve student's critical thinking through Project-Based Learning (PBL). This research used a quantitative method, which is a quasi-experimental research design, by applying a non-equivalent pre-test post-test control group design. The study was carried out at Semarang City High School. This study's sample size was 200 students from Semarang City High School. The data were obtained through the critical thinking test. This research used a t-test with a significant level of 0.05 to analyze the data. Based on the research analysis, Students in the control group boosted their critical thinking score by 9.58 points, from 65 to 74.58. Meanwhile, the experimental group students' critical thinking score jumped by 19.99 points, from 60.77 to 80.76. The increase in the critical thinking score is 10.41. The result also showed a Sig. (2-tailed) value of 0.000. This number is less than 0.05. It indicated that is accepted. Based on the result of the Sig. (2-tailed) value t-test calculation, it can be concluded that due to the diverse learning methods applied, there are disparities in students' critical thinking results with the acceptance. Project-based learning improves students' critical thinking skills. The conclusion is that the PBL paradigm improves students' critical thinking skills.*

**Keywords:** Critical thinking; Project Based Learning (PBL); 21st century skills

### INTRODUCTION

The world is entering the 21st-century era, namely the era of the Industrial Revolution 4.0. An era where information technology and robotics have become the basis in every sphere of human life. One of the challenges in the era of the Industrial Revolution 4.0 is to prepare human resources with skills across basic sciences to compete globally. Industrial Revolution 4.0 combines physical and digital technology with analytics, artificial intelligence, cognitive technology, and the Internet of Things (IoT), building interconnected digital companies that can

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produce more appropriate policies (Priantari et al., 2020). The era of education influenced by the Industrial Revolution (RI) 4.0 is called Education 4.0. Education in the Industrial Revolution 4.0 era is characterized by using digital technology in the learning process, known as the cyber system. This system can make the learning process continuous without space and time limits. The era of the Industrial Revolution 4.0 is a tough challenge for our education. As currently implemented, education and learning that only emphasizes knowledge content to exclude attitudes and skills content will produce students who cannot compete in the RI 4.0 era.

The world is constantly changing. Students must become ready for the changes. Students must prepare for the skills required for the twenty-first century. This is especially true for high school students nowadays. Critical thinking is one of the abilities necessary for students to be self-directed learners. This ability will assist students in adjusting to university life. However, critical thinking abilities are frequently overlooked because of the teacher-centered nature of the classroom. Students must be able to distinguish between facts and views and verify accurate information to be autonomous learners. According to early findings from a study performed at LB LIA Palembang, a non-formal English Language Institution in Palembang, various issues with their critical thinking abilities occurred, including difficulty in attempting to present reasons. At the same time, in the discussion, they struggle only to parrot friends' answers and need more understanding about the topic of the debate, as well as difficulties synthesizing knowledge they know and information they obtained before making a choice, resulting in poor critical thinking abilities (Fitria & Tahrún, 2021). Furthermore, researchers have looked at the effects of concept maps on learners' critical thinking (Aygün & Yavuz, 2020; Chen & Hwang, 2019; El Soufi & See, 2019; Febriani, 2019; Muthoharoh & Hartono, 2022; Pratama, 2017; Pravita & Kuswandono, 2021; Wahid et al., 2022; Yulia & Budiharti, 2019).

Project-Based Learning (PBL) is a learning strategy that encourages students to use higher-order thinking abilities. Students learn more effectively when they are involved in meaningful activities. "Tell me, and I will listen; teach me, and I will remember; involve me, and I will learn," Franklin said. This approach suits kindergarten- to university-level students (Fitria & Tahrún, 2021). PBL allows students to collaborate on conceptual understanding, apply past information, and learn new skills. A project can be created by combining many disciplines. Other advantages of PBL include allowing students to display better skills, enhancing students' success, challenging students to solve real-world issues, and becoming good collaborators (Coyne et al., 2016), improving topic understanding, and fulfilling the demands of students with diverse talents and learning styles.

The ability to think rationally and reflectively is referred to as critical thinking. As a result, it assists humans in deciding what to believe or do through intellectual processes such as conceiving, applying, analyzing, and evaluating knowledge, which leads to invention. Students apply these skills to solve issues in novel contexts, draw inferences and generalizations, mix scoop in unknown patterns, and make evidence-based decisions.

Previous research gaps are shown in several studies, particularly in elementary and secondary schools, which have focused on PjBL, such as Jirana et al. (2020), which carried out a study that revealed that using the PjBL model influenced the learning process. Fitria & Tahrin (2021) that PBL has an impact on strengthening students' critical thinking skills. More research is needed to have a more positive influence on society. Issa & Khataibeh (2021) revealed a statistically significant difference ( $\alpha = 0.05$ ) between the traditional and project-based learning strategies. As a result, the differences favored the project-based learning technique. Umam et al. (2022) found that students may increase their creativity and critique skills while undertaking project-based learning in the classroom. Priantari et al. (2020) found that the Science, Technology, Engineering, Art, and Mathematics (STEAM) method and the PjBL paradigm improve students' critical thinking skills. Different results were conducted by Anazifa & Djukri (2017) that Project-based learning and problem-based learning do not affect students' critical thinking. Baysura et al. (2016) discovered that while more than half of prospective instructors claimed that they learned the PBL method in theory, almost half of them stated they did not get to use it. Although numerous studies have been completed using the PBL model, the education field's issues regarding learning model selection are still ongoing. It is due to various circumstances, including a mismatch between the learning paradigm and the subject to be taught.

With an emphasis on the learning process that takes place in a project as the end result, PBL is a learning model that can help students become better critical thinkers by enabling them to work together on projects that explore and enhance their learning. By using appropriate learning media, learning materials can be made more understandable for students, which also helps them master the learning objectives. As facilitators and motivators, teachers play a crucial role in fostering an engaging and innovative learning environment by utilizing engaging and enjoyable technological learning resources, which enable students to comprehend the course materials and meet the learning objectives (Intiana et al., 2023; F. Wahyuni et al., 2022; S. Wahyuni & Febianti, 2019). Applying technology as a teaching tool can assist teachers in creating more exciting, productive, and effective lessons that encourage students to learn (Mortini et al., 2023; Sugiani, 2023). English teachers must be able to decide what kind of technology to provide in their classrooms so that students not only learn how to use it but also are motivated to become individuals who can use technology more positively in line with current trends because the use of technology in the classroom can also improve the learning environment and create students' interest in learning (Prayudha, 2023). When the technology is applied appropriately, it can enhance the learning processes and reduce achievement gaps (S. Wahyuni & Febianti, 2019).

Facts show that students' critical thinking abilities often need to be improved. Low student creativity might be connected to input or procedure in a learning environment. The expectation in learning is to produce skilled graduates in conformity with the demands of the twenty-first century. According to the expectations, it is vital to assess students' critical thinking abilities and creativity at an early stage and to implement a learning model capable of stimulating student talents. Many scholars have studied ways to promote

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student creativity. However, the subject is strongly tied to students' everyday lives, and none of them highlights the application of the PBL model in evolution to increase students' critical thinking and creativity. Furthermore, students need help with mastering the material. Based on the issue, the aim of this research is to improve students' critical thinking through project-based learning (PBL).

**Critical thinking**

Learning that fosters critical thinking also allows for considerable engagement in the classroom (Fajar et al., 2020). When used appropriately, critical thinking is depicted as a metacognitive method that entails a variety of subskills such as interpretation, evaluation, and inference that improve the chances of generating a rational deduction to arrive at a specific argument or solution to a question (Pravita & Kuswandono, 2021). Furthermore, critical thinking has been linked to higher-order thinking in Bloom's taxonomy (Al Zahrani & Elyas, 2017; Jirana et al., 2020). Bloom's updated taxonomy grouped thinking into six categories. Remember, comprehend, apply, analyze, evaluate, and create are the six categories of thinking, which are classed as lower-order thinking skills (LOTS) through higher-order thinking skills (HOTS). Analysis, assessment, and design are frequently used to define critical thinking (Anazifa & Djukri, 2017).

Furthermore, critical thinking is primarily related to cognitive processes related to knowledge interpretation and appraisal. A person can use critical thinking to develop conclusions based on the data supplied and appraise the available information regarding validity and reliability. Critical thinking is also defined as mastery achieved via possessing and developing mental capacities associated with comprehension and the logical evaluation of discoveries from multiple sources (Pravita & Kuswandono, 2021). Aygün & Yavuz (2020) summarize and conclude previous researchers' ideas about critical thinking, stating that critical thinking is defined as a purposeful, self-regulatory decision that results in the perception, examination, assessment, and inference of the conceptual, methodological, criteria, or contextual evidence on which that judgment is based.

Every class has its distinct traits. The repetitious atmosphere of one-way teaching will encourage students' passivity and boredom throughout the class. In this scenario, the lecturer's inventiveness is required to create enjoyable activities. In addition, encouraging student engagement and critical thinking through active learning is vital in teaching-learning activities. The lecturer is the facilitator of dynamic learning practices that emphasize student engagement. Active learning in the classroom will assist students in grasping the courses by incorporating them as the focus of knowledge in activities. During the lessons, students are taught independence and critical thinking skills (Fitria & Tahrin, 2021).

**Project Based Learning (PBL)**

Project-based learning begins with an essential inquiry and concludes with a product. Kilpatrick developed the Project Method, leading to project-based learning (Sularmi et al., 2018). Project-based learning is a learning style in which students actively participate in their learning. In response to problem-solving exercises, learners are taught how to create a real-world product.

Furthermore, this learning paradigm may help students improve their creativity while creating a project and educate them to work effectively together. Students must think critically as part of the project/product (Mekarsari & Suprijono, 2019).

Learning as a group is a lot of fun because it simplifies working on the assigned project. As a result, the 2013 curriculum incorporates project-based learning to improve education quality in Indonesia. This is mentioned in Article 31, paragraph (3) of the 1945 Constitution concerning the government's attempts to organize a national education system, such as project-based learning. Project-based learning is a novel approach to all disciplines' learning strategies. This technique is used to succeed in the twenty-first-century learning strategy to increase learners' capacity. Define project-based learning as an educational technique focusing on actual yet unstructured challenges (Arifin, 2020; Umam et al., 2022).

The experience of students being challenged to solve issues is at the heart of this orientation. A project-based learning technique was created and implemented to increase educators' competency in carrying out enjoyable learning. Many nations have had success with project-based learning techniques. This demonstrates that this strategy has a significant influence on schooling. Learning using this approach is deemed promising since it shows learners' capacity to think critically. Many project-based learning models' core design ideas attempt to assist students in going from novices to experts and improving their capacity to transmit information. As a result, schools and organizations dedicated to deeper learning often refer to project-based learning as a critical education technique (Umam et al., 2022).

## **METHOD**

### **Respondents**

This research used a quantitative method, which is a quasi-experimental research design, by applying a non-equivalent pre-test and post-test control group design. Respondents in this study were Senior High School students from the Indonesian province of Central Java in Semarang. Respondents were chosen through random sampling once the Google Form inquiry link was distributed. Senior High School students were given critical thinking tests as an instrument. This research accepted a total of 200 samples. As a result, the respondents separated the class into two groups: the experimental group (100 students) and the control group (100 students). The experimental group utilized the Project-Based Learning model, whereas the control group employed the standards-based learning model (SBL).

### **Instruments**

A test was used to collect the data. This study used a critical thinking test as an instrument. It consisted of six questions in essay-type items following the California Critical Thinking Skills Test from Facione (2015). Before testing the hypothesis, the normality test of Kolmogorov-Smirnow and homogeneity tests of Levene's formula were run. All the analyses were done using SPSS version 19.

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**Procedures**

The first part of the approach begins with identifying the research schools and preparing the research tools. Furthermore, the PBL teaching model is influenced by enhancing critical thinking and assessing the normalcy and homogeneity of the instrument. The second stage involves gathering data from the schools of the selected students. The data was then evaluated with SPSS statistics software.

**Data analysis**

The writers used descriptive statistics and inferential statistics. With a significance level of 0.05, the data were automatically computed and analyzed using Microsoft Excel 2019, and the SPSS 19 version was used for all analyses. An independent sample t-test was used to evaluate the hypothesis. According to Muthoharoh & Hartono (2022), the t-test is a commonly used statistic for finding significant differences between two means. This sort of test is still effective with small data sets.

**RESULTS AND DISCUSSION****Normality Test**

A normality test was carried out before using a t-test to evaluate the research hypothesis and see if the data in both classes had a normal distribution. Table 1 shows the outcomes of the normality test of critical thinking.

Table 1. Normality Test of Critical Thinking

Groups	Pretest			Posttest		
	Statistic	df	Sig.	Statistic	df	Sig.
Experiment	0.553	100	0.200	0.271	100	0.101
Control	0.452	100	0.115	0.367	100	0.107

Table 1 discovered that the experimental group's Kolmogorov-Smirnov pre-test score was 0.553 with Sig. 0.200 > 0.05, whereas the control group's pre-test score was 0.452 with Sig. 0.115 > 0.05. The experimental group's Kolmogorov-Smirnov post-test score was 0.271 with Sig. 0.101 > 0.05, whereas the control group's post-test score was 0.367 with Sig. 0.107 > 0.05. They demonstrate that all samples' data were normal.

**Homogeneity Test**

The homogeneity test was calculated to assess how similar the samples were in the two classes. Levene statistical test was utilized to determine and calculate the pre-test of the homogeneity test with a significance level of 0.05. Table 2 shows the outcomes of the homogeneity test of critical thinking.

Table 2. Homogeneity Test of Critical Thinking

Pretest				Posttest			
Levene Statistic	df1	df2	Sig.	Levene Statistic	df1	df2	Sig.
3.228	1	199	0.078	3.340	1	199	0.074

Table 2 proved that the significance of the pre-test between the experimental and controlled groups is 0.078, and the post-test between the experimental and controlled groups is 0.074. It can be concluded the data of the pre-test and post-

test data were homogenous because the homogeneity test result is higher than the significance level of 0.05.

### Critical Thinking Value Data

The findings of this study demonstrate the average critical thinking skills of the experimental and control groups throughout the post-test and pre-test. After calculating the average value, the gain score, the difference between the two groups, post-test and pre-test, is computed. Table 3 shows the outcomes of assessing students' critical thinking abilities.

Table 3. Critical Thinking Score of Students

Groups	Pretest	Posttest	Difference
Experiment	60,77	80,76	19,99
Control	65	74,58	9,58

Table 3 displays students' critical thinking scores. Students in the control group boosted their critical thinking score by 9.58 points, from 65 to 74.58. Meanwhile, the experimental group students' critical thinking score jumped by 19.99 points, from 60.77 to 80.76. The increase in the critical thinking score is 10.41.

### Hypothesis Test

The t-test was used to assess the data on the importance of critical thinking abilities shown above. The t-test was performed using the SPSS 19 software. The t-test results are shown in Table 4.

Table 4. Analysis of the Effect of Project-Based Learning on Students' Critical Thinking

Source	F count	Value Sig. (2-tailed)	Criteria	Test decision
Project-Based Learning Model	10.572	0,000	<0.05	Accepted

The above data in Table 4 reveals a Sig. (2-tailed) value of 0.000. This number is less than 0.05. As a result of being accepted. Due to the diverse learning methods applied, there are disparities in students' critical thinking results with the acceptance. Project-based learning improves students' critical thinking skills.

The study data shown above reveals that employing the Project Based Learning learning style considerably influences students' critical thinking skills. Oktavianto et al. (2017) say Project Based Learning helps boost thinking skills. Students' thinking abilities can improve since there are exercises in studying syntax that educate pupils to think. The trained and perfected thinking process will improve students' critical thinking abilities.

The results demonstrated improved critical thinking abilities following project-based learning. Remember that critical thinking is a metacognitive skill (Sularmi et al., 2018). Project-based learning can help students enhance their metacognition. Boosting learners' metacognition also involves increasing

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learners' capacity to solve issues rationally and reflectively, as these abilities are present in critical thinking.

When faced with difficulty, learners who develop their problem-solving abilities rationally and reflectively are precious. Furthermore, cooperative learning requires students to address each topic collectively. This indicates that the teacher has provided a conducive learning atmosphere. The learning environment is an actual learning environment in the project-based learning approach. Learners will learn faster in this atmosphere, which may be achieved through project-based learning. This suggests that instructors may respond to Geçit & Akarsu (2017)'s challenge that critical thinking abilities can be developed if teachers can adequately design, build, and arrange the learning environment.

Because of project-based learning, a pleasant learning environment can enhance items that assist in attaining geography learning objectives. According to Oktavianto et al. (2017), this occurs when (1) students are challenged to solve real-world problems, (2) students become more active in their learning, (3) students' performance during project implementation is more organized, (4) students have flexibility in project completion, and (5) students are eager to compete to produce the best project. After implementing project-based learning, these five factors influence students' critical thinking skills. The same thing happened in another study that found that project-based learning can boost critical thinking abilities.

Another factor contributing to increased critical thinking after project-based learning is increased student enthusiasm and collaboration. This is consistent with the findings of the study that project-based learning increases learner motivation. Learners who collaborate help improve their critical thinking skills. Another study by Putri et al. (2022) found that the data analysis of the E-Paket PBL obtained a high rating from professionals and students. As a result, it is appropriate for classroom usage. The effectiveness test findings revealed variations in grade IV students' critical thinking skills after learning to utilize the PBL E-Package. The PBL E-package increased the critical thinking skills of fourth-grade primary school students. According to Suteja & Setiawan's (2022) research shows a substantial difference in students' writing skills before and after adopting the project-based learning paradigm.

**CONCLUSION**

From the discussion presented above, the following conclusions can be drawn. Project-based learning has a substantial impact on student's critical thinking abilities. This occurs because students participate more actively in the learning process, increasing their motivation. Project-based learning that is carried out correctly can create a good learning environment. A good learning environment is learning that fosters interaction between students so that they work together to find ways to solve problems. Third, project-based learning can be used to achieve learning objectives. Lesson learning in contextualized project-based learning will help achieve learning objectives. From the conclusions that have been presented, the researcher proposes the following suggestions. First, teachers might employ Project Based Learning to help students enhance their



critical thinking abilities. Second, instructors must understand the grammar of Project Based Learning for the learning to be carried out correctly. Third, instructors can use Project Based Learning to accomplish learning goals.

### **AUTHOR STATEMENT**

**Agnes Widyaningrum:** Conceptualization, methodology, treatment, data collection, original draft. **Yovita Mumpuni Hartarini:** Conceptualization, supervision, discussion, draft revision & proofreading.

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