

The Influence of Project-Based Online Learning and Self-Efficacy on Students' Critical Thinking Learning Outcomes

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Abstract

Online project-based learning models have become a significant concern in modern education. In physics subjects, understanding motion dynamics requires strong critical thinking skills. The research aims to describe students' critical thinking abilities regarding the concept of using project-based learning online (PjBoL) and face-to-face (PjBL) based on the level of self-efficacy (high, medium, low) and interaction between learning methods and self-efficacy. This research used an experimental design with research subjects in the form of class XI students at SMAN 1 Kesamben. Learning was carried out over six meetings using the same material. The independent variable in this research is the PjBoL model, while the dependent variable is students' critical thinking abilities. Data analysis was done using two-way ANCOVA to evaluate the relationships and interactions between these variables. The research results show a significant difference in students' critical thinking abilities on the concept of dynamics of motion between PjBoL and face-to-face, as well as in students' critical thinking abilities on self-efficacy. It is recommended that the PjBL Model, carried out face-to-face, is suitable for millennial students and has been proven to have better critical thinking learning outcomes.

Keywords

PjBoL; PjBL; Self-Efficacy; Critical Thinking Skills; Learning Outcomes

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1. INTRODUCTION

Reigeluth's (2013) learning design theory states that the components needed in a learning process include the learning situation and the methods applied. The learning situation consists of the desired outcomes and learning conditions. Desired outcomes include effectiveness, efficiency, and attractiveness; learning conditions include what is taught, who teaches it, conditions of the learning environment, and obstacles in planning and developing learning tools. The method component is the method or model used in the learning process. Reigeluth's learning design theory seems worthy of being implemented in the current learning process to achieve the desired implementation and learning outcomes.

Communication is carried out using increasingly sophisticated technological devices (W. Wang et



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al., 2024). Computers, Android communication tools, and the internet help humans and are needed for communication in this century. Many social media platforms can be used to communicate (Nathanael & Nainggolan, 2022; Steffan, 2020; G. Wang et al., 2022). 21st-century learning implies that there are four things (4C) that students must have, namely: 1) Critical thinking and problem-solving, 2) Creative and innovative, 3) Communication, and 4) Collaboration (Chiruguru & Chiruguru, 2020; Syahril et al., 2022, p. 4; Wulansari et al., 2022).

The critical thinking ability in learning encourages students to use logical reasoning in understanding and making decisions on complex problems (Maryati et al., 2020). In this case, students use their initial abilities to solve problems that exist and occur in the surrounding environment. They can solve all issues both independently and in groups. Apart from that, students are expected to be able to plan, analyze, and express their ideas when solving problems. Students' ability to be creative and innovative is directed so that they can develop, implement, and convey new ideas to others, have an open attitude, and are always responsive to new perspectives (Weng et al., 2022).

The teacher's role in developing students' creative and innovative abilities is to provide space and opportunities for students to achieve achievements and make it a habit to give appreciation to students, no matter how small their achievements. The goal is to motivate students to continue to improve their achievements. The communication skills students possess demonstrate mastery to communicate effectively in various forms and contents orally, in writing, and in multimedia (Reith-Hall & Montgomery, 2023).

Learning that prioritizes joint activities, such as group discussions, will train students to get used to collaborating and working with others. In this way, success is interpreted as collective success, no longer just individual success. The leading indicator highlighted is tacit knowledge in commitment (Nguyen, 2024). The most important thing is a commitment to corruption. Corruption is a chronic disease that is eating away at government bureaucracy in Indonesia. Corruption causes huge state losses and hinders national development. Next is a commitment to bureaucratic efficiency and effectiveness: Government bureaucracy in Indonesia is often criticized for being slow, inefficient, and ineffective. This causes budget waste and hinders problem-solving.

Adapting quickly in the education sector is necessary based on the current situation. Students' success depends on 21st-century skills (Rotherham & Willingham, 2010). Current learning should be carried out by applying appropriate methods. Learning is expected to involve more student activities (active students) so that teachers play more of a role as guides to students in learning and solving problems. The teacher is a facilitator whose role is to facilitate the learning needs of his students. This is because each student has unique characteristics, so their needs and ways of learning are also different. The online learning model can be applied to meet the learning needs of children in today's increasingly connected era because it can create a win-win situation between students and teachers. Online learning is a model that can be applied synchronously or asynchronously.

The era of Society 5.0 is a renewal that places humans as the main component, not just a passive component like in the Industrial Revolution 4.0. "Renewal in this era can produce new value through elaboration and collaboration on systems, information, and technology, which also improves the quality of human resources needed or human capital," the three main capabilities facing society 5.0. including the ability to solve complex problems and become a problem solver for himself and many people. The ability to think critically, not only in the classroom but also in social life and the surrounding environment, so that social sensitivity and the ability to be creative arise. To answer these challenges, a person must have high "self-efficacy" (Alfares, 2021; Anksorus & Bradley, 2020; Conradty et al., 2020).

According to a Canadian psychologist (Bandura, 2017), self-efficacy is a person's belief in their ability to complete something successfully. This means that when an individual has high self-efficacy, he believes he can do something (Al-Abyadh & Azeem, 2022; Alqurashi, 2016). Self-efficacy is a construct proposed by Bandura based on social cognitive theory. In his theory, Bandura (1997) stated

that human action is a reciprocal relationship between the individual, the environment, and behavior (triadic reciprocal causation).

In learning, self-efficacy is necessary so that students can succeed in the learning process (Anksorus & Bradley, 2020; Conradty et al., 2020; Gosselin et al., 2021). Interestingly, in learning, students with good self-efficacy are expected to impact critical thinking learning outcomes positively. According to (Dahar. R. W., 2011), critical thinking is students' ability to understand scientific meaning, both theory and its application in everyday life. Meanwhile, according to Bloom, critical thinking is the ability to grasp understandings, such as expressing material in a more understandable form, providing interpretations, and applying them (Sutianah, 2022).

One of the benefits of improving critical thinking skills is that students have good problem-solving skills. This ability is also essential in learning. For a student, problem-solving means finding solutions to problems in science courses, facing new situations, and finding flexible, valuable, and elegant solutions. A problem for someone means an extraordinary question where students have the necessary initial information but do not know the methods and steps that will lead them to the previous solution, so abilities are needed to make appropriate and quick decisions regarding the problem (Chamidy et al., 2020). Problem-solving is generally considered the most significant cognitive activity in daily Learning (Jonassen, 2000). Efficient and effective work systems and procedures can be created by reforming the bureaucracy, simplifying work rules and procedures, and utilizing information and communication technology (Hidayat et al., 2024; Putri et al., 2024).

From the results of the bibliographic metadata of Scopus-accredited articles, the following picture of variable analysis is obtained:

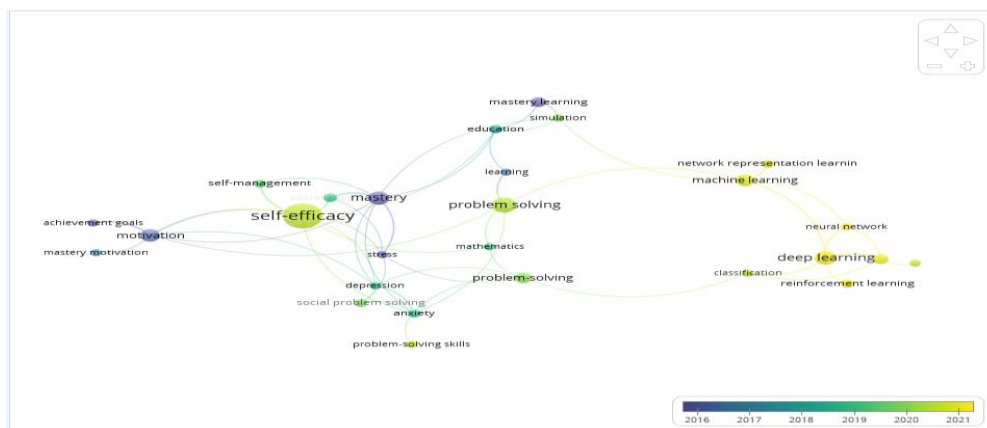


Figure 1. Bibliography VOS Viewer Meta Data Analysis

Figure 1 metadata shows the relationship between variables researched in reputable, indexed articles Scopus on ScienceDirect, a website that provides subscription access to scientific research databases. Data is obtained that Self-Efficacy is related to several other variables such as "Motivation", "self-management," "mastery", "and social support." However, in the analysis of bibliographic metadata, the variable "online learning" has not been found. This makes it possible for researchers to research this variable so that novelty can be found.

Metadata on images is carried out on each variable of 100 reputable articles accessed via ScienceDirect that have been indexed in Scopus; there are online representation learning variables that are not yet connected to the self-efficacy variable. Likewise, the problem-solving variables that have been researched are still not connected to the self-efficacy variable. Therefore, research and studies still need to be carried out regarding the influence of online learning and self-efficacy. From the explanation of the background above, the researcher took the title "The Influence of Project-based Online Learning (PjBOL) and Self-efficacy on Students' Critical Thinking Learning Outcomes on the Concept of Dynamics of Motion in Physics XI Subjects."

2. METHODS

The design of this research is experimental. An experimental research design is a quantitative research design that aims to determine the impact of treatment on outcomes, even though the research subjects use specific procedures (Creswell & Creswell, 2017). The experimental research design used in this research is quasi-experiments (Arikunto, 2016).

In this study, a pretest-posttest control group design was used. The experimental, control, and control groups were given a pre-test to determine the differences in general knowledge between the two groups. The pre-test results are said to be back if the test group or class scores are not significantly different.

The subjects in this research were students of SMAN 1 Kesamben class XI semester 2. These students studied the dynamics of motion in physics. The number of parallel teacher classes is two classes. The implementation of this research chose two classes, namely, 1 class as the experimental group and 1 class as the control class.

Determining the experimental and control classes is carried out classically, using already formed classes. The subjects were grouped into two groups: the experimental group, which received treatment using the PjBoL learning model, and the control group, which received treatment using the PjBL model. The treatment was conducted on experimental and control class students who took science subjects.

Data collection activities were carried out using research instruments. The data collected from the data collection process is then checked, organized, coded, and analyzed to obtain information that can explain and answer the problem that has been formulated. The data collection instruments in this research used pre-tests and post-tests, the development of which started from preparing grids to developing question items. In addition, measurements will be carried out to determine the level of self-efficacy using Bandura's Instrument Teacher Self-Efficacy Scale.

3. FINDINGS AND DISCUSSIONS

The purpose of hypothesis testing is to determine whether the hypothesis is true. Three hypotheses will be tested regarding the influence of the independent variable on the dependent variable. Results of research data calculations using the ANCOVA method: The two routes have previously gone through several prerequisite tests explained in the previous sub-chapter. The test results of the influence of the independent variable on the dependent variable are presented in Table 4.

Table 1. Two-Way Calculation Results Ancova
Learning Model * Self -Efficacy

Learning Model	Self - Efficacy	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
PjBOL	Low	48.668 ^a	3.994	40.764	56.571
	Medium	62.478 ^a	.972	60.554	64.402
	High	81.549 ^a	3.538	74.550	88.549
PjBL	Low	60.411 ^a	5.474	49.581	71.242
	Medium	76.871 ^a	.919	75.053	78.689
	High	92.995 ^a	5.697	81.723	104.267

- a. Covariates appearing in the model are evaluated at the following values: Pre-Test Critical Thinking = 38.36

The data in Table 1 presents the results of data analysis after covariance is present in the pre-test. In general, it can be seen in the table that the highest mean value is found in the learning process that uses the PjBL model with the level of self-efficacy of students in the high group, namely 92.995. This means that the PjBL learning model and high levels of student self-efficacy can increase students' post-test scores in physics learning on motion dynamics material. Interventions that target the development of self-efficacy and the application of PjBL learning methods can be helpful strategies for improving students' critical thinking learning outcomes in Physics subjects, especially in Motion Dynamics material by the research topics that have been carried out. Next, the test results of each hypothesis will be presented to see the influence of each variable.

Table 2. Pairwise Comparisons

Pairwise Comparisons						
(i) Learning Methods	(j) Learning Methods	Mean Difference (I.J.)	Std. Error	Sig. b	95% Confidence Interval for Difference b	
					Lower Bound	Upper Bound
PjBOL	PjBL	-12.527 ^a	3.209	<.001	-18.877	-6.178
PjBL	PjBOL	15.527 ^a	3.209	<.001	6.178	18.877

Based on estimated marginal means

*. The mean difference is significant at the.05 level

b. Adjustment for multiple comparisons: Bonferroni

The analysis results in Table 2 show that the treatment has a significance level of < 0.001, far below the specified standard significance level. Because the sig value < 0.05 means H₀ is rejected. This shows differences in learning outcomes for students' critical thinking skills on the concept of Motion Dynamics in the Physics XI subject between the group of students who received project-based Online Learning learning treatment and students who received project-based Learning learning treatment.

Table 3. Significance of Mean Difference

Dependent Variable: Critical Thinking Post-Test

(I) Self - Efficacy	(J) Self - Efficacy	Mean Difference (I.J.)	Std. Error	Sig. b	95% Confidence Interval for Difference b	
					Lower Bound	Upper Bound
Low	Medium	-15.135	3.453	<.001	-23.513	-6.758
	High	-32.733	4.767	<.001	-44.296	-21.170
Medium	Low	15.135	3.453	<.001	6.758	23.513
	High	-17.598	3.419	<.001	-25.891	-9.304
High	Low	32.733	4.767	<.001	21.170	44.296
	Medium	17.598	3.419	<.001	9.304	25.891

Based on estimated marginal means

*. The mean difference is significant at the.05 level

b. Adjustment for multiple comparisons: Bonferroni

The analysis results in Table 3 show that the treatment has a significance level of < 0.001, far below the specified standard significance level. Because the sig value < 0.05 means H₀ is rejected. This shows

differences in learning outcomes for students' critical thinking skills on the concept of Motion Dynamics in Physics XI subjects based on the level of self-efficacy (high, medium, low). These results can be interpreted as self-efficacy influence on students' thinking abilities.

Table 4. Ancova Result Tes
Dependent Variable: Critical Thinking Post-Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9643,555	11	876.687	22.693	<.001	.661
Intercept	8774,832	1	8774.832	227.133	<.001	.640
Method	56,491	1	56.491	1.462	.229	.011
S.E	37,547	2	187.273	4.848	.009	.070
CtPreTest	1161,455	1	1161.455	41.712	<.001	.246
Method * SE	81,072	2	40.536	1.049	.353	.016
Method * CtPreTest	20,072	1	20.072	.520	.472	.004
SE * CtPreTest	116,559	2	58.279	1.509	.225	.023
Method * SE * CtPreTest	32,879	2	16.439	.426	.654	.007
Error	4945,017	128	38.633			
Total	695000,000	140				
Corrected Total	14588,571	139				

a. R squared = .661 (Adjusted R Squared = .632)

Using the analysis presented in Figure 4., it can be seen that the influence of the learning model provided and self-efficacy have almost parallel patterns. With the PjBoL learning model, they tend to have lower critical thinking ability and learning outcomes compared to those who received treatment using the face-to-face PjBL model. You can also see the data in Table 4.18. It can be seen that the results of the analysis of the relationship between variables have a significance level = 0.654, where this value is above the specified standard significance level. Because the sig value is > 0.05, H0 is accepted. This shows that there is no significant interaction between learning methods (Project Based Learning Online and Face to Face) and the level of self-efficacy (high, medium, low) in students' critical thinking abilities on the concept of Motion Dynamics in Physics XI subjects.

The Influence of Learning Models on Critical Thinking Ability Learning Outcomes

PjBL is a learning model that encourages students to complete related projects and apply concepts to help them build knowledge (Cruz et al., 2022). Project-based learning emphasizes student-centered learning when conducting an in-depth topic investigation (McCann, 2022). Constructively, students explore or deepen their learning by taking a research-based approach to problems and questions that are meaningful, real, and relevant. Grant (2002) states that this explanation is an understanding of project-based learning. This learning model can be applied when the facilitator wants to create an active learning environment and asks students to focus on their development.

Researchers found that project-based learning is a form in which students undertake independent learning to understand ideas and principles better (Almazroui, 2023; Chang et al., 2024; Cruz et al., 2022). It is important to remember that developing critical thinking skills does not occur naturally but can be learned and improved through practice, experience, and continuous learning. Therefore, learning and developing critical thinking skills is essential in formal and informal education. Students' critical

thinking skills are necessary for learning, especially in how they act and behave toward learning problems. Learning activities carried out interactively can improve these abilities. They can achieve this by investigating the issues faced in the project. Then, in this research, the learning model was carried out online in learning Motion Dynamics material.

Theoretically, this model provides opportunities for students to understand the basic concepts of Motion Dynamics more independently to actualize themselves in the learning process. This is not the case with PjBL model learning, which is online. Students' focus on understanding the concepts of the material being taught becomes irregular. Interactions between educators and students are rarely found in the learning process. Theoretically and conceptually, in learning technology, learning actions like this, which require deepening concepts to apply them directly, are not appropriate to do online. Therefore, opportunities for project-based learning conducted online to improve learning outcomes are reduced.

This study's results indicate a significant difference in the pre-test and post-test results in the learning outcomes of critical thinking skills in the experimental and control groups. This vital difference was better in the control group than in the experimental group. Differences influence crucial thinking ability and learning outcomes in teaching strategies. This research shows significant differences in learning outcomes for critical thinking skills in the experimental and control groups. This is proven by the results of testing the first hypothesis in the research, namely that there is a significant difference in students' critical thinking abilities on the concept of Motion Dynamics in the Physics XI subject between those who study using Project Based Learning online and face to face.

Differences in Critical Thinking Ability Based on Self-Efficacy

Critical thinking can be defined as students' cognitive abilities in understanding and mastering scientific concepts through phenomena, events, objects, or activities related to the material. Students can master concepts if they know the meanings of event processes, incidents, phenomena, and objects through the teacher's observation and explanation process (Degeng & Degeng, 2018).

Critical thinking is an important ability that must be developed in students (Astutik & Wijayanti, 2020; Lesman et al., 2023). If students can master the concepts of the subjects being taught, then in general, it can be said that they have understood or comprehended the concepts. Children have critical thinking from when they are small until they grow up, and at any time, a person has a particular understanding of something. To support this ability, self-confidence is needed to act according to certain situations. Bandura stated that self-efficacy is an individual's belief in their abilities, influencing how they react to certain situations and conditions. (Bandura, 1997). Self-efficacy refers to the perception of an individual's ability to organize and implement actions to perform specific actions. In other literature, Bandura states that self-efficacy is perceived belief, the power to influence someone.

Self-efficacy is a self-assessment where an individual can believe that the actions taken are right or wrong, correct or flawed, and can or cannot meet the requirements for doing something (Alwisol, 2004). A person's self-confidence in their ability to act in a particular situation is known as self-efficacy (Nwanzu & Babalola, 2019). Self-efficacy refers to an individual's belief regarding the ability to mobilize the motivation, cognitive resources, and actions needed to succeed in a given task (Luthans et al., 2004). So, it can be concluded that self-efficacy is related to how individuals feel capable of doing something.

Empirical evidence regarding the influence of self-efficacy on learning outcomes shows that students have a high level of self-efficacy. Those who are moderate to high have learning achievements that are consistently above students with a level of self-efficacy—the low one. In the learning process using the same method, the results also showed that students had a high level of self-efficacy. Those who are moderate to high have superior learning outcomes. This is because their confidence in themselves to apply their understanding is high.

In line with this, this research also found that students had a high level of self-efficacy, and those

who are medium and high tend to have good learning outcomes. Their self-confidence in facing situations that require them to master concepts and then be able to apply these concepts correctly is relatively high. This makes learning goals more straightforward. Meanwhile, students with low self-efficacy levels have less self-confidence in understanding concepts. This is not very pleasant when they must apply the concepts they have learned directly. Therefore, this type of learner has a smaller chance of achieving high learning outcomes when compared to learners who have a higher level of self-efficacy. Medium and high. Students' self-efficacy level is known to be positively correlated with the learning achievement achieved.

The interaction of Learning Models and Self-Efficacy in Critical Thinking Ability

strategies can trigger students to utilize their self-efficacy to think critically. The results of this study are also in line with the results of research conducted by (Risnawati et al., 2018), who said that project-based learning can influence students' self-efficacy. Alfares's (2021) research results also conclude that learning strategies influence students' self-efficacy.

Another finding is that students new to conceptual material have better critical thinking skills if they have high self-efficacy and are given appropriate learning strategies. This result aligns with Shahzad et al. (2023), who stated that self-efficacy is created in the mind as personal knowledge and expressed as innovation. His research on entrepreneurial learning in new companies as an entrepreneurial development strategy is a way of developing individual expertise in entrepreneurship education. The dimensions of entrepreneurial development in new companies are significantly related to self-efficacy.

However, the findings of this research show an inconsistent direction, that there is no significant interaction between the learning model and self-efficacy on the learning outcomes of critical thinking skills in the Physics subject on Motion Dynamics material for class XI students. This inconsistency is thought to be caused by the delivery of material online. Meanwhile, the material taught requires understanding concepts and the project-based learning model used. Apart from the learning model chosen, the type of content contained in Physics learning, Motion Dynamics material, emphasizes conceptual content. If learning Motion Dynamics material has a lower level of material content, such as factual knowledge and principles, perhaps the influence of the project learning model carried out online will not be as influential. The interaction analysis results show no significant interaction between the chosen learning model and self-efficacy on learning outcomes for critical thinking skills. The relationship between students with high, medium, and low levels of self-efficacy and critical thinking learning outcomes when applying different learning models does not show significant differences in learning outcomes. In the findings of this research, the PjBL learning model has a higher average score at each level of self-efficacy students have when compared with the PjBoL learning model. On the other hand, it is based on students' self-efficacy level, and there is no significant difference between classes that apply the PjBoL model and classes that use the PjBL model. In both classes, each level of self-efficacy obtained higher post-test scores.

4. CONCLUSION

Students' critical thinking abilities regarding the concept of motion dynamics in the Physics XI subject between those who study using project-based learning online (PjBoL) and face-to-face (PjBL). Students' critical thinking abilities regarding the concept of motion dynamics in the Physics XI subject are based on the level of self-efficacy (high, medium, low). There is no significant interaction between learning methods (Project Learning Online and face-to-face) and the level of self-efficacy (high, medium, low) in students' critical thinking abilities on the concept of Motion Dynamics in Physics XI subjects.

The implications of this research indicate that online project-based learning has great potential to improve students' critical thinking abilities by involving them in authentic problem-solving. High self-

efficacy is also essential in increasing students' self-confidence, so combining online project-based learning and high self-efficacy can deepen students' understanding of the subject matter and improve their critical thinking skills.

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