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The effect of science projects through the edmodo platform to enhance critical thinking and students' science motivation: A mixed-method study

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project-based learning, edmodo, critical thinking, students' science motivation

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Abstract

Covid-19 has changed every aspect of life including the world of education. The changing of the learning system presents challenges for education stakeholders. Face-to-face learning has turned into online-based learning. The study aimed to analyze the effect of project-based learning through Edmodo to enhance students' critical thinking skills and science motivation. It was a mixed-method study using an explanatory sequential design. The study was conducted for 1 semester on the second-semester students involving 140 students and divided into 4 classes. One of the classes became the control class. The purposive sampling technique was used in the sampling stage. The instruments were tests, questionnaires, interviews, observations, and documentation. The data analysis techniques were N-Gain and MANOVA strengthened by qualitative data through the stages of data collection, data reduction, data display, and conclusions. The results indicate an effect of project-based learning through Edmodo on the student's critical thinking skills and science motivation. The value of the increase in critical thinking skills and science motivation in the experimental class is better than in the control class by reviewing the N-Gain value.

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INTRODUCTION

The COVID-19 pandemic has had a major impact on all aspects of life (Chang, et al. 2021; Lee, 2020; WHO, 2020). In the world of education, a pandemic pushes to use the online system. This situation has a major impact on all groups (Maheshwari, 2021), especially teachers, students, and also parents. One of the issues is the lack of people's readiness for implementing and utilizing online learning systems. This lack of preparation causes online learning to be less than optimal.

There is evidence in a survey released by the Indonesian Child Protection Commission (KPAI) on distance learning with 1,700 respondents. The survey results show that 77.8% of respondents stated that there were piles of assignments because all teachers gave assignments within a short time. Meanwhile, 37.1% of respondents complained that the time for doing assignments was narrow, which made students restless and tired. 42.2% of respondents stated that they did not have internet access. 15.6% of 116 respondents did not have adequate facilities, such as laptops or smartphones with adequate specifications for online learning. The survey measured that the interaction between teachers and students was only 20.1% and was limited to providing assignments from teachers to students. As many as 79.9% of respondents stated that teaching and learning interactions such as classroom had disappeared. There is no learning interaction such as question and answer or explanation of the material from the teacher. The existence of online learning limits children's activities and social interactions, resulting in an unfavorable impact on children's education and development.

The survey shows that online learning is less fun for students. It even has an impact on children's mental health (Fegert, et al. 2020; Mekonnen, 2020;

IASC, 2020). The poor learning quality makes students less motivated and decrease student performance (Muslimin & Harintama, 2020; Hebebci, et al. 2020). Eriyanto, et al. (2021) state that motivation affects the performance or achievement of student learning outcomes. Motivation is also a mental factor that encourages someone to learn. The research results from Chang, et al. (2020) state that the existence of online learning causes a decrease in student motivation to learn. The results also explain that online classes make students interact less with other students and lack skill development. El-Seoud, et al. (2014) state the success and failure of e-learning are highly dependent on student motivation.

Motivation is a desire or inclination that guides a person to perform a behavior or job (Özüdoğru, 2021). Apriana & Hidajat (2020) explain that motivation is an impulse that exists in students to carry out behavior and learning activities to achieve the desired goals. Harnett (2016) mentions that motivation plays a key role in developing achievement in online learning. Realizing the importance of motivation in improving student performance or achievement of learning outcomes, a teacher must make efforts to create fun online learning (Mustakim, et al. 2021). One of the teachers' innovations in online learning is to use project-based learning using Edmodo.

Project-based learning provides more opportunities for students to think and carry out activities during learning (Fatimah, et al. 2021; Handayani, et al. 2021; Suyandari, et al. 2018, Fatimah, 2018; Suryandari, et al. 2017; Lestari, et al. 2024). Chiang & Lee (2016) state that Project-based learning directs students to solve problems through an inquiry process to develop students' thinking skills, develop students' creativity, and encourage students to collaborate with teams. Project-based learning follows the nature of science learning in that learning not only emphasizes products or concepts but also directs students to have scientific attitudes and science process skills, in line with the objectives of science learning. The science curriculum is structured to provide a stock of scientific character values through practical or experimental activities using scientific methods so that students can think critically and appreciate evidence or facts (Kemdikbud, 2016; Gogoi & Munda, 2016; Lacap, 2015; Sormunen & Köksal, 2014).

An online project-based science learning can be supported by utilizing Edmodo application. Edmodo is an application developed by O'Hara & Borg in 2008 (Alamsyah et al., 2021). He also explains that Edmdo can make virtual classes comfortable and safe for students and teachers. Edmodo is an application that has complete and simple features so that it is easily understood by both teachers and students (Handayani, et al. 2021). The existence of complete features in Edmodo makes it easier for teachers to carry out innovative learning. Teachers can send videos, materials, quizzes, and assignments in a more interesting form.

The research focuses on the implementation of project-based learning through the Edmodo application to improve students' critical thinking skills and science motivation.

RESEARCH METHOD

The research was a mixed-methods, using an explanatory sequential design (Creswell, 2011; Shorten & Smith, 2017). It was conducted for one semester (6 months) for the second-semester students, totaling 140 students. The purposive sampling technique was used in the sampling stage. The consideration of taking the sample is the type of university, including public and private universities in Central Java. The selected study programs are preservice teachers in primary teacher education programs in the same semester and at the same age level. As an indicator of science motivation measurement, the researcher adopted the instrument from the Students' Motivation Towards Science Learning Scale (SMTSL) developed by Tuan, et al. (2005). The science motivation instrument consists of 36 statement items with 6 aspects, namely self-efficacy, active learning strategies, science learning values, performance goals, achievement goals, and learning environment stimulation. Meanwhile, the critical thinking aspect uses indicators introduced by Facione (2011), which consist of actual, reason, inference, argumentation, and implication. More details is presented in Table 1.

Table 1. Critical Thinking Aspects and Indicators (Facione, 2011)

Aspect	Indicator
Fact Analysis (Actual)	Students can analyze the meaning of the facts presented in the problem correctly and honestly.
Submission of Reason (Reason)	Students can organize thoughts and express reasons clearly, logically, or reasonably.
Conclusion (Inference)	Students can distinguish between conclusions based on valid and invalid logic

Aspect	Indicator
Submission of Arguments (Argumentation)	Students can refute an irrelevant argument and deliver relevant arguments.
Presentation of Implications (Implication)	Students can ask a view and question the implications of a view

Instruments in this study were observations, questionnaires, interviews, and tests. The quantitative research is a quasi-experimental with Nonequivalent Control Group Design, which is presented in Table 2.

Table 2. Nonequivalent Control Group Design

Class	Pretest	Treatment	Post-test
A1	O1	X	O2
A2	O1	X	O2
A3	O1	X	O2
B	O1	-	O2

Table 2 is a quantitative research design for implementing project-based learning through Edmodo consisting of classes A1-A3 as the experimental classes. These classes are treated (X) with an Edmodo-based project model. Meanwhile, class B is a class that is not treated and only uses conventional methods. Each class was given a pre-test (O1) before treatment and post-test (O2) after treatment. The data analysis technique used MANOVA, analyzed with the SPSS application to see the effect of project-based learning through Edmodo in improving students' critical thinking skills and science motivation. The N-Gain value is given to determine the value of the increasing in students' critical thinking skills and science motivation.

After the quantitative data is obtained, the qualitative data analysis is conducted to support and complement the results of quantitative data. The qualitative data analysis technique used a model developed by Miles and Huberman, namely data collection, data reduction, data display, and conclusions.

RESULT AND DISCUSSION

Learning science using project-based learning through Edmodo is one of the innovations made by educators in implementing meaningful online learning. The research was conducted for one semester using as many as 140 students to produce pretest and post-test scores as presented in Figure 1.

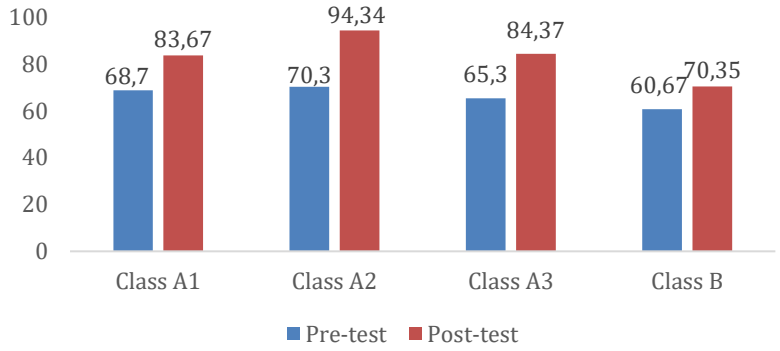

Figure 1. The average pre-test and post-test of students

Figure 1 shows that class A2 has the highest average pre-test and post-test scores compared to other classes. Meanwhile, class B showed the lowest score, either the average pre-test score or the average post-test score. After calculating the pre-test and post-test values, then the N-Gain value of each class was measured. he results of N-Gain is presented in Table 3. Table 3 shows that class A2 has the highest average N-Gain value compared to other classes, which is 0.80. While class B shows the lowest N-Gain value, which is 0.2. Table 4 shows the interpretation of the N-Gain value of critical thinking skills for each class.

Table 3. The results of the average N-Gain of students' critical thinking skills

Class	Average Pre test	Average Post test	Average N-Gain
A1	68.70	83.67	0.47
A2	70.30	94.34	0.80
A3	65.30	84.37	0.54
B	60.67	70.35	0.23

Table 4. Interpretation of the N-Gain value of students' critical thinking skills

Class	Average N-Gain	Interpretation
A1	0.47	Moderate
A2	0.80	High
A3	0.54	Moderate
B	0.23	Poor

The average N-Gain scores of students in class A2 show high criteria, while classes A1 and A3 show moderate criteria. And class B shows poor criteria. Based on the results of the N-Gain analysis, it explains that there is an increase in critical thinking skills in each class. However, the experimental class, namely the class using project-based learning based on Edmodo, has a higher improvement than the class taught through conventional learning. While the students' initial and final science motivation scores is presented in Figure 2. Students' science motivation includes 6 aspects, namely self-efficacy, Active learning strategies, Science learning value, Performance goal, Achievement goal, and Learning environment stimulation.

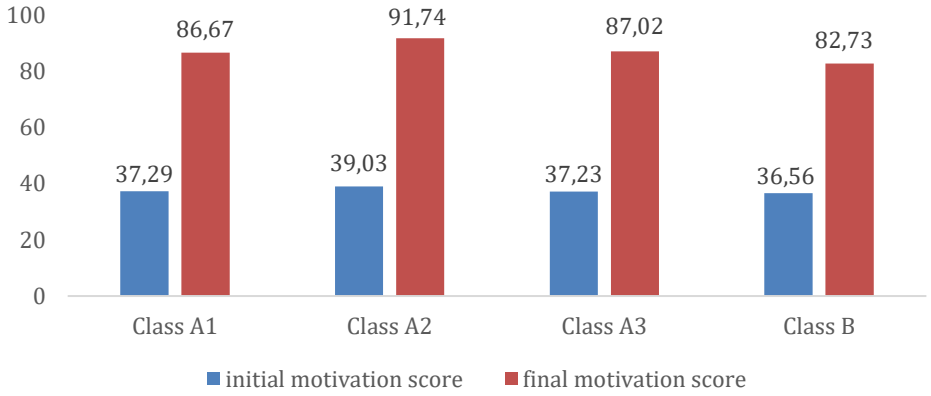

Figure 2. The average score of the initial and final scores of students' science motivation

Figure 2 shows that class A2 shows the highest average science motivation initial score and the highest average science motivation final score compared to other classes. Meanwhile, class B shows the lowest score, both the initial score average and the final score average for science motivation. Next, the N-Gain value of each class is measured. The results of N-Gain are presented in Table 5.

Table 5. The results of the average N-Gain of students' science motivation

Class	Initial Score Average (%)	Final Score Average (%)	Average N-Gain
A1	37.29	86.67	0.78
A2	39.03	91.74	0.86
A3	37.23	87.02	0.79
B	36.56	82.73	0.72

Table 5 shows that class A2 has the highest N-Gain score compared to other classes, which is 0.86Meanwhile, class B shows the lowest N-Gain score, which is 0.72. Table 6 shows the interpretation of the N-Gain value of science motivation for each class.

Table 6. Interpretation of the N-Gain value of students' science motivation

Class	Average N-Gain	Interpretation
A1	0.78	High
A2	0.86	High
A3	0.79	High
B	0.72	High

Based on the results of the analysis in Table 6, it shows that students' science motivation has a high increase in all classes. Class A2 has the highest increase in science motivation compared to other classes. While class B (conventional) has the lowest increase in science motivation. Analytical techniques are applied using multivariate analysis of variance (MANOVA) assisted by SPSS to determine the effect of Edmodo-based project-based learning on students' critical thinking skills and science motivation. The results of the analysis is presented in the Table 7.

Table 7. MANOVA

	Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	0.99	6057.641	2	137	0.00	0.99
	Wilks' Lambda	0.01	6057.641	2	137	0.00	0.99
	Hotelling's Trace	88.43	6057.641	2	137	0.00	0.99
	Roy's Largest Root	88.43	6057.641	2	137	0.00	0.99
Group	Pillai's Trace	0.43	52.319	2	137	0.00	0.43
	Wilks' Lambda	0.57	52.319	2	137.	0.00	0.43
	Hotelling's Trace	0.76	52.319	2	137	0.00	0.43
	Roy's Largest Root	0.76	52.319	2	137	0.00	0.43

Table 7 clearly shows that the p-values for the four different multivariate tests produce a number of 0.00, which is less than 0.05. These results imply a significant effect of the independent variable on all dependent variables. Therefore, there is a statistically significant effect of project-based learning through the Edmodo platform on students' critical thinking skills and science motivation with a significance value of 0.00. Furthermore, table 8 is to ascertain how the dependent variables differ from the independent variable.

Table 8. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Science Motivation	190.74	1	190.74	23.73	0.00	0.15
	Critical Thinking	5261.91	1	5261.91	104.44	0.00	0.43
Intercept	Science Motivation	65145.03	1	65145.03	8105.62	0.00	0.98
	Critical Thinking	444816.80	1	444816.80	8829.24	0.00	0.98
Group	Science Motivation	190.74	1	190.74	23.73	0.00	0.15
	Critical Thinking	5261.91	1	5261.91	104.44	0.00	0.43
Error	Science Motivation	1109.10	138	8.04			
	Critical Thinking	6952.44	138	50.38			
Total	Science Motivation	138895.00	140				
	Critical Thinking	1022266.47	140				
Corrected Total	Science Motivation	1299.85	139				
	Critical Thinking	12214.35	139				

a. R Squared = 0.147 (Adjusted R Squared = 0.141); b. R Squared = 0.431 (Adjusted R Squared = 0.427)

Based on Table 8, it is clear that prior Edmodo-based project-based learning has a statistically significant effect on both critical thinking skills (F (1, 138) = 104.44; $p < .0005$; partial $\eta^2 = 0.431$) and science motivation (F (1, 138) = 23.73; $p < .0005$; partial $\eta^2 = 0.147$). It is crucial to note that the partial eta squared calculates the proportion of variance explained by a given variable that remains after accounting for variance explained by other variables in the model. Based on Table 8, both critical thinking skills and science motivation have large effect size since these values are higher than 0.14.

Project-based learning utilizing Edmodo is one of the efforts made by educators to make online science learning more fun. So that students do not feel under pressure and stress with online-based learning. Project-based learning begins with brainstorming, containing questions and answers between teachers and students. These questions contain problems that must be solved by students. The existence of problems given through brainstorming will provide opportunities for students to think deeply. The brainstorming techniques can be used by educators in innovating a lesson to develop students' critical thinking skills (Araña & Magbanua-Claur, 2022; Balyk et al., 2021). In addition, it will also get new ideas from students to encourage students' creative thinking skills (Cruz-Suárez, et al., 2022). Online learning is a challenge for educators and students around the world. Therefore, it needs to pay attention to the

level of anxiety and mental health of students because they affect student performance (Chamdani, et al., 2021; Fatimah & Mahmudah, 2020).

Project-based learning will encourage students to always use their thinking skills to solve problems by creating a product. (Alsaleh, 2020) suggests that one strategy that can develop critical thinking skills is to use project-based learning. Likewise, Rosiyanah, et al. (2019) proves that project-based learning can improve critical thinking skills. The findings made by Cortázar, et al. (2021) also show that online project-based learning is proven to improve students' critical thinking skills. Through the Edmodo platform, it is easier for educators to convey information and monitor student activities. Supriyatno, et al. (2020) prove that Edmodo-based online learning can improve students' critical thinking skills. Through the Edmodo platform, educators can submit videos, pictures, or case studies accessed by students. Then students can comment in the provided column. With this feature, students will be more flexible in conveying their ideas (Wahyuni et al., 2019).

Based on the results of observations and interviews with students, project-based learning provides a large opportunity to be creative and innovative in solving problems and creating a product. By making a product, the students learn a scientific concept from various points of view so that they can generate innovative ideas. It will encourage students to always use their thinking skills (Suryandari, et al. 2018). Project-based learning also encourages students to actively participate in learning and develops students' scientific communication skills.

Besides improve critical thinking skills, project-based learning through the Edmodo platform can increase students' science motivation (Putu & Wahyuni, 2022; Wahyuni et al., 2019). The existence of a poll feature in Edmodo makes it easier for educators to know the situation and condition of students both before and after learning science. Attractive features make students happy and comfortable studying (Wajdi, et al., 2021). The analysis results show that the students' science motivation meets a good category, proved by a high level of confidence by 97.97% that they believe they can understand science even though science is difficult. And, 94.94% believe they can do tests and assignments well, which it proves high self-efficacy. Ichsan, et al (2020) states that self-efficacy has a high influence on learning, motivation, and performance. It means that someone who has high self-efficacy will try to always learn and they are sure that they will succeed.

Active learning strategies play an active role in building new knowledge based on their previous understanding. The questionnaire shows that 97.97% of respondents state the students will try to understand new science concepts. Meanwhile, 90.90% of respondents state that when they get a new science concept, they try to relate it to previous experiences. Furthermore, as many as 97.97% of respondents also state that if they do not understand the concept of science, they will discuss it with other lecturers or friends. Shinde (2020) states that constructivism is building new knowledge based on previous knowledge. The existence of constructivists is proven to be effective in developing students' scientific attitudes, and students' inductive thinking and reasoning. Several ways to build constructivist students are by involving active learners, a democratic learning environment, and interactive and student-centered activities.

Science learning value shows the highest category comparing other science motivation indicators. Based on the questionnaire, 95.95% of respondents state that learning science through e-learning can stimulate students' thinking and develop problem-solving skills. 93.93% of respondents state that this e-learning-based science-learning activity stimulates students' curiosity. In addition, 96.96% of respondents state that lecturers always provide opportunities for students to conduct the investigation process in building scientific concepts. During learning, lecturers always provide opportunities for students to conduct investigations and create projects so that students can build their knowledge.

Performance goals are the next indicator of scientific motivation. The questionnaire shows that 95.95% of respondents play an active role in learning to be smart by other friends and getting attention from the lecturers by 91.91%. These results prove that students have a high tendency to get attention from friends and lecturers, not to get high grades. Also, it provides an illustration that needs to develop high competitiveness for students to achieve better achievements.

Achievement goal is an indicator of motivation that shows their level of satisfaction with competency achievement and increasing student achievement during science learning. Based on the questionnaire analysis, the achievement goals of the students show the high category by 86.86%. 91.91% of students state that they are satisfied when they can solve difficult problems. In addition, 97.97% of students are happy when other friends accept their opinions or ideas, and almost 100% of students are happy when lecturers accept their opinions or ideas. Some of these results prove that students have high

achievement goals. Inuwa (2016) mentions that the level of satisfaction affects a person's performance positively and significantly. Redhana, et al. (2019) state that satisfaction is one of the important factors to know in every lesson. Continued, the existence of a high level of interaction between lecturers and students or fellow students has a strong effect on the level of student satisfaction.

Learning environment stimulation is one of the indicators of science motivation, which emphasizes the stimulation of the student learning environment. Based on the results of the questionnaire analysis, 81.21% of respondents had a positive response on learning environment stimulation. 92.92% of respondents were interested in being active during learning since the science material was very unique and could be viewed from various perspectives, and 89.89% of respondents were happy with learning science since the material was challenging. Then, 91.91% of students were interested in e-learning-based science learning since the lecturers used interesting and innovative methods. And, 90.90% of respondents were happy with science learning since lecturers could direct all students to play an active role.

CONCLUSION

The results of the analysis show the effect of Edmodo-based project-based learning on students' critical thinking skills and science motivation. The enhancement in critical thinking skills and science motivation in the experimental class is better than in the control class by reviewing the N-Gain value. The Edmodo feature makes it easier for lecturers to deliver material more effectively and efficiently. In addition, the complete and non-monotonous appearance of Edmodo makes students happier and more comfortable studying science.

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