

## **Project Based Learning: Development of Monitoring Wind Direction and Speed with Solar Power as Learning Media**

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**Abstract:** Learning in the classroom needs appropriate methods and packaging to get good results for students. This study aims to determine the differences in learning methods using project-based practical learning and regular learning. The study was carried out using quantitative methods by conducting evaluations and interviews with students. Data processing uses the Manova test statistical data processing application. The sample from this research was students in the 3rd semester of the Airport Engineering Technology Study Program. From the results of data processing, it can be seen that there are differences in terms of understanding, collaboration and learning outcomes between students who use project-based learning methods and those who use regular learning systems. Project-based learning methods have fostered better understanding and collaboration. We hope that with the results of this research, educators will use project-based learning methods more often to foster understanding and collaboration between students in the campus environment.

**Keywords:** Anemometers, Learning Media, Project-Based Learning, Solar Panels

### **A. Introduction**

In the world of aviation, wind data in the form of direction and speed is very important for pilots to determine the direction when taking off and landing an aircraft. The direction and speed of the wind will be visible visually on the runway in the form of a windsock, but pilots can also request this data from air traffic controllers in the control tower (Santoso, 2022) (Soleh, 2022). Human resources to maintain this wind data equipment mostly come from aviation campuses. In aviation campuses, comprehensive lectures are given on international aviation standards. In particular, aviation campus courses play a role in producing quality students, namely humans who are able to develop scientific attitudes, have skills in aviation at airports (Azizah & Widjajanti, 2019).

Aviation, which is part of science, essentially has two components, namely product and process components (Suhanto et al., 2024). Science in the field of aviation as a product is a collection of empirical and analytical activities carried out by practitioners

for decades. As a product, aviation consists of a collection of knowledge consisting of facts, procedural concepts and concepts in the safety process from one place to another. Meanwhile, as a process, aviation is a transportation activity that moves people or goods from one place to another safely (Soleh & Kesumawati, 2019). The purpose of aviation learning is to provide students with an understanding of science and equip them with creative skills to produce a product that will reflect a person's mastery of competence as a result of their learning. Aviation is essentially a product and a process. As a product, aviation is a collection of knowledge in moving goods and people from one place to another (Amelia & Aisya, 2021) (Pirdaus, 2024). The results of learning on the aviation campus will produce technology that can provide convenience and safety for the world of aviation (Iswantari, 2021). Based on this, understanding in learning needs to use assessments that do not only refer to the cognitive domain but also need assessments that can measure student skills. In this regard, teachers must provide project assignments for students. The current situation in the learning field shows that learning methods for understanding and creative skills are not handled systematically (Ardhyantama & Widodo, 2020). This is because educators are still relatively using learning by means of discussion, and classical face-to-face one-way. So that students' abilities are limited to theory and presentation. In fact, an educator must not only understand the existing theory but how we can better understand and understand to produce a work that can be accepted and used to help the learning process. In other words, a student must also have an understanding (Sari et al., 2021). Understanding is often considered as something that is based on students understanding, where only those who know can understand. Student understanding should not be interpreted only as the ability to create something that really understands something, but can also combine existing ideas and then apply them into something different, which is better than encouraging students to be more dynamic. One of these learning models is the project-based learning model (Tsybulsky & Muchnik-Rozanov, 2021).

This learning model is a learning model that involves focusing on meaningful questions and problems, problem solving, decision making, the process of finding various sources. Each member is given the opportunity to work collaboratively, and closes with a presentation of the results (Suhanto et al., 2024). Project-based learning is a learning model that provides opportunities for educators to manage classroom learning by involving project work. Project-based learning is an application of interactive learning between students. So it can be defined as a teaching that tries to link technology with aviation safety issues, or with projects in the classroom with the aviation industry (Iswantari, 2021). The project-based learning model has great potential to create a more interesting and useful learning experience for students. In project-based learning, students are encouraged to be more active in learning (Dewi et al., 2024).

Project-based learning is an effort to empower students to gain new knowledge and understanding based on their experiences through various presentations, and also has

great potential to create a more interesting and useful learning experience for students (Danim, 2023). The project-based learning method is a systematic learning method that involves students in learning science and skills through the process of investigating real problems and creating various carefully designed works. Project-based learning is a teaching and learning process that involves students working on a project that is useful for solving community or environmental problems (Bintoro et al., 2024). Project-based learning has great potential to provide a more interesting and meaningful learning experience for students. In project-based learning, students will carry out, (Soleh et al., 2024) (Amalia et al., 2024), namely: First, students make their own decisions within a previously determined framework. Second, students try to solve a problem or challenge that does not have one definite answer. Third, students are encouraged to think critically, solve problems, collaborate, and try various forms of communication. Fourth, students are responsible for finding and managing the information they collect themselves. Fifth, evaluations are carried out continuously throughout the project. Sixth, students regularly reflect and contemplate what they have done, both the process and the results. Working on a project in project-based learning is seen in the process, understanding and cooperation of students in the learning process so that it will have an impact on increasing student understanding (Sari et al., 2021). The study also found that taking at least one project-based course during the first four semesters influenced students' perceptions of STEM skills, perceptions of the value of taking a STEM course, and STEM career aspirations. Furthermore, we found that the impact of project-based courses on STEM career aspirations was mediated by STEM skills and perceptions of the value of the course. The impact of PjBL was not moderated by race or gender. We highlight areas for future research and the promise of PjBL for engaging students in STEM professions (Zagirniak et al., 2021) (Beier et al., 2019).

In the implementation of learning there is a problem that students do not understand the material and goals of learning given by the teacher. So many students only follow formal learning but they do not understand the purpose and meaning of the learning. This problem continues to recur and there is no effort to fix and solve the root of the problem. In terms of material, the curriculum and syllabus have met the established standards, but in its implementation, it is still not in accordance with the achievement of the set courses. What will be observed in particular is how project-based learning influences student understanding and collaboration. Therefore, we conducted a study to use project-based learning to determine the effect of conventional learning methods with project-based learning. It is expected that this study will improve learning, and student output and outcomes will improve.

## **B. Methods**

This study is a quasi-experimental research design with a non-equivalent post-test only control group design (Soleh et al., 2022). The population in this study were 3rd semester students of the Airport Engineering Technology Study Program. The total

number of classes is 2 classes. Based on population characteristics and the inability to randomize individuals, the sampling in this study was carried out using the cluster random sampling technique. The sample in this study consisted of two groups, namely the experimental group and the control group. The experimental group was treated by implementing a project-based learning model, while the control group was given regular learning. The data collected in this study were data on understanding, student cooperation based on observation results and learning outcomes with essay tests. Data were analyzed using MANOVA. Before the analysis was carried out, data normality and homogeneity were tested as prerequisite tests (Anggraini & Wulandari, 2020). The SPSS application was used to test normality and homogeneity.

### C. Results and Discussion

The students involved in this study were 18 students in the control group and 24 students in the experimental group. The total number of students involved was 42 people. In this study, there were two data obtained, namely understanding data and educational cooperation data. Descriptive results (mean, standard deviation, maximum value, and minimum value) can be seen in Table 1.

**Table 1. Results of Calculation of Understanding and Cooperation Scores**

Statistic Variable	Understanding		Cooperation	
	Experiment	Control	Experiment	Control
Mean	82,96	76,72	83,08	76,11
Standard Dev.	5,622	5,624	4,201	5,96
Minimum Score	70	69	72	68
Maximum Score	91	90	91	90

Looking at Table 1 above, it is known that the average score of students' understanding in the class with the project-based learning model is 82.96, and the average score of cooperation is 83.08. The average score of understanding in the class with the regular learning model is 76.72 and the average score of cooperation is 76.11. This indicates that descriptively the project-based learning model is better for students in order to improve understanding and cooperation.

**Table 2. Tests of Normality**

	Class	Statistic	df	Sig.	Statistic	df	Sig.
Understanding	Experiment	.157	20	.200*	.935	20	.193
	Control	.158	20	.200*	.927	20	.134
Cooperation	Experiment	.140	20	.200*	.931	20	.163
	Control	.147	20	.200*	.957	20	.482

Testing on the assumptions and initial prerequisites of the analysis is needed to prove that the statistical data meets the requirements. Testing includes normality testing and homogeneity testing. Normality testing is done to ensure that the sample comes from a normally distributed population, so that hypothesis testing can be done. The data normality test in this study used the Kolmogorov Smirnov Test Statistic with the help

of SPSS for Windows. The results of the analysis showed the Kolmogorov-Smirnov statistical value for the understanding of the experimental group 0.157 and the control group 0.158. The results of the cooperation analysis of the experimental group (0.140) and the control group (0.147). So it can be concluded that the data group understanding, m and cooperation of the experimental group and the control group are more than 0.05 which means they are normally distributed. Then the test can continue to the next test.

**Tabel 3. Levene's Test of Equality of Error Variances**

	Levene Statistic	df1	df2	Sig.	
UndersstandingBased on Mean	.012	1	38	.915	
	Based on Median	.047	1	.830	
	Based on Median and with adjusted df	.047	1	34.745	.830
	Based on trimmed mean	.010	1	38	.919
Coopertion	Based on Mean	.253	1	.618	
	Based on Median	.098	1	.756	
	Based on Median and with adjusted df	.098	1	34.599	.756
	Based on trimmed mean	.229	1	38	.635

Furthermore, to measure whether the groups have the same variance or not, a homogeneity test of variance between the two groups is carried out between the groups. The two groups of data are tested for homogeneity of variance between groups using the Levene's test. The results of the analysis show that all Levene's statistical values show significant figures of more than 0.05, both for understanding and cooperation data. This means that the variance between the experimental group and the control group is homogeneous, namely for the understanding and cooperation data. Thus, it can be continued to the next test. To test whether there are differences in several dependent variables between several different groups, a manova test is carried out. Then the decision is taken by analyzing Pillai's Trace, Wilks' Lambda, Hotelling's Trace and Roy's Largest Root. The results of the manova analysis of the learning process are presented in Table 4 and Table 5.

**Table 4. Results of Manova Analysis**

Effect		Value	F	Hipotesis Df	Error df	Sig.
Intercept	Pillai's Trace	0,999	8500.125 <sup>b</sup>	3,000	36,000	0,000
	Wilks' Lambda	0,001	8500.125 <sup>b</sup>	3,000	36,000	0,000
	Hotelling's Trace	708.344	8500.125 <sup>b</sup>	3,000	36,000	0,000
	Roy's Largest Root	708.344	8500.125 <sup>b</sup>	3,000	36,000	0,000
Class	Pillai's Trace	0,838	62.000 <sup>b</sup>	3,000	36,000	0,000
	Wilks' Lambda	0,162	62.000 <sup>b</sup>	3,000	36,000	0,000
	Hotelling's Trace	5,167	62.000 <sup>b</sup>	3,000	36,000	0,000
	Roy's Largest Root	5,167	62.000 <sup>b</sup>	3,000	36,000	0,000

From table 4, it can be seen that the statistical values of Pillai's Trace, Wilks' Lambda,

Hotelling's Trace, Roy's Largest Root are each with  $F = 8500.125b$ , with a significance value of 0.000, this means that  $H_0$  is rejected. Therefore, the alternative hypothesis  $H_1$  is accepted. So, there is a difference in understanding and cooperation simultaneously between students who use project-based learning models compared to students who use regular learning models.

**Table 5. Tests of Between-Subjects Effects**

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	Understanding	1755.625 <sup>a</sup>	1	1755.625	133.387	.000
	Cooperation	1612.900 <sup>b</sup>	1	1612.900	135.898	.000
Intercept	Understanding	250747.225	1	250747.225	19051.074	.000
	Cooperation	252492.100	1	252492.100	21274.279	.000
Class	Understanding	1755.625	1	1755.625	133.387	.000
	Cooperation	1612.900	1	1612.900	135.898	.000
Error	Understanding	500.150	38	13.162		
	Cooperation	451.000	38	11.868		
Total	Understanding	253003.000	40	1755.625		
	Cooperation	254556.000	40	1612.900		
Corrected Total	Understanding	2255.775	39	250747.225		
	Cooperation	2063.900	39	252492.100		

From the multivariate analysis of the relationship between the project-based learning model and the regular learning model with understanding, it gives an F value of 133.387 and a significance of 0.000 which is smaller than the significance level of 0.05. This means that  $H_0$  with the statement that there is no difference in understanding between students who use learning with the project-based learning model and students who use learning with the regular learning model is rejected. This means that there is a significant difference in understanding between students who use learning with the project-based learning model and students who use learning with the regular learning model.

Multivariate analysis shows the results of the relationship between the learning model and cooperation giving an F value of 85.117 with a significance of 0.000 which is less than the significance level of 0.05. This means that  $H_0$  with the statement that there is no difference in cooperation between students who use learning with the project-based learning model and students who use learning with the regular learning model is rejected. This means that there is a significant difference in learning outcomes between students who use the project-based learning model and students who use learning with the regular learning model. The results of this study are in line with the

results of research conducted in his research entitled Effectiveness of Problem-Based Learning, Literacy Project-Based Learning, and Inquiry-Based Learning, in improving mathematical connection skills, it is stated that the project-based learning method is different from other learning methods (Abidin, 2020).

The study entitled A review of project-based learning in higher education: Student outcomes and measures states that the focus of problem-based learning lies in the application of knowledge, while project-based learning, which is based on active construction learning science. Emphasizes the construction of knowledge. This process of creating new knowledge allows students to test and achieve their ideas in the way they want, which encourages their innovation competence. Thus, we believe that it is important to encourage teachers in higher education to adopt project-based learning. In addition, although disciplines were not analyzed in this review, there are many applications of project-based learning in STEM education. Future research should consider the application of project-based learning more in the humanities and social sciences (Guo et al., 2020) (Soleh et al., 2024).

The manova analysis showed that understanding in the learning process between the experimental group and the control group showed different values. This means that there is a significant difference between the experimental group and the control group in terms of understanding. Another study stated that this meta-analysis of 20 years of research synthesized quantitative results comparing the effects of project-based learning on students' academic achievement, and investigated the study features that influenced this in various educational settings (Chen & Yang, 2019).

Understanding is the process, method, or act of understanding or comprehending. Understanding can also be interpreted as the ability to capture the meaning and significance of the material being studied. Understanding is a cognitive process that deals with abstract or physical objects, such as messages, situations, or people (Halawa & Lase, 2022). Understanding can be related to the ability to draw conclusions. In the learning process, each individual student has different abilities in understanding what he or she is learning (Riar et al., 2022).

Some types of understanding include: Relational understanding, which is understanding that is not just knowing and memorizing, but also knowing how and why it can happen. Self-understanding, which is deep recognition of one's potential, such as interests, abilities, personality, values, and attitudes (Meyliana et al., 2023). Conceptual understanding, which is the ability to grasp concepts, such as expressing a material presented in a form that is more understandable.

Cooperation is an activity carried out by two or more people to achieve a common goal. Cooperation is carried out by helping each other and synergizing to realize the goal. Cooperation can be successful if it is done well, namely by: Coordinating, Synergizing, Improving communication skills. Cooperation is an attitude of wanting

to do a job together without looking at the background of the person being invited to collaborate to achieve a goal (Ganesan & Cai, 2021).

Cooperation can be done in various fields, such as: In community life, cooperation can be realized in the form of mutual cooperation. Mutual cooperation is working together to complete work and enjoy the results of that work fairly. In the business world, cooperation can be done in the form of partnerships (Curry et al., 2019). Partnerships are business strategies carried out by two or more parties to achieve mutual benefit. In international relations, cooperation can be carried out between the Indonesian government and friendly countries or international organizations (Winingsih et al., 2023).

Understanding and cooperation is the process of working together between two or more parties to achieve a common goal. Cooperation can occur in various fields, such as economics, politics, social, education, and culture. Collaboration has several benefits, including: Increasing efficiency, Building strong relationships, Promoting innovation, Achieving better results than could be achieved independently. Some forms of cooperation include: Cooperation based on interests, bargaining, namely cooperation that arises because of an agreement or contract, spontaneous cooperation, namely cooperation that is carried out without prior planning and without any ulterior motives student (Fatmaryanti et al., 2019).

Some things that are needed for teamwork to be successful are: first, adjustment of understanding of team goals and division of tasks. Second, willingness to compromise and accept feedback. Third, ability to convey views, suggestions, and criticism objectively and politely. Fourth, a sense of group solidarity. Fifth, group responsibility. Sixth, regular monitoring of the collaboration process (Pearson & Rose, 2021).

A significant relationship was found between project-based learning methods and collaborative learning, course learning, iterative learning, and authentic learning, which in turn resulted in student engagement. The results showed that the PBL technique increased student engagement by allowing knowledge and information sharing and discussion. Thus, the project-based learning approach is highly recommended for educational use by students and should be encouraged in universities (Almulla, 2020).

The success of improving the quality of learning in the experimental group compared to the control group cannot be separated from the intervention of the project-based learning model applied to the experimental group so that learning conditions became more active, enjoyable and comfortable. In addition, the learning model also has a major influence on the quality of learning in this study to achieve high effectiveness, cooperation and efficiency. The Project-Based Learning Model can also increase students' self-confidence, understanding for learning, creative abilities, and self-

admiration and develop an attitude of cooperation between students (Soleh et al., 2023).

Project-based learning is a learning model that provides opportunities for teachers to manage learning in the classroom by involving project work. To produce a meaningful project and in accordance with what is expected, not only knowledge is needed but also high creativity. The balance between the two will support the success of a project that will be later. The results of this project will show how the learning outcomes of an individual are (Muninggar et al., 2023). In other words, understanding and cooperation are two things that are interconnected and affect each other. At airports, the aspect of understanding and cooperation is needed to support flight safety (Soleh et al., 2024) (Soleh, 2022).

The balance between the two will support the success of a project later. The results of this project will show how the learning outcomes of an individual (Muninggar et al., 2023). In other words, understanding and cooperation are two things that are interrelated and influence each other. At the airport, the aspects of understanding and cooperation are very much needed to support flight safety (Soleh et al., 2024) (Soleh et al., 2022). By increasing flight safety in Indonesia, it will increase the trust of the global community in the world of aviation in Indonesia.

#### **D. Conclusions**

Based on the results of the study on project-based learning, it was concluded that there was a significant difference in the project-based learning model on student understanding, there was a significant influence of the project-based learning model on cooperation. It was found that there was a difference in understanding and cooperation between students who followed the project-based learning model and those who followed the regular learning model. Based on the findings of this study, it is recommended that educators use the project-based learning model in order to improve student understanding and cooperation. During the project-based learning process, limited equipment is one of the obstacles that can disrupt the smoothness of the learning process.

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