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Project Based Learning: Modifying Runway Lights as Visual Landing Aids Using Solar Power

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ABSTRAK

Kondisi yang ditemukan dalam bidang pembelajaran yaitu pengemasan pembelajaran alat peraga untuk pemahaman dan keterampilan kreatif belum tertangani secara sistematis. Berdasarkan hal tersebut, penelitian ini bertujuan untuk menganalisis perbedaan model pembelajaran Project-based Learning dengan pembelajaran konvensional. Studi dilakukan dengan metode kuantitatif dengan melakukan evaluasi dan wawancara terhadap para siswa. Populasi dalam penelitian ini adalah mahasiswa semester 8 Program Studi Teknologi Rekayasa. Sampel dalam penelitian berjumlah 40 orang. Metode yang digunakan dalam pengumpulan data adalah observasi, wawancara, dan tes. Instrumen pengumpulan data menggunakan lembar observasi dan soal tes. Pengolahan data menggunakan aplikasi pengolahan data statistik uji manova. Hasil penelitian yaitu terdapat perbedaan dari sisi kreativitas, kerjasama dan hasil belajar dari para siswa yang menggunakan metode pembelajaran berbasis proyek dengan yang menggunakan sistem pembelajaran konvensional. Metode pembelajaran berbasis proyek telah menumbuhkan kreativitas, kerjasama dan hasil belajar yang lebih baik. Disimpulkan bahwa model pembelajaran berbasis proyek dapat meningkatkan kreativitas, kerjasama dan hasil belajar siswa. Implikasi penelitian ini yaitu penerapan model pembelajaran model pembelajaran Project-based Learning dapat menumbuhkan kreativitas dan kerjasama antar siswa sehingga dapat digunakan dalam pembelajaran.

ABSTRACT

The conditions found in the field of learning, namely the packaging of learning aids for understanding and creative skills, have not been handled systematically. Based on this, this study aims to analyze the differences between project-based learning models and conventional learning. The study was conducted using a quantitative method involving evaluations and student interviews. The population in this study was 8th-semester students in the Engineering Technology Study Program. The study sample amounted to 40 people. The methods used in data collection were observation, interviews, and tests. Data collection instruments used observation sheets and test questions. Data processing used the statistical data processing application of the MANOVA test. The study results showed differences in cooperation and learning outcomes between students who used the project-based learning method and those who used the conventional learning system. The project-based learning method has fostered better creativity, cooperation and learning outcomes. It was concluded that the project-based learning model can improve creativity, cooperation and student learning outcomes. This study implies that applying the project-based learning model can foster creativity and cooperation between students so that it can be used in learning.

1. INTRODUCTION

Visual landing aids as one of the courses that are part of aviation vocational education have an important role in improving the quality of education in the field of aviation. Specifically, the visual landing aids course also plays a role in producing quality students, namely humans who are able to develop scientific attitudes, have skills in the field of visual navigation at airports (Smith & Johnson, 2021; Soleh et al., 2024). Visual landing aids which are part of science which essentially have two components, namely product and process components. Science in the field of visual landing aids as a product is a collection of empirical and analytical activities carried out by scientists for years (Brown & Taylor, 2019; Psyllou et al.,

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2018). As a product, a visual landing aid consists of a collection of knowledge consisting of facts, concepts, principles and concepts in the process of landing an aircraft at an airport (Clark & Patel, 2023; Gan & Feng, 2018). Meanwhile, as a process, a visual aid is a series of structured and systematic processes carried out to determine the concepts, principles and methods in the process of landing an aircraft. The purpose of learning visual aid is to provide an understanding of the scientific discipline of visual landing aids and creative skills to produce a product that will reflect a person's mastery of competence as a result of their learning. Visual aid is essentially a product, process and application. As a product, a visual aid is a collection of knowledge and processes in flight navigation (Brown & Taylor, 2019; Psyllou et al., 2018; Thompson & Lee, 2022; Yuan et al., 2020).

As a process, a visual aid is a process used to study objects of study, find and build scientific products, and as an application, visual aid theories will produce technology that can provide convenience and safety for the world of aviation (Martinez & Green, 2020; Psyllou et al., 2018; Smith & Johnson, 2021; Soleh et al., 2024). Based on this, the assessment in visual aids needs to use an assessment that does not only refer to the cognitive domain but also needs an assessment that can measure students' skills. In this regard, teachers must provide project assignments for students. In other words, a student must also have creativity. Creativity is often considered a skill based on natural talent, where only those who are talented can be creative. Student creativity should not only be interpreted as the ability to create something completely new, but can also combine existing ideas and then apply them into something different from what existed before (Bintoro et al., 2024). However, the conditions found in the field of visual aid learning at this time turned out that the packaging of visual aid learning for understanding and creative skills was not handled systematically (Suzer et al., 2018). This is because educators are still relatively packaging learning by discussing, presenting and making papers. So that students' abilities are limited to theory and presentation. Previous research findings also revealed the current problem, namely the lack of consistency in the application of aids in various aviation education institutions (Johnson & Smith, 2022; Walker & Hernandez, 2021). The reality in the field of being a visual aid educator is not only having to understand the existing theory but how we can be more creative in producing a work that can be accepted and used to help the learning process (Amalia et al., 2024).

The solution to increasing creativity is to implement learning that encourages students to be more creative. One of these learning models is the project-based learning model. The project-based learning model is a learning model that involves focusing on meaningful questions and problems, problem solving, decision making, the process of finding various sources, providing opportunities for members to work collaboratively, and closing with a presentation of real products (Aerts et al., 2017; Pan et al., 2021; Yamin et al., 2020). The project-based learning model focuses on the core concepts and principles of a discipline, facilitating students to investigate, problem solve, and other meaningful tasks, centered on students and producing real products (Dewi et al., 2024; Sharma et al., 2020). Project-based learning is a learning model that provides opportunities for educators to manage learning in the classroom by involving project work. Project-based learning is an application of active learning (Izati et al., 2018; Mulyati et al., 2022). Simply put, project-based learning is defined as a teaching that tries to link technology with aviation safety issues, or with classroom projects with the aviation industry. The project-based learning model has great potential to create a more engaging and rewarding learning experience for students (Aerts et al., 2017; Izati et al., 2018; Mulyati et al., 2022; Pan et al., 2021; Yamin et al., 2020). In project-based learning, students are encouraged to be more active in learning. Project-based learning is a learning strategy that empowers students to gain new knowledge and understanding based on their experiences through various presentations. Project-based learning has great potential to create a more engaging and rewarding learning experience for students (Soleh et al., 2024).

Previous research findings state that Project-based learning provides opportunities for educators to manage classroom learning by involving project work (Culclasure et al., 2019; Handayani et al., 2021; Ulya et al., 2020). Other studies also reveal that Project-based learning can increase student activity and creativity. Based on this (Mutakinati et al., 2018; Sumarni & Kadarwati, 2020; Yustina et al., 2020), Project-based learning model can create a more interesting and beneficial learning experience for students. In project-based learning, students are encouraged to be more active in learning. Project-based learning is a learning strategy that empowers students to gain new knowledge and understanding based on their experiences through various presentations. Project-based learning has great potential to create a more interesting and beneficial learning experience for students. However, there has been no study on Project-Based Learning: Modifying Runway Lights as Visual Landing Aids Using Solar Power. Based on this, this study aims to analyze Project-Based Learning in Visual Landing learning.

2. METHOD

This study is a quasi-experimental research design with a non-equivalent post-test only control group design. The population in this study were 8th semester students of the Airport Engineering Technology Study Program at the Palembang Aviation Polytechnic. 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 conventional learning. The data collected in this study were creativity data, student cooperation based on observation results and learning outcomes with essay tests. The methods used in collecting data are observation, interviews, and tests. Observation techniques are carried out through observations that have a better level of accuracy and reliability. This study conducted observations on Cadets at the Palembang Aviation Polytechnic and Hang Nadim International Airport, Batam. This interview method is used to obtain data related to runway lights. Interview activities were conducted with existing electrical technicians at Hang Nadim International Airport, Batam. The test method determines student learning outcomes after implementing Project-Based Learning. The instruments used in collecting data are observation sheets and test questions. The research instrument grid is presented in Table 1.

Table 1. Research Instrument Grid

No	Question Type	Question
1	Essay question on Visual Landing Aid System Design	Name the types of runway lights and explain their functions and characteristics!
2		Complete the Precision Approach Path Indicator image!
3		Describe each component of the visual landing aid system image and explain how it works!
		Explain the visual landing aid circuit system!

Data were analyzed using MANOVA. Before the analysis was carried out, data normality and homogeneity tests were first carried out as prerequisite tests. The normality test for data distribution used the Kolmogorov Test and Shapiro-Wilks Test statistics (Suhanto et al., 2024). Testing criteria: data has a normal distribution if the resulting significance number is greater than 0.05 and in other cases the data is not normally distributed. The homogeneity test of variance between groups uses Levene's test of Equality of Error Variance (Soleh et al., 2022). Test criteria: data has the same variance (homogeneous) if the significance number obtained is greater than 0.05 and in other cases the sample variance is not the same (not homogeneous). Normality and homogeneity tests use the SPSS Version 26.00 application.

3. RESULT AND DISCUSSION

Result

The number of students involved in this study was 40 people divided into two groups (experimental group and control group), each consisting of 20 people and 20 people. In this study there were two data obtained, namely creativity data and visual aid education cooperation data. Descriptive calculations (mean, standard deviation, maximum value, and minimum value) in Table 2.

Table 2. Recapitulation of the Results of Calculating Creativity and Cooperation Scores

Variable Statistic	Creativity		Cooperation	
	Experiment	Control	Experiment	Control
Mean	85.80	72.55	89	74.05
Standard Deviation	3.302	3.927	3.418	4.310
Score Mininum	80	62	82	67
Score Maximum	91	78	95	82

The results of the data analysis are presented in Table 2, it is known that the average creativity score of students in the class with the project-based learning model is 85.80, and the average score of the Visual Aid learning outcomes is 89. The average creativity score in the class with the conventional learning model is 72.55 and the average score of the Visual Aid learning outcomes is 74.05. These results indicate that descriptively the project-based learning model is relatively better as a learning facility for

students in order to improve creativity and learning outcomes. The results of the normality test are presented in Table 3.

Table 3. Tests of Normality

	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Creativity	Experiment	0.157	20	0.200	0.935	20	0.193
	Control	0.158	20	0.200	0.927	20	0.134
Cooperation	Experiment	0.140	20	0.200	0.931	20	0.163
	Control	0.147	20	0.200	0.957	20	0.482
Grade	Experiment	0.115	20	0.200	0.980	20	0.928
	Control	0.103	20	0.200	0.974	20	0.843

To test statistical evidence, a research hypothesis test must be carried out, starting with testing the assumptions and analysis prerequisites. Assumption testing is carried out to determine whether the available data can be analyzed parametrically or not. In relation to the statistics used for data analysis in this study, the assumption tests carried out include normality tests, homogeneity tests, and correlation tests between variables. Normality tests are carried out to ensure that the sample comes from a normally distributed population, so that hypothesis testing can be carried out. The data normality test in this study used the Kolmogorov Swirnov Test Statistic with the help of SPSS V.26 for Windows. The results of the analysis showed the Kolmogorov-Smirnnov statistical value for the creativity of the experimental group (0.193) and the control group (0.134). The results of the analysis of the cooperation of the experimental group (0.163) and the control group (0.482). The results of the analysis of the experimental group value (0.928) and the control group value (0.843). So it can be concluded that the data group creativity, cooperation, and learning outcomes of the experimental group and the control group are more than 0.05, which means they are normally distributed. So that further testing can be carried out. Levene's Test of Equality of Error Variances showed in Tabel 4.

Table 4. Levene's Test of Equality of Error Variances[a]

		Levene Statistic	df1	df2	Sig.
Creativity	Based on Mean	0.012	1	38	0.915
	Based on Median	0.047	1	38	0.830
	Based on Median and with adjusted df	0.047	1	34.745	0.830
	Based on trimmed mean	0.010	1	38	0.919
Cooperation	Based on Mean	0.253	1	38	0.618
	Based on Median	0.098	1	38	0.756
	Based on Median and with adjusted df	0.098	1	34.599	0.756
	Based on trimmed mean	0.229	1	38	0.635
Grade	Based on Mean	0.909	1	38	0.346
	Based on Median	0.867	1	38	0.358
	Based on Median and with adjusted df	0.867	1	35.903	0.358
	Based on trimmed mean	0.879	1	38	0.354

To measure whether the groups have the same variance between the groups, a homogeneity test of variance between groups was conducted. Three groups of data were tested for homogeneity of variance between groups using the Levene's test. The results of the analysis showed that all Leveve's statistical values showed significant figures of more than 0.05, both for creativity, cooperation, and Visual aid learning outcomes. This means that the variance between the experimental group and the control group is homogeneous, both for creativity, cooperation, and learning outcomes. So that further testing can be carried out. The manova test is used to test whether there are differences in several dependent variables between several different groups. Decisions are taken by analyzing Pillai's Trace, Wilks' Lambda, Hotelling's Trace and Roy's Largest Root. The results of the manova analysis of the Visual aid learning process are presented in Table 5 and Table 6.

Table 5. Results of Manova Analysis

Effect		Value	F	Hipotesis Df	Error df	Sig.
Intercept	Pillai's Trace	0.999	8500.125	3.000	36.000	0.000
	Wilks' Lambda	0.001	8500.125	3.000	36.000	0.000
	Hotelling's Trace	708.344	8500.125	3.000	36.000	0.000
	Roy's Largest Root	708.344	8500.125	3.000	36.000	0.000
Class	Pillai's Trace	0.838	62.000	3.000	36.000	0.000
	Wilks' Lambda	0.162	62.000	3.000	36.000	0.000
	Hotelling's Trace	5.167	62.000	3.000	36.000	0.000
	Roy's Largest Root	5.167	62.000	3.000	36.000	0.000

Based on Table 5, it appears that the statistical values of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root are each with F = 8500.125, with a significance value of 0.000, this means that H_0 is rejected. Therefore, the alternative hypothesis H_1 is accepted. So there are differences in creativity, cooperation, and Visual aid learning outcomes simultaneously between students who follow the project-based learning model and students who follow the conventional learning model.

Table 6. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	Creativity	1755.625	1	1755.625	133.387	0.000
	Cooperation	1612.900	1	1612.900	135.898	0.000
	Grade	2235.025	1	2235.025	147.719	0.000
Intercept	Creativity	250747.225	1	250747.225	19051.074	0.000
	Cooperation	252492.100	1	252492.100	21274.279	0.000
	Grade	265853.025	1	265853.025	17570.945	0.000
Class	Creativity	1755.625	1	1755.625	133.387	0.000
	Cooperation	1612.900	1	1612.900	135.898	0.000
	Grade	2235.025	1	2235.025	147.719	0.000
Error	Creativity	500.150	38	13.162		
	Cooperation	451.000	38	11.868		
	Grade	574.950	38	15.130		
Total	Creativity	253003.000	40	1755.625		
	Cooperation	254556.000	40	1612.900		
	Grade	268663.000	40	2235.025		
Corrected Total	Creativity	2255.775	39	250747.225		
	Cooperation	2063.900	39	252492.100		
	Grade	2809.975	39	265853.025		

Based on the results of the multivariate analysis of the relationship between the project-based learning model and the conventional learning model with creativity, the F value is 133.387 with a significance of 0.000 which is smaller than the significance level of 0.05. This means that Ho, which states that there is no difference in creativity between students who take learning with the project-based learning model and students who take learning with the conventional learning model, is rejected. This shows that there is a significant difference in creativity between students who take learning with the project-based learning model and students who take learning with the conventional learning model. The results of the multivariate analysis show that the relationship between the learning model and learning outcomes gives an F value of 85.117 with a significance of 0.000 which is smaller than the significance level of 0.05. This means that Ho, which states that there is no difference in learning outcomes between students who take learning with the project-based learning model and students who take learning with the conventional learning model, is rejected. This shows that there is a significant difference in learning outcomes between students who take learning with the project-based learning model and students who take learning with the conventional learning model.

Discussion

The data analysis results show differences between students who take part in learning with a project-based learning model and students who take part in learning with a conventional learning model. This is due to several factors. First, the project-based learning model can increase student creativity. The results of the MANOVA analysis show that creativity in the learning process between the experimental group and the control group provides different values. Creativity is often considered a skill based on natural talent, where only talented people can be creative. Everyone can think creatively (Suhanto et al., 2024). In the project-based learning model, students are more faced with problem-solving, decision-making in their own way, and decision-making against a framework (Muzdalifah et al., 2023; Putri et al., 2018). With the problems or challenges presented, students design a process to determine solutions to the problems or challenges presented. Students are collaboratively responsible for accessing and managing information to solve the problems they face (Muzdalifah et al., 2023; Putri et al., 2018; Simamora et al., 2022). The many activities students carry in the learning process require students to have: First, a high and deep curiosity (Nirmayani & Dewi, 2021; Sudewi et al., 2023). Second, being able to express opinions and find answers by asking others or looking for answers in books and learning resources. Third, they provide lots of ideas; fourth, they develop their imagination; and fifth, they convey the results of what is made to others. This can have an impact on increasing student creativity. Learning activities carried out by implementing project-based learning impact student creativity.

Second, the project-based learning model can improve student cooperation. The results of the MANOVA analysis show that the learning outcomes in the learning process between the experimental group and the control group provide different values. So, it can be said that there is a significant difference between the experimental group and the control group in terms of cooperation. The difference in student cooperation results can be explained by the fact that the learning conditions are fun, more challenging, and more interesting, and a more lively classroom atmosphere helps students feel more comfortable so that the level of products produced is better. In addition, students are free to express their opinions when deciding. Students feel more appreciated in learning (Setyowati et al., 2018; Winatha et al., 2018). This has an impact on their enthusiasm to produce the best work. In the project-based learning process, students experience analyzing and synthesizing information the teacher conveys (Danim, 2023; Soleh & Kesumawati, 2019). Each student is actively involved physically and mentally in every aspect of the activity so that students understand the learning material better. The emphasis on learning is not limited to efforts to force or cram someone with several concepts that are memorized but rather lies in efforts to make someone have a set of knowledge, attitudes, values, and skills (Aerts et al., 2017; Pan et al., 2021; Yamin et al., 2020). The learning process gives students the freedom to find solutions or solve problems from various sources. The freedom given to students to find alternative solutions to their problems provides a more meaningful and enjoyable learning atmosphere and comfortable conditions in the learning process (Dewi et al., 2024; Sharma et al., 2020).

Third, the project-based learning model can improve student learning outcomes. Project-based learning is a learning approach that gives students the freedom to plan learning activities, carry out projects collaboratively, and ultimately produce work products that can be presented to others (Aerts et al., 2017; Izati et al., 2018; Mulyati et al., 2022; Pan et al., 2021; Yamin et al., 2020). In contrast to conventional learning models, the teaching and learning process is more directed at transferring knowledge from educators to students. Educators consider learning only for memorization, and learning tends to only meet curriculum achievement targets without looking at the achievements and learning process proportionally. As a result of this kind of learning, students only accept what the educator conveys without thinking deeply as if the ideal and meaningful learning process is neglected. From this description, these two learning models have different characteristics, thus affecting the level of creativity and achievements that follow the project-based learning model with the conventional learning model. Previous findings stated that the Project-based learning model has a major influence on the quality of teaching aids learning, which in this study achieved high effectiveness, cooperation and efficiency (Izati et al., 2018; Mulyati et al., 2022). Other studies also revealed that the Project Based Learning Model can increase students' self-confidence, creativity for learning, creative abilities, self-admiration, and cooperative attitudes between students (Mulyati et al., 2022; Soleh et al., 2024). The limitation of this study is that it was only conducted on 8th-semester students of the Engineering Technology Study Program. Other studies are expected to expand the research population for more valid results. This study implies that project-based learning allows teachers to manage classroom learning by involving project work. To produce a meaningful project and by what is expected, knowledge and high creativity are needed. The balance between the two will support the success of a project later. This project's results will show an individual's learning achievements. IncreasingIncreasing flight safety in Indonesia will increase global public confidence in aviation.

4. CONCLUSION

Based on the results of the study on project-based learning with the subject of visual landing aids at the airport, it was concluded that there was a significant influence of the project-based learning model on student creativity, there was a significant influence of the project-based learning model on student learning outcomes and there were differences in creativity and learning outcomes between students who followed the project-based learning model and those who followed the conventional learning model. Based on the findings of this study, it is recommended that lecturer use the project-based learning model in order to improve student creativity, cooperation and learning outcomes.

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