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Project Based Learning: Development of Taxiway Light as a Visual Landing Aid Using Solar Power

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Abstract: This research aims to determine the differences in learning methods in the classroom using project-based learning and conventional learning. The research was carried out using quantitative methods by conducting evaluations and interviews with cadets. Data processing uses the Manova test statistical data processing application. The sample from this research was Palembang Aviation Polytechnic cadets in visual aid courses, especially taxiway lights. From the results of data processing, we can see differences in terms of creativity and learning outcomes between cadets who use project-based learning methods and those who use conventional learning systems. Project-based learning methods have fostered creativity and better learning outcomes. Hopefully with the results of this research, lecturers will more often use project-based learning methods to foster the creativity of Aviation Polytechnic cadets within the Ministry of Transportation of Indonesia.

Keywords: Project-based learning, Taxiway light, Visual Aid

A. 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. In particular, the course on visual landing aids plays a role in producing quality students, namely people who are able to develop a scientific attitude and have skills in the field of visual navigation at airports. Visual landing aids are part of science which essentially has two components, namely product and process components. Science as a product is a collection of the results of empirical activities and analytical activities carried out by scientists for centuries (Fatonah, Wildan, Purnomo, & Soleh, 2020). As a visual landing aid product, it consists of a collection of knowledge consisting of facts, concepts, principles and concepts in the process of landing an airplane at the airport. Meanwhile, as a process, visual aid is a structured and systematic series carried out to determine concepts, principles and methods in the aircraft landing process (Samari, Kristiawan, & Fitria, 2023).

The aim of visual aid learning is to provide an understanding of the scientific discipline of visual aids and work skills to produce a product that will reflect a

person's mastery of competence as a result of their learning (Soleh, Gauthama, Suhanto, Rifai, & Alddi, 2023). Visual aid is essentially a product, process and application. As a visual aid product, it is a collection of knowledge and processes in aviation navigation. As a process, visual aid is a process used to study objects of study, discover and build scientific products, and as an application, visual aid theories will give birth to technology that can provide convenience and safety for the world of aviation (Widiana, 2016). Based on this, assessments in visual aids need to use assessments that do not only refer to the cognitive domain but need assessments that can measure students' skills. In this regard, teachers must provide project assignments for cadets.

The definition of visual aid science according to Hendro Darmojo is knowledge about the universe and all its contents or it could be said to be rational and objective knowledge about the universe and all its contents. Meanwhile, according to Nash, science is a way or method for observing nature. Nash also explained that the way science observes the world is analytical, complete, careful, and connects one phenomenon with other phenomena, so that the whole forms a new perspective on the object being observed (Rifai, et al., 2022). It is the same as the explanation from Powler that science is a science that deals with natural phenomena and systematic objects that are arranged in an orderly manner, generally accepted in the form of a collection of results from observations and experiments. Based on several experts above, it can be concluded that science is human knowledge about natural phenomena and objects obtained by observation, research, or trials based on the results of human observations.

Therefore, science learning should be oriented towards activities that support understanding of concepts, principles and procedures in relation to the context of their daily lives. The current conditions found in the field of visual aid learning are that the packaging of visual aid learning for understanding and creative skills is not handled systematically. This is because educators still relatively package learning by means of discussions, presentations and writing papers. So the cadets' abilities are limited to theory and presentation. The reality in the field is that being a visual aids lecturer means you don't only have to understand the existing theory but also how we can be more creative to produce work that can be accepted and used to help the learning process. In other words, a cadet must also have creativity. Creativity is often considered a skill based on natural talent, where only those who are talented can be creative. This assumption is not entirely true, although in reality it appears that certain people have the ability to create new ideas quickly and in a variety of ways. In fact, everyone has the ability to think creatively. According to Satiadarma, creativity is one of the assets that cadets must have to achieve learning achievements (Setiadarma, Monti, & Waruwu, 2003).

Cadet creativity should not be interpreted only as the ability to write Create something completely new, but you can also combine existing ideas and then apply them into

something different from what existed before. To increase creativity, it is deemed necessary to carry out learning that encourages cadets to be more creative. One of the 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 searching for various sources, providing opportunities for members to work collaboratively, and closing with a real product presentation. The project-based learning model focuses on the core concepts and principles of a discipline, facilitating cadets to investigate, problem-solving and other meaningful tasks, is student-centered and produces real products. According to Thomas, project-based learning is a learning model that provides teachers with the opportunity to manage learning in the classroom by involving project work (Wena, 2010).

Project-based learning is an application of active learning. In simple terms, project-based learning is defined as teaching that tries to link technology with everyday life problems that are familiar to students, or with school projects. According to Trianto the project-based learning model has enormous potential to create a more interesting and useful learning experience for students (Trianto, 2011). In project-based learning, students are encouraged to be more active in learning. According to the Big Indonesian Dictionary, a project is a work plan with specific targets and a firm completion date. Joel L Klein explains that project-based learning is a learning strategy that empowers students to gain new knowledge and understanding based on their experiences through various presentations (Widyantini, 2014).According to Thomas, et al it is stated that project-based learning is a learning model that provides teachers with the opportunity to manage learning in the classroom by involving project work.

State that Project Based Learning is learning that provides teachers with the opportunity to manage learning in the classroom by involving project work. Project-based learning has enormous potential to create a more interesting and beneficial learning experience for students. According to the Buck Institute for Education, the project-based learning method is a systematic learning method that involves students in learning knowledge and skills through a process of investigating real problems and creating various carefully designed works. Meanwhile, according to Ridwan Abdullah Sani, it is teaching and learning that involves students working on a project that is useful for solving community or environmental problems. Project-based learning has great potential to provide a more interesting and meaningful learning experience for students, according to Gear (Hosnan, 2013).

Meanwhile, the characteristics of project-based learning according to the Center for Youth Development and Education Boston are: 1) Students make their own decisions within a pre-determined framework. 2) Students try to solve a problem or challenge that does not have a definite answer. 3) Students are encouraged to think critically, solve problems, collaborate, and try various forms of communication. 4) Students are responsible for finding and managing the information they collect themselves. 5)

Evaluation is carried out continuously throughout the project. 6) Students regularly reflect and reflect on what they have done, both the process and the results (Hosnan, 2013). Project work in project-based learning looks at the process, creativity and activities of cadets in the learning process so that it will have an impact on increasing cadet learning outcomes. According to Sudjana learning outcomes are the abilities that students have after receiving learning experiences. These abilities include cognitive, affective and psychomotor aspects. Learning outcomes can be seen through evaluation activities which aim to obtain evidentiary data that shows the level of cadets' abilities in achieving learning objectives. Based on this opinion, it can be concluded that Project Based Learning is a model that emphasizes cadets being able to learn independently by solving the problems they face and cadets can also produce a project or real work (Jihad & Haris, 2013).

B. Methods

This research follows a quasi-experimental research design with a non-equivalent post test only control group design. The population in this study were cadets in the third semester of the airport engineering technology study program at the Palembang Aviation Polytechnic. The total number of classes is 1 class. Based on population characteristics and individual randomization cannot be carried out, sampling in this study was carried out using a 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 applying a project-based learning model, while the control group received conventional learning (Soleh, 2019).

The data collected in this research is cadet creativity data collected using questionnaires and learning outcomes using essay tests. Data were analyzed using Manova. Before the analysis is carried out, data normality and homogeneity testing is first carried out as a prerequisite test. Testing the normality of data distribution used the Kolmogrov Test and Shapiro-Wilks Test statistics. Test 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. Test the homogeneity of variance between groups using Levene's test of Equality of Error Variance (Candiasa, 2004). Test criteria: data has the same variance (homogeneous) if the significance figure obtained is greater than 0.05 and in other cases the sample variance is not the same (not homogeneous). Test normality and homogeneity using the SPSS Version 20.00 application.

C. Results and discussion

The number of cadets involved in this research was 20 people, divided into two groups (experimental group and control group), each with 10 people. In this research, two data were obtained, namely creativity data and learning outcomes data) Visual aid education. Descriptive calculations (mean, mode, standard deviation, maximum value and minimum value) can be seen in Table 1.

Table 1. Recapitulation of Calculation Results for Creativity Scores and Learning Outcomes

Statistic	Creativity		Learning Outcomes	
Variable	Experiment	Control	Experiment	Control
Mean	125	95,20	84	81
Modus	132	98	85	80
Standar Deviasi	8,30	4,55	1,48	2,5
Skor Mininum	112	85	83	74
Skor Maksimum	138	104	87	86

Based on Table 1 above, it can be seen that the average creativity score for cadets taught using the project-based learning model is 125, and the average score for Visual Aid learning outcomes is 84. The average creativity score taught using the conventional learning model is 95. 20, and the average Visual Aid learning outcome score is 81. These results indicate that descriptively the project-based learning model is relatively better as a learning facility for cadets in order to increase creativity and learning outcomes.

To prove that this has been statistically tested, research hypotheses have been tested, preceded by testing of the assumptions and prerequisites for the analysis. Assumption testing is carried out to determine whether the available data can be analyzed parametrically or not. Regarding the statistics used for data analysis in this research, the assumption tests carried out include normality tests, homogeneity tests, and correlation tests between variables. Normalization 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.20 for Windows (Ahmad, 2021).

The results of the analysis show that the Kolmogorov-Smirnnov statistical value for the creativity of the experimental group (0.9) and the control group (0.169) is greater than 0.05. So it can be concluded that the learning creativity data for the experimental group (0.210) and the control group (0.210) are normally distributed. So that further tests can be carried out. The Kolmogorov-Smirnnov statistical value for the Visual aid learning outcomes of the experimental group and the control group is greater than 0.05. So it can be concluded that the visual aid learning outcomes for the experimental group (0.08) and the control group (0.91) are normally distributed. The homogeneity of variance test between groups is used to measure whether groups have the same variance between groups. The homogeneity of variance test between groups used Levene's test which was carried out on four groups of data.

The results of the analysis show that all Leveve's statistical values show a significant number of more than 0.05, both creativity value data and Visual aid learning outcome data. This means that the variance between the experimental group and the control group is homogeneous, both for creativity value data and learning outcome value

data. So that further tests can be carried out. The correlation test between variables is used to determine whether there is a high enough relationship or not between the creativity variable and cadet learning outcomes in the Visual Aid course. If there is not a high enough relationship, then the same aspect is not measured in that variable, in other words the analysis can continue. The technique used to determine multicollinearity is to look at the VIF (variance inflation factor) value. Based on the results of the analysis, the data obtained show that creativity and learning outcomes are at a tolerance of 0.417 and a VIF of 2.398.

The results of the analysis of the multicollinearity test with the VIF value show that there is no multicollinearity in the value. This is indicated by the tolerance score approaching 1 and the VIF score approaching 1. So from the prerequisite tests that have been carried out, all groups come from a normally distributed population, have the same variance. or homogeneous and there are no multicollinearity problems between variables. Therefore, hypothesis testing with MANOVA 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 using Pillai's Trace, Wilks' Lambda, Hotelling's Trace and Roy's Largest Root analysis. The results of the MANOVA analysis of the Visual Aid learning process are presented in Table 2 and Table 3.

Table 2. Manova Analysis Results

	Effect	Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0,899	5,375E4[a]	2,000	63,000	0,000
	Wilks' Lambda	0,011	5,375E4[a]	2,000	63,000	0,000
	Hotelling's Trace	1720E3	5,375E4[a]	2,000	63,000	0,000
	Roy's Largest Root	1720E3	5,375E4[a]	2,000	63,000	0,000
Class	Pillai's Trace	0,815	1,775E4[a]	2,000	63,000	0,000
	Wilks' Lambda	0,147	1,775E4[a]	2,000	63,000	0,000
	Hotelling's Trace	5,433	1,775E4[a]	2,000	63,000	0,000
	Roy's Largest Root	5,433	1,775E4[a]	2,000	63,000	0,000

Based on table 2, it appears that the statistical values of Pillai's Trace, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root are each with F = 5.375E4a, with a significance value of 0.000, this means that H0 is rejected. Therefore, the alternative hypothesis Ha is accepted. In conclusion, there is a difference in creativity and simultaneous Visual Aid learning outcomes between cadets who follow the project-based learning model and cadets who follow the conventional learning model.

Table 3. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Creativity	17156,012[a]	1	17156,012	312,634	0,000
	Learning Outcomes	378,726[b]	1	378,726	85,117	0,000
Intercept	Creativity	815325,017	1	815325,017	1,702E3	0,000
	Learning Outcomes	464273,126	1	464273,126	1,032E5	0,000
Class	Creativity	15169,017	1	15169,017	311,763	0,000
	Learning Outcomes	378,327	1	378,327	86,132	0,000
Error	Creativity	3200,873	66	48,152		
	Learning Outcomes	281,210	66	4,261		
Total	Creativity	814534,000	65			
	Learning Outcomes	452783,000	65			
Corrected Total	Creativity	18423,847	64			
	Learning Outcomes	647,648	64			

Based on multivariate analysis, the relationship between learning model (X) and creativity gives an F value of 312.634 with a significance of 0.000 which is smaller than the significance level of 0.05. This means that Ho, who states that there is no difference in creativity between cadets who take part in learning using a project-based learning model and cadets who take part in learning with a conventional learning model, is rejected.

This shows that there is a significant difference in creativity between cadets who take part in learning with a project-based learning model and cadets who take part in learning with a 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, who stated that there was no difference in learning outcomes between cadets who took part in project-based learning models and cadets who took part in conventional learning models, was rejected. This shows that there is a significant difference in learning outcomes between cadets who follow the project-based learning model and cadets who follow the conventional learning model. The results of this research are in line with the results of research conducted by Triagustiana and Rati in their research entitled The Effect of Project-Based Learning

Models on Student Learning Achievement in View of Achievement Motivation, stating that project-based learning has a positive effect on student learning achievement (Danim, 2023).

The results of the Manova analysis show that creativity in the learning process between the experimental group and the control group provides a significant value ($p<0.05$). So it can be said that there is a significant difference between the experimental group and the control group in terms of creativity. Creativity is often considered a skill based on natural talent, where only those who are talented can be creative. This assumption is not entirely true, although in reality it appears that certain people have the ability to create new ideas quickly and in a variety of ways. In fact, everyone has the ability to think creatively. Creativity is the potential creative power possessed by individuals as a form of thinking in finding relationships between existing elements or new ways of dealing with problems that come from oneself in the form of a strong desire and creativity to create.

In this research, it was found that cadets who followed the conventional learning model had creativity that was in the medium to very high category, while all cadets who followed the project-based learning model were in the very high category. These findings are caused by different treatments. In the project-based learning model, cadets are more exposed to problem solving, making decisions on their own, making decisions about a framework. Given the problems or challenges posed, cadets design a process to determine solutions to the problems or challenges posed. Cadets are collaboratively responsible for accessing and managing information to solve the problems faced. The many activities carried out by cadets in the learning process mean that cadets must have: 1) a high and deep curiosity, 2) be able to express opinions and look for answers by asking other people or looking for answers in books and learning resources, 3) providing lots of ideas, 4) able to develop his own imagination, and 5) able to convey the results of what he creates to other people. This can have an effect on increasing cadet creativity. Through learning activities carried out by implementing project-based learning, this has an impact on cadet creativity, as proven by the results of research that has been carried out where the results of the analysis show that cadet creativity is in the very high category.

The findings of this research are in line with the opinion expressed by Satiadarma that creativity is one of the assets that must be possessed to achieve learning achievement (Setiadarma, Monti, & Waruwu, 2003). Cadet creativity should not be interpreted as the ability to create something completely new, but rather the intelligence that cadets have in combining existing ideas or changing these ideas according to existing needs and facilities and then implementing them. Rhodes explains the type of creativity known as the four p's of creativity, namely person, process, press and product. Creativity from a personal perspective shows the potential of creative power exists in every person. Creativity as a process can be formulated as a form of thinking where individuals try to find new relationships, get answers, methods or new ways of

dealing with problems. Creativity as a driving force that comes from oneself in the form of a strong desire and creativity to create. Creativity in terms of the results of everything a person creates as a result of their personal uniqueness in interaction with their environment (Susanto, 2015).

Creativity is the ability to create something new, as the ability to provide new ideas that can be applied in solving problems, or as the ability to see new relationships between previously existing elements. A person's creativity can be seen from their creative behavior or activities. According to Moreno what is important in creativity is not the discovery of something that no one has ever known before, but rather that the product of creativity is something new for oneself and does not have to be something new for other people or the world in general. Pamilu states that there are several factors that influence children's creativity, namely (1) emotional closeness, (2) freedom and respect, and (3) respect for achievement and creativity. The characteristics of a creative personality are: (1) Deep curiosity, (2) Frequently asking good questions, (3) Providing lots of ideas, (4) Freedom in expressing opinions, (5) Has a deep sense of beauty, (6) Has a broad sense of humor, (7) Has the power of imagination, (8) Is original in expressing ideas, and (9) Stands out in one of the arts. Creativity is owned by everyone without exception (Asih, Setemen, Artanayasa, & Widiartini, 2013).

However, if an individual's creativity is not developed, the child will follow and live with what he gets from other people without wanting to find his own solution. In other words, the individual only imitates what already exists and accepts what is ready-made. However, on the other hand, activities that activate individuals to solve problems and find solutions to problems are able to develop the creativity that each individual already has. The results of the Manova analysis show that the learning outcomes in the learning process between the experimental group and the control group provide significant values ($p<0.05$). So, it can be said that there is a significant difference between the experimental group and the control group in terms of learning outcomes. The difference in cadet learning outcomes can be described as learning conditions that are fun, more challenging, more interesting and a livelier class atmosphere that helps cadets feel more comfortable so that the level of product produced is better. Apart from that, cadets are free to express opinions when making decisions.

Cadets feel more valued in the learning process. This has an impact on his enthusiasm to produce the best work. In the project-based learning process, cadets experience the process of analyzing and synthesizing the information presented by the teacher. Each cadet is actively involved both physically and mentally in every aspect of the activity so that the cadets' understanding of the learning material becomes better. The emphasis of learning is not limited to efforts to force or stuff someone with a number of concepts that are merely rote, but rather lies in efforts to make someone have a set of knowledge, attitudes, values and skills. The learning process is carried out by

giving cadets the freedom to seek solutions or solutions to problems from various sources. The freedom given to cadets to look for alternative solutions to problems provides a more meaningful and enjoyable learning atmosphere as well as comfortable conditions in the learning process. To increase the meaningfulness of learning, the learning process should focus more on the activities of forming knowledge within cadets, rather than the learning process paying more attention to how the knowledge transfer process takes place.

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. In contrast to conventional learning models, the teaching and learning process is more directed only at transferring knowledge from teachers to cadets, teachers consider learning to be just for rote memorization, and learning tends only to meet curriculum achievement targets without looking at learning outcomes and processes proportionally. As a result of learning like this, cadets only accept what is conveyed by the lecturer without thinking deeply as if it were process Ideal and meaningful learning is neglected.

From this description, these two learning models have different characteristics, thus influencing the level of creativity and learning outcomes that follow the project-based learning model compared to conventional learning models. Sudjana defines learning outcomes as essentially changes in behavior as a result of learning in a broader sense including the cognitive, affective and psychomotor fields. Dimyati and Mudjiono also stated that learning outcomes are the result of an interaction between acts of learning and acts of teaching. Learning outcomes as an indicator of achieving learning goals in class cannot be separated from the factors that influence the learning outcomes themselves. The factors that influence learning outcomes, as follows (Lestari & Hadiwinarto, 2022): 1) Internal factors are factors that exist within the individual who is learning. Internal factors include: physical factors and psychological factors. 2) External factors are factors that exist outside the individual. External factors include: family factors, school factors, and community factors.

The success of improving the quality of learning in the experimental group compared to the control group was inseparable from the project-based learning model intervention applied to the experimental group so that learning conditions became more active, enjoyable and comfortable (Cao, 2018; Sembiring et al., 2023). Apart from that, the learning syntax also has a big influence on the quality of learning. Visual aids in this research achieved high effectiveness and efficiency. The Project Based Learning Model can also increase cadets' self-confidence, creativity for learning, creative abilities, and self-admiration (Dewanti, 2022; Pane et al, 2023). According to Thomas, project-based learning is a learning model that provides teachers with the opportunity to manage learning in the classroom by involving project work. To produce a project that is meaningful and meets expectations, it not only requires knowledge but also requires high creativity (Yanto, 2019). The balance between the two will support the

success of a project in the future. The results of this project will show the learning outcomes of an individual. In other words, creativity and learning outcomes are two things that are interconnected and influence each other.

D. Conclusions

Based on the research results, it is concluded that there is a significant influence of the project-based learning model on cadet creativity, there is a significant influence of the project-based learning model on cadet learning outcomes and there are differences in creativity and learning outcomes between cadets who follow the project-based learning model and those who follow the conventional learning model . Based on the findings of this research, it is recommended that lecturers use a project-based learning model in order to increase cadets' creativity and learning outcomes.

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