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SOLAR CELL PRACTICUM TECHNOLOGY INFORMATION MEDIA BASED ON PROJECT BASED LEARNING

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ABSTRAC

Learning the *Project Based Learning* (PjBL) model with case studies of Solar Cell problems is said to be quite effective in improving student learning outcomes in the UMI Electrical Engineering Electrical Energy Conversion course. This study was built with a literature review of aspects of creative thinking that emerged in PjBL learning. The low learning outcomes of students in the context of understanding Solar Cells is an impact of conventional learning. In this study, data was collected through questionnaires and interviews with 22 students in Electrical Engineering. Interview questions to students related to aspects of *fluency, flexibility, origilality* and *elaboration.* This research data was analyzed with quantitative and qualitative descriptive statistics mixed *method method*. The method used to test the effectiveness of PjBL learning is carried out by the intact group comparison method, *namely by comparing the value of learning outcomes in the experimental class or PjBL class and the control class.*

Keywords: *effectiveness, creative thinking, project based learning, learning outcomes*

A. INTRODUCTION

Cossu et al., (2024) stated that students' thinking creativity can affect achievement both for the courses studied. One of the ways to improve learning outcomes, it is advisable to study classroom methodology as a mediating factor in the development of creative thinking (Second-Marcos et al., 2023). According to Tong et al., (2020), PjBL provides benefits to effectively improve students' independent learning abilities, practical applications, and innovation. Students who study PBL in groups, better perform students than conventionally (Craig &; Marshall, 2019). Puspitarini et al., (2019) stated that lecturers who use the lecture method and book learning resources are said to attract less attention, so that students do not understand the material presented and student learning motivation decreases. Amiruddin et al., (2018) said the implementation of the PjBL learning model contributed to the development of the employability of SMK Mechanical Engineering students.

Findings on PjBL learning have evidence that it can improve student learning outcomes (Syakur et al., 2020; Nurhadiyati et al., 2020; Ratnasari et al., 2018). PjBL with a *science edutainment* approach also has a significant effect on student creativity and can build the work ability of lecturers in teams (Ardianti et al., 2017; Tsybulsky, 2019). Andriyani &; Anam, (2022) &; Diana et al., (2021) suggest that PjBL learning is positively correlated with collaborative skills

and can increase its effectiveness in STEM education. According to Andy Ariyanto &; Sutama, (2022) & Setyaningsih &; Rahman, (2022) that PjBL learning shows an increase in student independence character and can support problem-solving activities. These problem-solving abilities contribute to the theoretical expansion and empirical verification of the literature on constructivist learning and design thinking (Tsai et al., 2023). Thus, it can be concluded that PjBL learning can provide authentic assessment results, able to increase student creativity to train work attitudes in solving a problem and able to improve student learning outcomes. The purpose of this study was to determine how high the effectiveness of PjBL learning in the Electrical Energy Conversion course in the Electrical Engineering Study Program at the Indonesian Muslim University (UMI)

Creativity is the ability of the mind and soul that we can realize from nothing into something that exists, useful and meaningful (Gerard, 2016: 8). The creative thinking process can create emotions, ranging from a sense of joy or frustration that is natural and natural, Hutagalung &; Situmorang, (2008: 19) states that a person can think creatively based on: (1) trying to fatten original ideas or ideas by making new things, (2) paying attention to unexpected things. Creativity is an instinct that exists from birth, however, creativity cannot develop by itself, but requires stimulation from the environment (Firmansyah., A &; Roosmawarni, 2019: 155). Thus, creative thinking is the ability of individuals to produce something new, have a flexible mind and be open to various ideas, have authentic or original thinking and be able to develop new ideas to solve problems.

Silver (1997: 35) classifies this ability to think creatively as necessary several components: *fluency*, *flexibility* and *novelty*. However, by referring to the theoretical literature and Silver's statements, it can be concluded that creative individuals have a pattern of thinking that includes aspects of fluency, originality, flexibility and elaboration. Novelty is something that appears new in these four aspects. Mulyadi, (2011: 65) defines that creative is the ability to develop new ideas and new ways of solving problems and finding opportunities. According to Helmiati (2012: 52) in increasing student creativity in channeling new ideas or ideas that can be needed for student self-development based on knowledge, an approach through constructivism learning is needed.

Minister of Education and Culture number 4 of 2020, that PjBL in dasamya is a learning with an approach to constructivistic learning theories. Whileconstructivism itself is defined as generative learning, namely the act of creating something meaningful from what is learned (Dangnga &; Muis, 2015: 25). According to Piaget, (1999: 95) the union of this progressive accommodation with the mutual assimilation of the scheme constitutes an intelligence with a learning process that should not be considered as purely experimental or purely deductive, but which simultaneously partakes of experience and mental construction.A learning process approach that allows reducing the gap between the abilities of graduates and those expected in society by providing a project-based learning process by developing skills in the world of work (Suloworo, 2019: 46-49).

Daryanto & Raharjo (2012: 162) that the learning of the PjBL model has the following characteristics: (1) students decide to create a framework, (2) there are problems or challenges posed to students, (3) students design processes, determine solutions to the problems posed, (4) students are collaboratively responsible for accessing and managing information to solve problems, (5) the evaluation process is carried out continuously, (6) students periodically reflect on the activities that have been carried out, (7) the final product of learning activities will be evaluated qualitatively, and (8) the learning situation is very tolerant of errors and changes.

B. RESEARCH METHODS

This research is with descriptive and quantitative statistical approaches with *mixed method analysis*. Data collection was conducted through interviews and questionnaires filled out by 22 UMI Electrical Engineering students. Interview grids and questionnaires are related to questions on aspects of fluency, original, flexible and student elaboration. The results of the interview and

the contents of the questionnaire were then analyzed for the needs in designing PjBL learning with its tools.

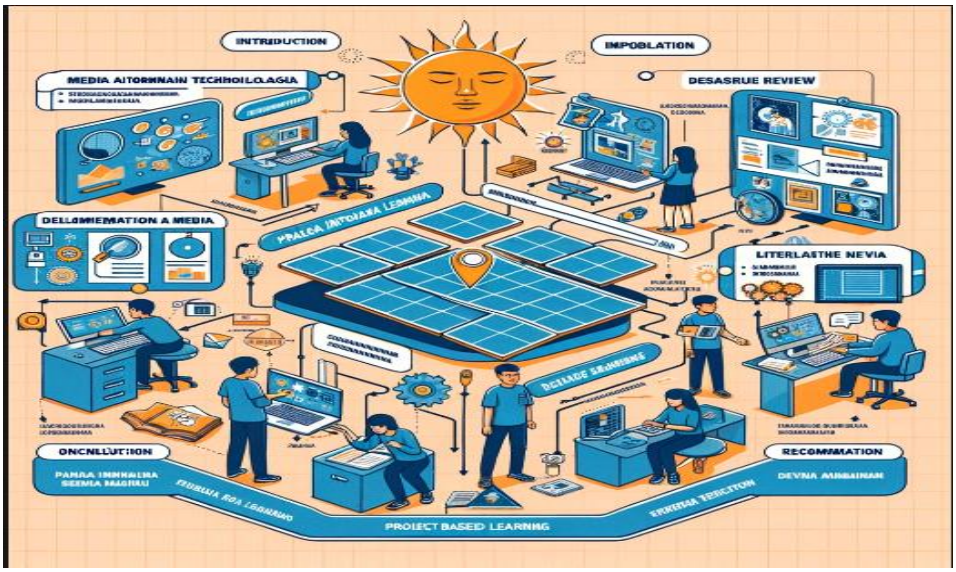

Figure 1. Research Flow

C. RESULTS AND DISCUSSION

1. Needs Analysis

Based on the results of identification and analysis of interviews with 22 students for 4 aspects of their creative thinking that influence their Electrical Energy Conversion learning is low on average. In Table 1. is a summary of data from questionnaires on 4 aspects of creative thinking that have a significant effect on learning Electrical Energy Conversion.

Table 1. Summary of the Results of the Student Creative Thinking Aspect Questionnaire

No	Problems	Score	
		Appropriate	Fits perfectly
A	**Flexibility Aspect**		
1	Unable to provide interpretation of images, stories, or problem assignments	73%	27%
2	An interesting presentation is needed on the material taught by the lecturer,	19%	81%
3	Have not been able to give consideration to the opinions of friends who have different views on the task of the questions	28%	71%
4	Have not been able to solve problems on the task of the problems in their own ways	26.4%	63.6%
B	**Original Aspect**		

5	Have not been able to complete tasks with a different way of thinking on their own with friends	90.9%	9.1%
C	**Elaboration Aspect**		
6	Unable to find a deeper meaning for the answers to the questions	81.8%	19.2%
7	Difficulty developing new ideas obtained from classmates,	90.9%	9.1%
8	Have never tried/seriously retested the results of your own answers on the question assignments	81.8%	18.2%

The next activity is to test learning products with the following steps:

a. Research test

There are 23 variables declared valid and reliable, obtained Cronbach Alpha value > 0.6 with r Table 0.413. To find out the influence between 4 aspects of creative thinking on learning outcomes with stages:

1) Partial t-test

The influence of aspects of fluency (X1), original (X2), flexibility (X3) and elaboration (X4) partially on learning outcomes (Y) is summarized in the following table:

Tabel 2 Anova

Model		Sum of Squares	df	Mean Square	F	Say.
X1	Regression	360,646	1	360,646	72,023	,000b
X2	Regression	134,472	1	134,472	8,242	,009b
X3	Regression	163,018	1	163,018	10,949	,004b
X4	Regression	159,753	1	159,753	10,613	,004b

Based on Table 2.shows the significance value to the 4 variables < 0.05. This gives the understanding that in each of the 4 variables, there is a significant influence on learning outcomes.

Tabel 3. Model Summary X1

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
X1	,885a	,783	,772	2,23772
X2	,540a	,292	,256	4,03932
X3	,595a	,354	,321	3,85860
X4	,589a	,347	,314	3,87970

Based on R Square in Table 3., it shows that the highest influence partially is the aspect of fluency X1 on learning outcomes, which is 78.3%.

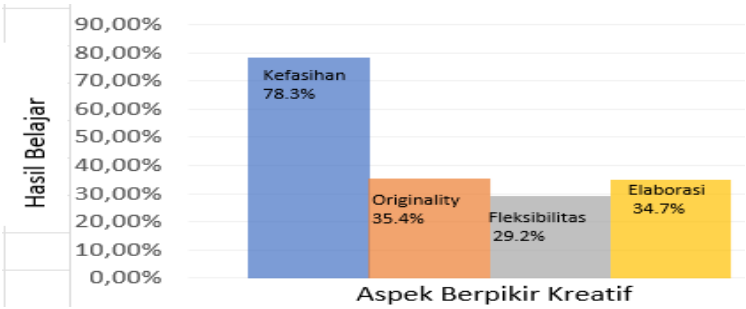

Figure 1. The Relationship of Creative Thinking Aspects with Learning Outcomes

2) Simultaneous F test

Test F is used to determine the relationship and influence of aspects of fluency attitude (X1), original (X2), flexible (X3) and elaboration (X4) simultaneously on learning outcomes (Y) presented in the following table:

Tabel 4.Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,938a	,880	,852	1,80467

a. Predictors: (Constant), X1, X2, X3, X4

Based on the R Square in Table 4.shows that the influence of X1, X2, X3, and X4 simultaneously on learning outcomes is 88%.

b. Class control and exprimen

The effectiveness of PjBL learning products is carried out with the *intact group comparison method*, which compares the value of learning outcomes in the experimental class group with the control class using Ngain_Persen formulation.

Table 5. Data Normality Test Results *N_Gain*

	Class	Kolmogorov-Smirnova Statistic	df	Say.	Shapiro-Wilk Statistic	df	Say.
D	Experimental Class	,190	22	,038	,888	22	,018
	Control Class	,160	22	,146	,944	22	,239

Refer to Table 5. Showing a significance value of > 0.05, then in the experimental class and the control class, the two data were expressed as nomal distributed.

Table 6. Class Ngain_Persen Group Statistics

	Class	N	Mean	Std. Deviation	Std. Error Mean
Ngain_Persen	= Experimental Class	22	62,3658	14,93011	3,18311
	= Control Class	22	31,3958	14,78829	3,15287

Table 7. List of Interpretations (%)

Percentage (%)	Interpretation
< 40	Ineffective
40 - 55	Less effective
56 - 75	Quite effective
> 76	effective

(Sumber : Hake, R.R, 1999)

Based on Table 7. The average score of the experimental class was 62.36% and the control class was 31.39%. By referring to the list of interpretation tables, the learning of the PjBL model in the experimental class falls into the category of quite effective. As for the learning control class with conventional methods, it is categorized as ineffective. Statistically descriptive, it can be explained that there is a difference in the effectiveness of learning the PjBL model with

conventional learning from the value of learning outcomes of the Electrical Energy Conversion course of Electrical Engineering students.

c. Technology Media

Kegiatan Praktik

Figure 2. Solar Cell Technology Media

D. CONCLUSION

The success of learning in the Electrical Energy Conversion course is marked by increasing student learning outcomes. This PjBL learning model is stated to be quite effective in implementing the Electrical Energy Conversion course. This PjBL learning has advantages, which are able to improve students' creative thinking skills. In 4 aspects of creative thinking that are explored to students, it is stated to have a positive influence on learning outcomes. The aspect of student fluency has a high influence on the learning outcomes of the Electrical Energy Conversion course. Things that need to be considered in the success of PjBL learning are determined by the role of lecturers who have a creative way of thinking. Lecturers who are highly creative in learning have strategies and techniques in teaching by looking at student characteristics. This research can be further developed by exploring aspects of creative thinking that are not yet present in this study.

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