



Implementation of Problem-based Learning Models Using E-Modules in Software and Game Development Courses to Improve Student Learning Outcomes in Vocational High Schools

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ABSTRACT

The Covid-19 pandemic has encouraged the application of distance learning. E-Module is a teaching material that is used by teachers in conveying information/material that is independent. so that students can understand the material without the help of the teacher. Problems that occur in students of SMKN 5 Malang are students who are difficult and do not understand the material so that it needs to be overcome by implementing E-Modules with 2 models, namely Project Based Learning and Problem Based Learning. This research is in the form of an experiment that involves X PPLG 1 and X PPLG 2 SMKN 5 Malang . The results of this study indicate that there are differences in the learning outcomes of students who are given the treatment of Problem Based Learning and Project Based Learning. Based on the two learning models, the problem-based learning model has an average score that is higher than the project-based learning model, which is 85 compared to 73.61, so that problem-based learning in this case is better than project-based learning.

Keywords: *E-Module, Problem Based Learning, Project Based Learning.*

1. INTRODUCTION

Technological developments have become very rapid and have an impact on all fields. This development was due to the industrial revolution which pushed people to change. The change in question is in all aspects including the educational aspect. The COVID-19 pandemic also contributed to making changes to this aspect. The application of physical distancing means that teachers must be able to adapt to the way learning is done anywhere and anytime. The use of technology is one of the solutions for learning to be effective. Technology-based learning allows offline learning to be carried out online and is widely used in 21st century learning [1].

Learning at the beginning of the even semester in 2022 is carried out face-to-face with a limited time of 6 hours with a total of 50% of students.

This learning must also be supported by adequate facilities, for example smartphones and laptops. Both of these devices play an important role in the implementation of limited face-to-face learning. Through these devices, students and teachers can conduct face-to-face meetings, assignments, and assessment of student learning outcomes. Face-to-face learning is limited to using smartphones more because these devices are practical and can be taken anywhere. Learning via smartphones is known as mobile learning or can be interpreted as learning using a mobile device [2].

Fundamentals of Software Development and Games (DDPPLG) is a productive Subject where students are more active in learning and usually take the form of practicum. In limited face-to-face learning for the DDPPLG Subject, the material is uploaded on Google Classroom. A mobile device is a device that can be taken anywhere. This is considered more effective when

used as the main learning tool. In addition, the operating system contained in these devices is important in mobile learning. Mobile learning is currently used in several educational institutions, including vocational schools [3]. Therefore learning can be maximized by using E-Module media. The subject (mapel) Fundamentals of Software Development and Games is one of the productive subjects in the Software Development and Games SMK department where the curriculum used already uses the latest curriculum, namely SMK – PK (Center of Excellence). SMK has a goal to prepare students for the world of work. Therefore, online learning is implemented using Google Classroom media with material uploaded on that media. The application through this media is not good, it is marked by the difficulty for students to understand the material in the media [4].

Based on the initial research that was conducted on 59 respondents from 3 SMKs in Malang, namely: SMK 5, 7, and 8 it was found that most students during face-to-face learning were limited to using smartphones with 4 GB of RAM. Apart from smartphones, students also need a stable internet connection to support limited face-to-face learning activities. Activities carried out face-to-face are limited on average by utilizing Google Classroom learning facilities with E-Modules in them [5]. The problem that occurs in DDPPLG learning is that students are less than optimal in capturing the material explained by the teacher. This is also due to the lack of depth of material and explanations provided by the teacher.

E-Modules are expected to be a solution for limited face-to-face learning using online forums such as WhatsApp and make it easier for students to understand the material presented by the teacher. E-module can also be interpreted as a flipped classroom because of its flexibility in use which can be used at home or at school. Over time, the flipped classroom approach has gained popularity, especially in educational institutions which emphasize more individualized learning for students [5].

Based on the presentation of the results of the initial research, it was found that most students used smartphones with an average RAM of 4GB with a minimum OS of Android 8 and IOS 12. The learning carried out at SMKN 5 MALANG was good, but there were several obstacles that students felt during learning, including material and connection. The material distributed by the teacher can be understood by students in the sufficient category as much as 54.2% with a total of 32 respondents from 59 respondents. The connection used is fairly good at 47.5% with a total of 28 respondents from 59 respondents. This study uses Problem Based Learning learning in the implementation of learning activities will be applied to experimental research. Problem Based Learning as a learning technique begins by offering problems to students,

where these problems are experienced or are students' daily experiences [7]. Problem Based Learning in its implementation involves a small group of students which involves all students in the learning process. Students can channel and enhance their strengths such as communication, teamwork, and problem solving skills by involving them in the process and holding them accountable for their learning [8].

Media comes from the word *medius* which means distributor of information. Learning media is something that provides information from sources to recipients. Learning Media can function to help advance student learning, but it is also beneficial for teacher teaching. Media is divided into 3, including visual, audio, and audiovisual media. Learning media must be adapted to existing field conditions in order to achieve effective and efficient learning.

E-Module is a media that is used independently by students to learn without the help of educators. The E-Module contains assignments that must be done by students complete with instructions. Student work results then discussed and presented. E-Module can be applied using Project Based Learning and Problem Based learning models Learning and unlimited time. Students can study material anywhere anytime as instructed and it can produce results Study student increase [9].

There are studies of long-term improvement in learning outcomes using E-Modules. In addition, the assessment method needs to be aligned with the intended results in order to evaluate the effectiveness of the teaching methodology. Learning outcomes show how well students understand translating human language into computer language and vice versa [10], [11].

In this study, student learning outcomes were obtained before treatment, namely by using the pretest and compared with after treatment, namely by Post-Test.

2. METHOD

2.1. Research design

Research using Quasi Experiment design. Quasi Experiment is a research design in which the subjects do not use random subjects, but the subjects already exist in each class. The research design is the Non-equivalent Control Group Design, which is a type of Quasi Experiment design, used in the experimental design of this study. The goal is to facilitate research. This study involved 2 class X at SMKN 5 MALANG class X PPLG 2 as the experimental class with special treatment, namely the application of E-Modules using Problem Based Learning and class X PPLG 1 as the control class with special treatment, namely the application of E-

Modules using project based learning models. Here is the design study.

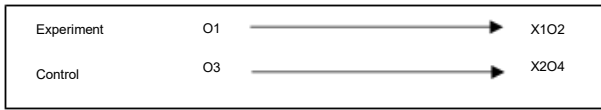


Figure 1 Research Design

Note:

- O1: The ability of the experimental class before being given treatment.
- O2: The ability of the experimental class after being given treatment.
- X1: E-Module treatment with a problem-based learning model
- X2: Treatment E-Module with project-based learning model.
- O3: Ability class control before being given treatment.
- O4: Ability class control once given treatment.

2.2. Sample and Research Population

Borg and Gall in the journal by [12] stated that experimental research requires a sample of 15-30 respondents for each group. This research was conducted at SMKN 5 MALANG with the subject of class X RPL students. This study used a sample of 15 students from 36 students per class. The steps used on this research:

- 1) Conduct a literature review, especially related to the problem under study
- 2) Identify and delimit the research problem
- 3) Formulate research hypotheses
- 4) Determine the independent and dependent variables, namely the variables whose changes are measured after the treatment.
- 5) Providing Pretest Questions in the form of case studies to prospective subjects. Prospective subjects in this study were students of class X PPLG SMKN 5 MALANG.
- 6) Record the acquisition value of the Pretest conducted by prospective subjects.
- 7) Implementing Learning
- 8) Giving Posttest Questions to research subjects
- 9) Record Results

2.3. Research design

The dependent variable of this research is the Application of E-Modules. The research was carried out by giving a pre-test then carried out the treatment and finally the implementation of the post-test. The results of the pre-test and post- test were compared to find out how much improvement had been made in Problem Based Learning and Project Based Learning.

2.4. Test Items

2.4.1. Instrument Validity Test

Validity Test is the form of testing conducted to find out the research instrument can be used (valid) or not. The validity results are obtained from the validator's assessment. Results obtained from the suggestions and criticisms of experts, the media material was analyzed qualitatively and results measured using *Likert scale* following.

Table 1. Instrument Validity Criteria

Score	Criteria
5	Very Good
4	Good
3	Enough
2	Not enough
1	Very Not Enough

2.4.2. Test Validity Question Items

Test the Validity of the Items to test the Pre - Test Post - Test in the instrument use Pearson correlation. grain matter can valid if > r table.

$$r_{xy} = \frac{N(\sum X \sum Y)}{\sqrt{\{(N\sum X^2 - (\sum X)^2)(N\sum Y^2 - (\sum Y)^2)\}}}$$

Note:

- r xy : The ability of the experimental class before being given treatment.
- Σ X : The ability of the experimental class after being given treatment
- Σ Y : E-Module treatment with a problem-based learning model
- Σ X 2 : Treatment E-Module with models project-based learning
- Σ X 2 : Ability class control before being given treatment
- Σ X Y : Ability class control once given treatment
- N : Sample

2.4.3. Test Reliability

Reliability testing is calculated using the alpha formula from Cronbach, as stated [13].

$$r = \left[\frac{k}{n} \right] \left[1 - \frac{\sum \phi_n^2}{n} \right]$$

note:

- r 11 = reliable instrument k
- Σ Ø n 2 = number of item variances Ø 1 2
- r 11 = reliable instrument k
- Σ Ø n 2 = number of item variances Ø 1 2

2.4.4. Test Power Differentiator

The discriminating power test is to measure the items in order know ability when differentiating high and low ability students [14] is presented on the following formula.

$$DB = \frac{\sum T_B}{\sum T} - \frac{\sum R_B}{\sum R}$$

note:

- DB = Discriminating Power
- $\sum T_B$ = Number of high ability participants who answered correctly
- $\sum T$ = Number of participants with high abilities
- $\sum R_B$ = Number of low ability participants who answered correctly
- $\sum R$ = Number of low ability participants

2.4.5. Test Level Difficulty Question Items

To find out the difficulty of a question, it is necessary to test it with the following formula.

$$TK = \frac{\sum B}{\sum P}$$

note:

- TK = Difficulty Level
- $\sum B$ = Amount student answer Correct
- $\sum P$ = Total participant test

The categories in this difficulty level test include Difficult, Medium, and High which are presented as follows.

Table 2. Difficulty Level of Question Items

Range	Category
0.00 – 0.32	Hard
0.33 – 0.66	Medium
0.67 – 1.00	Low

2.5. Prerequisite Analysis Test

2.5.1. Normality Test

The use of the normality test is used to determine whether a data set is normal or not. The purpose of using this test is to determine the second posttest data normal group or not, to determine the next step (parametric or non-parametric). Test normality data using the Shapiro – Wilk test formula. If mark significance ≥ 0.05 so data stated normal.

$$W = \frac{(\sum a_i x_i)^2}{\sum (x_i - \bar{x})^2}$$

note:

- W = Statistical Value of Shapiro – Wilk
- a_i = Shapiro – Wilk test coefficient

- x_i = i-th sample data
- \bar{x} = average sample data

2.5.2. Homogentiy Test

When two or more samples from the same population are compared, the homogeneity test is used. The following is formula homogeneity test by [15].

$$F = \frac{SA^2}{SB^2}$$

note:

- SA² = Biggest variance
- SB² = Smallest variance

If p-values $\geq \alpha = 0.05$ on mark significance 5% , so data the homogeneous. If price F count $< \text{or} = F$ table on level 5% ($= 0.05$) with et al on the numerator ($dk1 = n1 - 1$) And etc. on the denominator ($dk2 = n2 - 1$) , then H₀ accepted, data second own variant The same, If mark F count $>$ from F table , so H₀ rejected [16].

2.6. Prerequisite Analysis Test

2.6.1. Normality Test

The purpose of using this test is to determine whether the posttest data for both groups is normal or not, for the next step (parametric or non-parametric). Test normality data using the Shapiro – Wilk test formula. If mark significance ≥ 0.05 so data stated normal.

$$W = \frac{(\sum a_i x_i)^2}{\sum (x_i - \bar{x})^2}$$

note:

- W = Statistical Value of Shapiro – Wilk
- a_i = Shapiro – Wilk test coefficient
- x_i = i-th sample data
- \bar{x} = average sample data

2.6.2. T-Test

The T test is carried out if the distribution of the data is normal. The t test used is the paired sample t test. If the distribution is abnormal, then proceed with the Wilcoxon or Mann-Whitney test. The paired sample t test is presented in the following formula [17].

$$t_{hit} = \frac{D}{\frac{SD}{\sqrt{n}}}$$

note:

- t hit = mark t count
- D = average difference in posts test
- SD = Standard Deviation difference of Post - Test

N = Amount Sample

3. RESULTS

The data obtained is presented and analyzed. There are results of data analysis as follows.

3.1. Learning Outcomes

In this study improve learning outcomes in class X PPLG 2 with Problem Based Learning. The following is a description of the test results for class X PPLG 1 and X PPLG 2.

Group Statistics					
	Model Belajar	N	Mean	Std. Deviation	Std. Error Mean
Pos_tes	PJBL	15	80.3333	7.18795	1.85592
	PBL	15	91.6667	6.45497	1.66667

Figure 2 Description of posttest results after treatment

Based on the picture above, the results of X PPLG 2 using Problem Based Learning increased to 91 and in class X PPLG 1 with Project Based Learning it only increased to 80.3. The Normality test uses the Shapiro Wilk test with the following significance values.

Tests of Normality							
Model Belajar	Kolmogorov-Smirnov ^a			Shapiro-Wilk			Sig.
	Statistic	df	Sig.	Statistic	df	Sig.	
Pre_Tes PJBL	.183	15	.188	.939	15	.369	
PBL	.233	15	.027	.913	15	.149	

a. Lilliefors Significance Correction

Figure 3 Normality Test

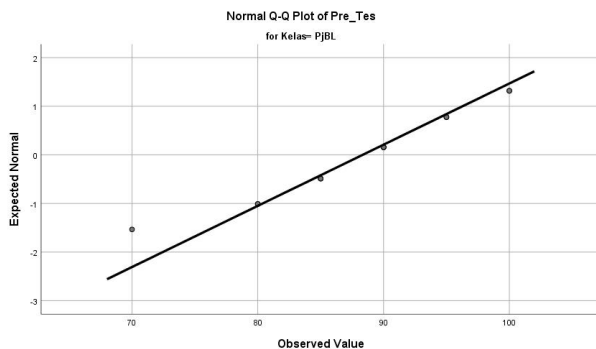


Figure 4 PjBL Pre-test Plots

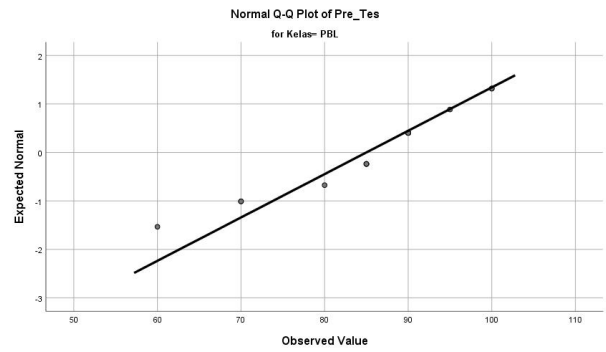


Figure 5 PBL Pre-test Plots

The normality test above uses the Shapiro Wilk test with a significance value of >0.05, which means that the data is normally distributed. It is known from the distribution close to the line. Furthermore, the homogeneity test was carried out using Levene.

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Pre_Tes	Based on Mean	.741	1	28	.397
	Based on Median	.927	1	28	.344
	Based on Median and with adjusted df	.927	1	25.950	.345
	Based on trimmed mean	.818	1	28	.374

Figure 6 Homogeneity Test

The homogeneity test got a result of 0.397 which means the data is homogeneous because it is > 0.05.

The next test is the Difference Test using the t-test. The t-test performed was the paired sample t-test. The t-test is presented in the following figure [18].

Table 3. T-test Result

Range	Levene's test	T-test
	Sig.	Sig. (2-tailed)
Post-test	0.743	0

T test is used to determine whether the hypothesis is accepted or not. This can be seen from the significance of the Levene test. In the table above the significance value of the T test is 0. So it can be concluded that H0 is rejected and Ha1 is accepted.

4. DISCUSSION

The application of Project Based Learning and Problem Based Learning at X PPLG SMKN 5 Malang has a positive impact on student learning outcomes [19]. This can be seen from trials conducted on 36 children with a sample of 15 children per class. The students in this study were students in class X PPLG 1 and X PPLG 2. The implementation of the 2 models had different improvements. The improvement in class X PPLG 2 using Problem Based Learning was greater than that in

class X PPLG 1. Learning outcomes were measured from the scores obtained from the pre-test and post-test and then compared. The question indicators are as follows.

Table 4. Pre-test and Post-test Indicators

No	Sig.	Items
1	Analyze Program Code	4
2	Able to apply the rules of the programming language	4
3	Able to declare code	4
4	Able to solve problems in code	4
5	Specifies the output of the code	4
Total		20

The number of items used in the pre-test and post-test is 20 items with the arrangement based on the table above. In class X PPLG 1, the average score on the pre-test was 70.83 and X PPLG 2 got a score of 70.69. Improved learning outcomes were obtained in X PPLG 2 using Problem Based Learning better than class X PPLG 1, namely from 70.69 to 85 in 36 students and to 91.67 from a sample of 15 students.

5. CONCLUSION

5.1. E-Module

In this study improve learning outcomes in class X PPLG 2 with Problem Based Learning. The following is a description of the test results for class X PPLG 1 and X PPLG 2.

E-Module as a learning tool for class Ten PPLG 1 and Ten PPLG 2 SMKN 5 Malang can increase students' understanding of the program code. This can be proven by the increasing average score of students in each class. E-Modules are made using A4 format. In the E-Module there are several materials including forms, repetition and combining with arrays and branching. Each material is equipped with a way of writing program code, materials, exercises, and there are also discussions and assignments. Discussions on the E-Module are carried out online and offline. Online discussions are carried out via WhatsApp and face-to-face offline [20].

5.2. Learning Model

The learning model is an important component of supporting delivery material to students comfortably during learning. models on this study uses Problem Based Learning (PBL) and Project Based Learning (PjBL). Based on this model, Problem Based Learning has the increase in the average value is higher than Project Based Learning, namely from 85 become 91.66667 from a sample of 15 students.

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