Project-Based Learning as Implementation of The Independent Learning Curriculum in Mathematics

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Abstract. The independent learning curriculum used by the Indonesian government since the 2021/2022 academic year to presents is challenges teachers in managing learning. The learning process as a form of providing learning experiences for students must fulfill the characteristics of independent learning curriculum, namely being able to develop students' soft skills and character, focusing on essential material and packaged in flexible learning. In this study, a project-based learning was used in learning mathematics to provide learning experiences according to the characteristics of the independent learning curriculum. This research was conducted on class VIII with a total of 25 students of junior high school. Based on the results of the study, among activities in project-based learning, individual activities have a direct influence on student learning outcomes compared to group activities. Project scores that show the group activities have very small effect on individual scores and student learning outcomes. This shows that the application of group work among students needs to be increasingly considered, considering that students' skills in group work are decreasing.

Keywords: project-based learning, group assessment, individual assessment, learning outcomes.

1 Introduction

The concept of the independent learning curriculum leads to project-based learning which aims to develop soft skills such as leadership, integrity, communication skills and good teamwork, as well as forming character that is in accordance with the Pancasila student profile [1]. The independent learning curriculum gives schools the freedom to develop a curriculum that is more appropriate to the needs of students and the surrounding community [2]. With this freedom, schools can develop a mathematics curriculum that is more oriented towards the application of mathematics in real life, so that students will better understand the use of mathematics in daily life.

Mathematics education plays an important role in the development of technology and innovation in the modern era. Through good mathematics education, students will be able to understand the mathematical concepts needed in technology development and innovation needed in this era. Mathematics learning with the independent learning curriculum can help produce graduates who have skills better math [3]. By developing a more advanced mathematics curriculum relevant to society's needs and more oriented

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towards the application of mathematics in real life, students will more easily understand mathematical concepts and apply it in real situations. Apart from that, learning mathematics with the independent learning curriculum can also help increase student creativity to solve the problem [4].

Project-based learning is a learning method that has been widely developed in developed countries such as the United States. Project based learning is an innovative learning method, which emphasizes contextual learning through complex activities. Project Based Learning is learning that places more emphasis on solving authentic problems that occur every day through direct practical learning experiences in the community. Project-Based Learning can also be interpreted as project-based learning, experience-based education, authentic learning that is rooted in real life problems [5] – [7]. Gijbels [8]states that Project Based Learning is used to refer to many contextualized approaches to instruction that anchor much of learning and teaching in concrete. This focus on concrete problems of initiating the learning process is central in most definitions of Project Based Learning [9].

The advantages of the Project Based Learning method are [10]: (1) Training students to use reasoning in solving problems; (2) Train students in making hypotheses in solving problems based on simple concepts; (3) train critical and contextual thinking skills with real problems faced; (4) Training students to carry out trials in proving hypotheses; (5) Training in decision making regarding problem solving by: (a) Encouraging students to participate actively and concentrate in discussions; (b) Stimulate students to think by returning questions to them; (c) Encourage students to make problem analysis, problem synthesis, carry out evaluations, and compile a summary of evaluation results; and (d) Helping students identify sources, references and principles (material) when studying problems and alternative problem solutions.

The aim of this research is to determine the effect of applying the project-based learning method on mathematics learning regarding linear equations by using 2 projects to assess individual students' knowledge. By separating treatment of groups and individuals, researchers want to know the direct or indirect influence of the project-based learning method in mathematics learning process.

2 Methods

The research method used in this research uses a quantitative approach with linear regression analysis as shown in figure 1. Each variable in figure 1 represents:
x_1: student scores on project 1
x_2: student scores on project 2
y: students daily test scores
z: student learning outcomes

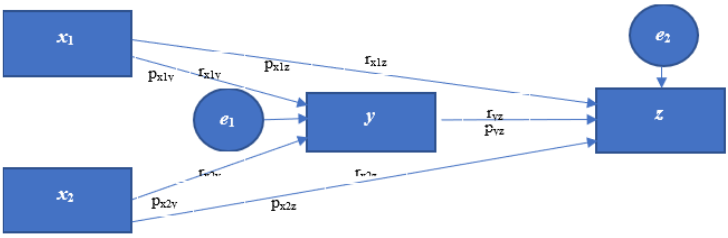

Fig. 1. Linear regression analysis models.

The linear regression analysis model is used to analyze the pattern of relationships between variables with the aim of determining the direct or indirect influence of a set of independent variables on the dependent variable[11]. The advanced linear regression analysis model discussed is a pattern of cause-and-effect relationships. Therefore, the formulation of the research problem in the linear regression analysis framework only revolves around the independent variables (x_1, x_2, y) to the dependent variable z (fig. 1). This research involved a learning process over 5 meetings using 1 class as an experimental class containing 25 students at Mts Darul Muawanah Jombang. The project-based learning method was used as a treatment given to the experimental class to determine both direct and indirect effects. The data in this research is a student scores in the form of two project scores (group evaluation), one daily test score (individual evaluation) and one student learning outcome. All the data collect by instrument that is valid and reliable such as project evaluation as the team scores, individual examinations as individual scores and midterm examination as student learning outcome. There are 2 models that we can get from the Fig. 1 as the structural models. From those models we can see if there are indirect effect that cause by project score into the learning outcomes scores.

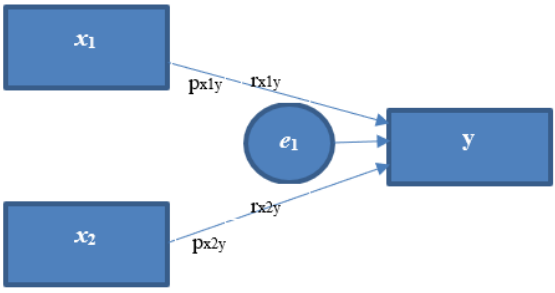

Fig. 2. Linear regression as model 1.

Linear function for model 1 is

$$y = p_{x_1 y} x_1 + p_{x_2 y} x_2 + e_1 \quad \text{...(1)}$$

The research hypothesis to be tested in model 1 is as follows:

1) H_1: There is a direct relationship between project 1 scores to individual scores

H_2: There is a direct relationship between project 2 scores to individual scores

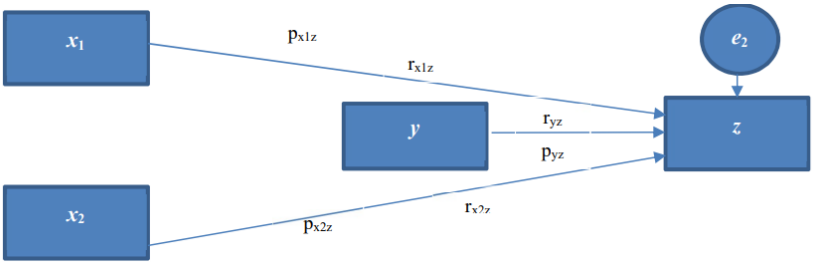

Fig. 3. Linear regression as model 2.

Linear function for model 2 is

$$z = p_{x_1 z} x_1 + p_{x_2 z} x_2 + p_{yz} y + e_2 \quad ...(2)$$

The research hypothesis to be tested is as follows:

1) H_1: There is a direct relationship between project 1 scores and student learning outcomes
2) H_2: There is a direct relationship between project 2 scores and student learning outcomes
3) H_3: There is a direct relationship between individual scores and student learning outcomes
4) H_4: There is an indirect relationship between project 1 scores and student learning outcomes through individual scores
5) H_5: There is an indirect relationship between project 2 scores and student learning outcomes through individual scores

3 Result

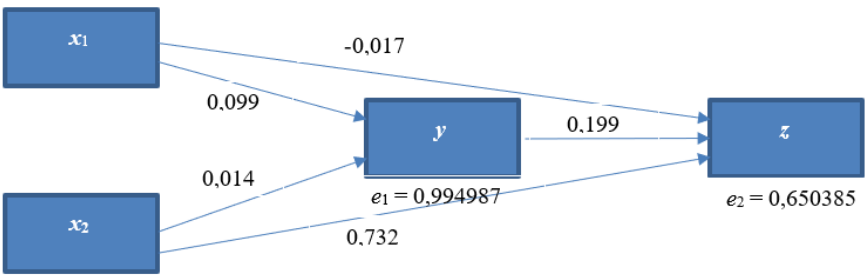

Fig. 4. Research result using regression analysis.

Before data analysis or statistical calculations from figure 4 are carried out, the normality assumption test, linearity test, autocorrelation test and multicollinearity test are first carried out. These four tests are requirements before proving the research hypothesis [11], [12]. This is part of parametric type inferential statistics which can only be used if the analysis requirements are met. Tranmer [13] stated that there are five assumptions that must be met to use path analysis, namely: (1) The relationship between variables in the linear model, additivity, has no interaction and causal effects; (2) All residual variables (which are not measured) are not correlated with any of the variables that build the model; (3) There is recursive, all arrows have one direction, no turning back; (4) The variables measured are on an interval scale; and (5) Variables are measured without error.

1. Data Normality Test. In this test the Kolmogorov-Smirnov Z test is used with the following test criteria:
   a. If the value of Asymp. Sig. (2-tailed) > 0.05 or equals to 0.05, then the data is normally distributed.
   b. If the value of Asymp. Sig. (2-tailed) < 0.05, then the data is not normally distributed.

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		25
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	4.36402367
Most Extreme Differences	Absolute	.096
	Positive	.071
	Negative	-.096
Test Statistic		.096
Asymp. Sig. (2-tailed)		.200[c,d]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.
d. This is a lower bound of the true significance.

Fig. 5. SPSS output for Normality Test.

Based on the calculation results at fig 5, the sig value of 0.200 is greater than the significance level of 0.05, so the data is normally distributed.

2. Regression Linearity Test. The linearity test aims to find out whether two variables have a linear relationship or not significantly. This test is usually used as a prerequisite in correlation or linear regression analysis. The linearity test is carried out by looking for the equation of the regression line of the independent variable on the dependent variable. Linear regression can be used if the linearity assumption can be met. The linearity assumption is an assumption that will ensure whether the data we have conforms to a

linear line or not. In this test, the F test (ANOVA) was used with the following test criteria:

a. If the Sig value >0.05 then the regression is not significant.
b. If the Sig value <0.05 or the Sig value=0.05, then the regression is significant.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	623.087	3	207.696	9.542	.000[b]
	Residual	457.073	21	21.765		
	Total	1080.160	24			

a. Dependent Variable: Hasil Belajar (Z)
b. Predictors: (Constant), Nilai Individu (Y), Proyek 1 (X1), Proyek 2 (X2)

Fig. 6. SPSS output for linear regression model.

Based on the calculation results at fig 6, the sig value of 0.000 is lower than the significance level of 0.05, means linear regression model.

3. Autocorrelation Test. The autocorrelation test was carried out to ensure that the variables Endogenous in path analysis do not correlate with each other, because if there is a strong correlation, then autocorrelation will occur so that testing the influence of endogenous variables on exogenous variables will be disturbed and the results less accurate. The criterion for this test is that the d value ranges between 0 and 4, namely $0 \le d \le 4$. Autocorrelation will not occur if $d = 2$. In this test, we have 2 model regression as shown in table 1 below.

Table 1. Durbin Watson value of each model.

Model	Independent variable	Dependent variable	DW
1	x_1, x_2	y	2.461408
2	x_1, x_2, y	z	1.975791

It turns out that the Durbin-Watson coefficient are close to 2. Thus, it can be concluded that in the regression between the independent variable and the independent variable, there is no autocorrelation.

4. Multicollinearity Test. Multicollinearity occurs when two variables are exogenous or have a very strong relationship or correlation. So, the influence of these variables is difficult to distinguish. The criteria used are: if the VIF value is around 1 or has a tolerance close to 1, then it is said that there is no multicollinearity problem in the regression model.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	T	Sig.	Tolerance	VIF
1	(Constant)	68.584	62.167		1.103	.282		
	Proyek 2 (X2)	.044	.641	.014	.068	.946	.998	1.002
	Proyek 1 (X1)	.081	.173	.099	.468	.644	.998	1.002

a. Dependent Variable: Nilai Individu (Y)

Fig. 7. SPSS output for Model 1.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-17.406	39.675		-.439	.665		
	Proyek 2 (X2)	.558	.398	.199	1.402	.175	.998	1.002
	Proyek 1 (X1)	-.013	.108	-.017	-.122	.904	.988	1.012
	Nilai Individu (Y)	.680	.132	.732	5.133	.000	.990	1.010

a. Dependent Variable: Hasil Belajar (Z)

Fig. 8. SPSS output for Model 2.

It turns out that the VIF value is close to 1 for all independent variables. Likewise, the tolerance value is close to 1 for all independent variables. Thus, it can be concluded that in the regression between the independent variable and the dependent variable, there is no multicollinearity between the independent variables.

Because the four prerequisites have been fulfilled, the regression model obtained can be used. There are two regression models obtained, namely model 1 which is composed of the independent variables project scores 1 (x_1) and project scores 2 (x_2) on individual scores (y). Model 2 is composed of the independent variables variables project scores 1 (x_1), project scores 2 (x_1), individual scores (y) on learning outcomes (z). From calculating the correlation between variables, the correlation matrix between all variables is obtained as table 2.

Table 2. Correlation value of each variables.

r_{ij}	x_1	x_2	y	z
x_1	1	-0.47	0.010	0.207
x_2	-0.47	1	0.099	0.046
y	0.010	0.099	1	0.732
z	0.207	0.046	0.732	1

Coefficient p is used to test research hypotheses with the following decision-making criteria:

a. If the p_{ij} value is < 0.05 or equals to 0.05 (the path coefficient p_{ij} is not significant) then H_0 is accepted and H_1 is rejected.
b. If the p_{ij} value is > 0.05 (the path coefficient p_{ij} is significant) then H_0 is rejected and H_1 is accepted.

From fig 4, we can construct the model 1 and model 2 by

$$y = 0.099x_1 + 0.014x_2 + 0.99495$$

$$z = -0.017x_1 + 0.732x_2 + 0.199y + 0.65038$$

First models show that project score give direct effect to individual score. Otherwise, second models show that project 1 give negative effect to learning outcome.

4 Finding and Discussion

Based on the results of the correlation coefficient calculation in table 2, it appears that not all variables have a significant influence. If an analysis is carried out on each variable, a significant influence occurs in project 1 on individual grades with 0.010 and project 2 on learning outcomes with 0.046.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.476	2	6.238	.111	.896[b]
	Residual	1240.664	22	56.394		
	Total	1253.140	24			

Fig. 9. F-test for model 1.

Model 1 regression analysis, fig 9, shows that project 1 and project 2 have a very small influence on individual grades, namely 1%. The results of the F test show that the significance value is 0.896, meaning the Sig value is >0.05, so it can be concluded that project 1 and project 2 simultaneously have no effect on individual scores.

Based on fig 7, the significance value of project 1 is 0.946, so the Sig value is >0.05. It can be concluded that the project 1 does not have a direct and significant effect on individual scores. The significance value of project 2 is 0.644, so the Sig value is>0.05. It can be concluded that project 1 does not have a direct and significant effect on individual values.

This can be interpreted as providing a project-based learning model, teachers should use individual assessment instruments in groups that can differentiate the results of project assessments carried out by students. Implementing projects in mathematics learning can be done not only by preparing media but also problems which are will be solved by the group. However, other forms of projects must also begin to be developed along with assessment instruments [14], [15].

Regression analysis in the second model shows that project 1, project 2 and individual scores have a significant direct influence on student learning outcomes. The magnitude of the influence given is 57.7%, quite large but with a project coefficient of 1 which is negative.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	623.087	3	207.696	9.542	.000[b]
	Residual	457.073	21	21.765		
	Total	1080.160	24			

Fig. 10. F-test for model 2.

The results of the F test, fig 10, show that the significance value is 0.000, meaning that the Sig value<0.05, so it can be concluded that project 1, project 2 and individual scores simultaneously influence learning outcomes.

Based on fig 8, the significance value of the individual scores is 0.000, so the Sig value<0.05. It can be concluded that project 1 has a direct and significant effect on learning outcomes. The significance value of project 1 is 0.175, so the Sig value is>0.05. It can be concluded that project 1 does not have a direct and significant effect on learning outcomes. The significance value of project 2 is 0.904, so the Sig value is>0.05. It can be concluded that project 1 does not have a direct and significant effect on learning outcomes.

The magnitude of the direct and indirect influence of each independent variable in model 2 is as shown in table 3 below. It appears that partially, the majority of independent variables have very little influence on the dependent variables. Implementing project-based learning in mathematics learning is not easy to do because teachers still focus on the material that must be understood through practice questions [15]. This causes students' constructive thinking to continue to be developed so that students can be more open in understanding the material provided [16], [17].

As mention in table 3, there are different magnitude of the influence of the independent variables on dependent variables. If the magnitude of the influence is very low (under 1%) then there is no influence of the independent variables to dependent variables. Even though only project 2 scores that show the highest magnitude of influence to learning outcomes, it will show different effect if the instrument was changing. Project-based learning, in the other side, show that social environment in mathematics lesson are still interesting dan challenging to be improved.

Table 3. The magnitude of the influence of the independent variables.

Independent variable	Dependent variable	Influence
Project 1 scores (x_1)	Individual scores (y)	0%
Project 1 scores (x_1)	Learning outcomes (z)	0.029%
Project 1 scores (x_1) through individual scores (y)	Learning outcomes (z)	0.033%
Project 2 scores (x_2)	Individual score (y)	0.001%
Project 2 scores (x_2)	Learning outcomes (z)	53.87%

Independent variable	Dependent variable	Influence
Project 2 scores (x_2) through individual scores (y)	Learning outcomes (z)	0.203%
Individual scores (y)	Learning outcomes (z)	4%

5 Conclusion

Based on the results of the analysis of model 1, it appears that there is no influence between the score of projects 1 and the score of projects 2 on individual scores. The magnitude of the influence of the score of projects 1 on the individual's scores is 0% and the magnitude of the influence of the score of projects 2 on the individual's score is 0.001%. This shows that the score of student projects should not only be based on the results of group work, but also based on individual performance within the group. Based on the results of the analysis of model 2, there is an influence of project 1, project 2 and individual scores on learning outcomes. Partially, the influence of project 2 scores on learning outcomes is 53%, while the influence of project 2 scores through individual scores on learning outcomes is only 0.2%. The influence of individual scores on student learning outcomes is 4%. This shows that the value of project 2 and individual scores have an influence on student learning outcomes.

Authors Contributions

Both authors were contributed to conceived and designed the analysis. The first Authors was contributed as data analysis to performed the result of this research. Contribution of the second Authors was collected the data and wrote the paper.

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