Original Paper

Using Project Based Learning (PBL) Design to Expand Mathematics Students' Understanding: A Case Study in Statistics Problem

Sugi Hartono[1*]

[1] Mathematics Department, Universitas Negeri Surabaya, Surabaya, Indonesia

[*] Sugi Hartono, Mathematics Department, Universitas Negeri Surabaya, Surabaya, Indonesia

Abstract

This paper describes some activities that the author has designed using Project Based Learning (PBL) to develop students' understanding of statistics. This study used a quasi-experimental method with a one group pretest-posttest quantitative research design. The subjects in this study are 30 students of class VII in SMP Negeri 6, Surabaya, Indonesia. The data collected using a questionnaire and a test. The validity of students' response used product-moment correlations and the reliability test used the Cronbach's Alpha formula, and the hypothesis was tested using the t-test (one sample t-test). The results showed that the positive response of students using PBL design to expand mathematics students' understanding of statistics, namely 85.83%. Furthermore, there was a difference in the students' learning outcomes before and after they learned through the PBL learning design, indicated by pretest the mean of score is 38.30 and a posttest mean score is 67.17. Besides that, $t_{observed}$ of pretest is 15.931 and $t_{observed}$ of posttest is 34.655, both are greater than t_{table} with a significant level α=0.05 is 2.042. Thus, we could be concludes that there as a difference the understanding of statistics students' outcome before and after learning with PBL design.

Keywords

project based learning, mathematics students' understanding, statistics

1. Introduction

Classroom learning should be an effort for students to be able to develop material revelation, increase knowledge, and knowledge will be used later for future life. But in fact, lately a lot of learning is more likely to be boring and less interesting, especially in junior high, Surabaya so that many students are

lazy in understanding the material and even prefer to turn away from learning by playing. In particular statistical materials, some students are lazy in calculating data especially if the data is large. This if left unchecked will have an impact on the decrease in the academic value of students.

Implementation of the model Based Project (PBL) is one alternative to overcome the above problems (Krajcik & Blumenfeld, 2006). The project-based learning model is one of the recommended of learning models in the implementation of curriculum 2013 in Indonesia. This is because PBL is a key strategy for creating independent thinkers and learners (Bell, 2010) and student-centered projects for active learning (Mosleh & Thom, 2017) that match the objectives of the 2013 curriculum. In addition PBL is also an innovative learning emphasizes complex activities with the goal of solving problems based on inquiry activities (Laviatin, 2008). Thompson and Beak (2007) also reported that they are students in a collaborative learning activity that challenges them as both individuals and group members. PBL allows students to learn by doing, applying their ideas while engaging in real-world activities through investigating questions, proposing hypotheses and explanations, discussing their ideas and finally developing solutions or outcomes (Diffily, 2002).

Some research results indicate that project-based learning has tremendous potential to train student' thinking processes (Thomas, 2000) that lead to students' creative thinking ability. So the students become enthusiastic in their learning, because the teacher acts as mediator and facilitator. The results of this study support the research conducted by Summers and Dickinson (2012) doing research and found that learners who learn to use project-based learning have higher learning achievement than the traditional learning. Leviatan (2008) also explained in his research that learning project-based is an innovative learning that emphasizes complex activities with the goal of solving problems based on inquiry activities. In addition, according to a study from Miswanto (2011) also shows that through a project-based learning model, students' learning outcomes on linear programming material become increasingly higher than before.

According to Markham et al. (2003), there are six aspects needed in PBL, namely: 1) authentic, real-world challenge; 2) academic all rigorous; 3) apply learning by using high-performances skills; 4) active exploration; 5) interact and make adult connections; 6) formal and informal assessment practices. Besides that PBL also allows students to investigate questions, propose hypotheses and explanations, discuss their ideas, challenge the ideas of others, and try out new ideas (Krajcik & Blumenfeld, 2006).

Using PBL in learning, it is expected that students better understand and know that the things learned related to real life around them so that the concept of statistics learned will be recorded more strongly in the memory of students and learning outcomes will be better. In addition, this project-based learning model is expected to improve student learning outcomes and improve the ability to solve daily problems related to the subject matter of statistics that has been received.

The purpose of this research is to describe the Project Based Learning (PBL) design of mathematics students' in learning statistics.

2. Method

2.1 Research Design

This study is a quantitative study with quasi experimental design using one-group pretest-posttest design that focuses on improving students' understanding in learning statistics to better outcomes before students get PBL learning. This research was conducted in class VII of SMP Negeri 6 Surabaya, Indonesia. This study is implemented for 2 months, February-April 2015.

2.2 Research Sample

The participants of the study were 1 class who were selected from cluster random sampling from 10 classes in the same grade from a junior high school at Surabaya city, Indonesia. The subjects in this study are 30 students of class VIIH, there are 15 are males and 15 are females. All students are in grade VII and aged between 12-13 years. Class VII H is the grade with the lowest average mathematics score compared to the other grade of the previous semester grade data.

2.3 Research Instruments and Procedures

The data collected using a questionnaire and a test. Pretest and posttest are the same questions consisting of 9 essays items. In our study, student activity categories to be observed include: 1) Listening or paying attention to teacher or friend explanations; 2) Observing, listening to, or view problems, events, or explanations in students worksheet; 3) Discussing or solving students worksheet or finding ways and answers in students worksheet; 4) Presenting the results of the discussion, providing feedback in groups; 5) Asking about the results of the discussion or observations to friends or teachers; 6) Making conclusions or summarize the learning materials in groups or together with teachers.

2.4 Data Analysis

The data analyses of our study are using validy, reliability, and hypothesis. The validity of students' response used product-moment correlations and the reliability test used the Cronbach's Alpha formula, and the hypothesis was tested using the t-test (one sample t-test).

3. Result

The results showed that the questionnaire of students responses filled by 30 students after following project-based learning on statistical materials obtained as follows:

Table 1. The Results of Response Students toward PBL Design

No	Responded aspect	Percentage (%)	
		Agree	Not Agree
1	The drawing on the students worksheet as an illustration allows me to better understand the given problem	100	0

100

2	Writing mathematical symbols in students worksheet does not make me dizzy	90	10
3	The language used on students worksheet is easy to understand	96.67	3.33
4	Asking questions given in any problem is made easy for me to do	90	10
5	The form of presentation of students worksheet made me interested to finish it immediately	70	30
6	The form of presentation of students worksheet can made me happy to finish it immediately	63.33	36.67
7	I easily understand the language, writing, and illustrations used in the test of learning outcomes	100	0
8	The form of presentation of students worksheet helped me to understand the concepts of materials being studies	76.67	23.33
	TOTAL	85.83	14.17

Based on the criteria of students' responses to instructional tools, it can be concluded that the overall percentage of students' responses to learning tools amounted to 85.83% which means that students' responses are positive to follow PBL lessons in statistics materials. The results of pretest before given PBL is presented in the following Table:

Table 2. Frequency Distribution of Student Learning Outcomes before PBL

The values	Frequency	Percentage (100%)	Information
0-20	4	13, 34	very less
21-40	13	43,33	less
41-60	11	36, 66	enough
61-80	2	6, 67	good
81-100	0	0	very good
Total	30	100%	

Based on the above table of 30 students who follow the learning there are 4 students or 13.34% which includes very less qualifications, there are 13 students or 43.33% which includes less qualification, there are 11 people 36.67% which includes enough qualification, and 2 persons or 6.67% good qualification. The overall average score is 38.3 and is in less qualification. While for posttest result data of student after given PBL is presented in the following Table:

Table 3. Frequency Distribution of Student Learning Outcomes after PBL

The values	Frequency	Percentage (100%)	Information
0-20	0	0	very less
21-40	0	0	less
41-60	8	26.67	enough
61-80	20	66.66	good
81-100	2	6.67	very good
Total	30	100%	

Based on the above Table of 30 students who follow the learning there are 8 students or 26.67% which includes sufficient qualification, there are 20 students or 66.66% which includes good qualification, and 2 persons or 6.67% including very good qualification. The overall average score is 67.2 and is in good qualification. Different test results of student learning before and after given project-based learning are as follows:

Table 4. Comparison of the Average Value of Pretest and Posttest

	Pretest	Posttest
Maximum value	62	88
Minimum value	17	50
Average	38.3	67.2
Standard deviation	13.1	10.6

Based on the above Table shows that the average value posttest results are higher than the average value of pretest results with a difference of 28.9. Improvement of learning outcomes can also be seen in t-test results that there are differences in student learning outcomes before and after learning using the PBL model, this is evidenced by the t-test as follows.

Table 5. The Results of T-Test

The value	Mean	$T_{observed}$	t_{table}	Significant	Sig (2-tailed)
Posttest	67.17	34.655	2.042	0.185	0.000
Pretest	38.30	15.931			

102

Based on the above table, the result of one sample t-test shows t-test pretest is 15.931, while $t_{observed}$ of posttest is 34.655. If the result of the calculation is compared with t_{table} (2.042) then t-test count is greater than price t table. Because $t_{observed}>t_{table}$ then there are differences in student learning outcomes before and after learning using PBL.

4. Discussion and Conclusion

Response is an idea or feeling of students after following the lesson. According to Poerwadarminta (2003), response means reaction or idea that is acceptance or rejection, as well as indifference to what is communicated by the communicator in the message. Student responses are traced through a questionnaire filled after students follow this PBL lesson. Based on the result, students' responses in PBL lessons in statistics materials is 85.83% which means that students' responses are positive.

Then we given the test, the average value of pretest results before the learning of PBL is 38.3 and the average value of posttest results after the learning of PBL is 67.2, of the two average scores are in good qualification. Based on the value seen difference, the average value after learning of PBL is better than the average value before learning of PBL.

Based on the above results, we can conclude that students' opinions about the use of project-based learning in improving students' mathematical understanding can be shown by the student's response is positive. While for difference of learning result of student before and after given PBL study can be shown with pretest average value is 38.30, mean value of posttest is 67.17. The difference in mean scores indicates that there is an increase in student learning outcomes. For test result $t_{observed}$ pretest and posttest value show bigger than t_{table}, that is t count pretest=15.931, t-count posttest=34.655, and t_{table}=2.042. Thus it can be concluded that there are differences in student learning outcomes before and after learning PBL, so that PBL can give effect to students' mathematical understanding so that student learning outcomes increase compared to previous tests.

References

Bell, S. (2010). Project-Based learning for the 21st century: Skills for the future. *The Clearing House*, *83*(2), 39-43. https://doi.org/10.1080/00098650903505415

Diffily, D. (2002). Project-Based Learning: Meeting Social Studies Standards and the Needs of Gifted Learners. *Gifted Child Today*, *25*(3), 40-43. https://doi.org/10.4219/gct-2002-69

Krajcik, J. S., & Blumenfeld, P. (2006). Project-based learning. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences*. NewYork: Cambridge.

Laviatan, T. (2008). Innovative Teaching and assessment Method: QBI and Project Based Learning. *Mathematics Education Research Journal*, *10*(2), 105-116. https://doi.org/10.1007/BF03217480

Markham, T. (2003). *Project based learning handbook: A guide to standards-focused project based learning for middle and high school teachers*. Novato, CA: Buck Institute for Education.

Miswanto. (2011). Penerapan model pembelajaran berbasis proyek pada materi program linier siswa

kelas X SMK Negeri 1 Singosari. *Jurnal Penelitian Dan Pemikiran pendidikan*, *1*(1), 1.

Mosleh, M., & Thom, M. (2017). *Design-Build, Project-Based Learning in an Engineering Materials Laboratory*. In ASEE Mid Atlantic Section Spring Conference, Morgan State University, Baltimore, Maryland.

Poerwadarminta, W. J. S. (2003). *Kamus Umum Bahasa Indonesia*. Jakarta: Balai Pustaka.

Summer, & Dickinson. (2012). A longitudinal investigation of project-based intruction and student achievement in high school social studies. *The Interdisciplinary Journal of Problem-Based Learning*, *6*(1), 82-103. https://doi.org/10.7771/1541-5015.1313

Thomas, J. W. (2000). *A review of research on project-based learning executive summary*. San Rafael, CA: The Autodesk Foundation.

Thompson, K. J., & Beak, J. (2007). The Leadership Book: Enhancing the Theory-Practice Connection through Project-Based Learning. *Journal of Management Education*, *31*(2), 278-291. https://doi.org/10.1177/1052562096297143