



Increasing the Students' Understanding of Analyzing Data Through Project-Based Learning

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Abstract. Statistics is a universal language in the modern association of the international community and as one of the main indicators of a nation's civilization. Because statistics are related to sample data, it is necessary to have the ability to interpret, understand and make good decisions on the data. However, most of the students still have difficulty in interpreting and analyzing the data, such as difficulty in choosing the right data processing technique that is relevant to the type of data, as well as errors in interpreting the results. The learning process that is suitable for overcoming the problems like this is project-based learning. The research that examines project-based learning has never discussed how to improve students' understanding of analyzing data, so this study wants to show that project-based learning can improve students' understanding of analyzing data. Data were collected through observations, questionnaires, project report documents, and tests given to seventy students taking statistics courses. The results of observations in class showed that students were very active in discussing, more skilled at communicating, very collaborative, and able to think critically in finding solutions. The results of the questionnaire showed that their learning motivation was high, most of the students agreed with this learning because it was very interesting, fun, and full of challenges. Reports on student project results show that they have performed well in analyzing data, namely understanding the types of data, selecting the appropriate statistical analysis, data processing procedures, and concluding. The students' test scores also increased.

Keywords: students' understanding · analyzing data · project-based learning

1 Introduction

Use of statistical science in research has been applied in all fields of science, even being used efficiently and continuously by companies in the world to obtain the best technology [1]. Statistics have become a necessity of civilization open-minded like reading and writing. Statistics is a universal language in the modern association of the international community and as one of the main indicators of a nation's civilization [2].

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M. L. Firdaus and A. Defianti (Eds.): MASEIS 2021, ASSEHR 718, pp. 265–272, 2023.

https://doi.org/10.2991/978-2-38476-012-1_34

Because statistics are related to sample data, it is necessary to have the ability to interpret, understand and make good decisions on the data. However, most students still struggle with understanding and analyzing data, such as picking the appropriate data processing procedures for the data type, as well as interpreting the results incorrectly [3].

Project-based learning (PjBL) is a constructivist approach that is suitable for solving complex problems in a creative, collaborative, and independent process and is known as a promising approach that can improve student learning outcomes in the Netherlands [4–6]. PjBL requires students to be engaged in employed on authentic projects and product development, thus having a more positive impact on student academic achievement than direct teaching. However, only 20% (6 of 30) of the studies reviewed were conducted in universities [7]. PjBL refers to an inquiry-based learning method that engages students in knowledge construction by asking them to complete meaningful projects and develop real-world products [8].

Research that examines project-based learning has never discussed how to improve the understanding of college students in analyzing data, which includes how to describe data, reduce data, represent data, and interpret data [9]. The ability of students to analyze data or have high statistical reasoning will have a positive impact on academic competence or student achievement [10]. PjBL techniques can increase student engagement by enabling knowledge and information sharing and discussion, so this learning approach is highly recommended for use in education by students and should be encouraged in universities [11, 12]. As a result, the goal of this research is to demonstrate that PjBL can boost students' activity, learning motivation, and comprehension of data analysis, all of which improve student learning outcomes.

2 Method

This study was guided in a large class with a total of seventy students (28 males, and 42 females), namely students taking statistics courses. The study was carried out by six times using the zoom platform by implementing the PjBL (3 times for cycle I, and three times for cycle II). PjBL learning carried out by students was: determining the topic of activities, making plans, collecting information from various sources, collecting case data related to the material, writing notes, and classifying the data obtained, communicating with lecturers associated activities that have been carried out, making reports in the form of presentations, carry out presentations, and record comments and suggestions from friends and lecturers. Furthermore, the data research collected included: student learning activity data using observation sheets, learning motivation data taken from results the questionnaire, student's understanding data analyzing data seen from project reports and learning outcomes are seen from post-tests.

2.1 Assessment of Students' Learning Activity

The students' learning activity is analyzed using intervals:

Activity score: $10 \leq x < 17$ less active

Activity score: $17 \leq x < 23$ quite active

Activity score: $23 \leq x < 30$ active [13].

2.2 Assessment of Learning Motivation

The students' learning motivation is seen from the results of the questionnaire with criteria: if the student answer yes given a score of 1, if answered is not given a score of 0 (consists of 6 statements), with the following evaluation interval:

Motivation scores: 0–2 low

Motivation scores: 3–4 enough

Motivation scores: 5–6 high [14].

2.3 Assessment of Project Result Report

Judging from four aspects, namely the ability to choose relevant statistical procedures, the ability to process data, the ability to interpret the results of processed data, and the ability to conclude the final results of data analysis activities (score using a scale of 0–100), with the following evaluation interval:

Score 0–24.9 very low understanding

Score 25–49.9 low understanding

Score 50–74.9 moderate understanding

Score 75–100 high understanding [15].

2.4 Assessment of Test Result

Student test results data were analyzed using the class average and classical learning completeness with the formula:

a. *Average Value*

$$\bar{X} = \frac{\sum X}{N}$$

with: \bar{X} = Average Value

$\sum X$ = Total of Score

N = Number of Student [16]

b. *Classical Learning Completeness*

$$CLC = \frac{TC \times 100\%}{N}$$

with: CLC = Classical Learning Completeness

TC = number of students who completed

N = Number of Student [17]

3 Result and Discussion

3.1 Score of Students' Learning Activity

Table 1 shows the score of students' learning activity:

Table 1 shows the score of students' learning activity have increased significantly from quite active in the cycle I became active in cycle II. It seems that students have actively collected data in the field according to the theme or problems that studied, the students was communicating with group friends, making the complete report, present the results of group reports, and make the final conclusions of the material.

3.2 Scores of Students' Learning Motivation

Table 2 shows the scores of students' Learning Motivation:

In both cycle, I and cycle II, the majority of students' learning motivation was high, as seen in Table 2. In the first cycle, 38 students (54.3 percent) showed strong learning motivation, while 60 students (85.7 percent) had high learning motivation in the second cycle. In cycle II, only one participant reported low learning motivation, accounting for 1.4 percent of the total.

Table 1. Scores of Students' Learning Activities

Observed Aspects	Cycle I			Cycle II		
	O-1	O-2	O-3	O-1	O-2	O-3
Students select and identify the problems	2	2	1	3	3	2
Students collect data in the field according to the theme/problems that studied	2	2	2	3	3	3
Students classifying data	1	2	2	2	3	3
Students collaborating and communicating with group friends	3	3	2	3	3	3
Students making notes or descriptions of the data collected	2	1	1	3	2	3
Students making the complete report	2	3	2	3	3	2
Students listen to the direction and guidance of the lecturer	3	3	3	3	3	3
Students reflect after receiving direction from the lecturer	2	2	3	3	3	3
Students present the results of group reports	3	3	3	3	3	3
Students make the final conclusions of the material.	2	3	3	3	3	3
Total	22	24	21	29	29	28
Average of Activity Score	22,33			28,67		
Criteria	Quite active			Active		

Table 2. Students' Learning Motivation

Score	Cycle I			Cycle II		
	Frequency	Percentage (%)	Description	Frequency	Percentage (%)	Description
0–2	9	12,8	Low	1	1,4	Low
3–4	23	32,9	Enough	9	12,9	Enough
5–6	38	54,3	High	60	85,7	High

Table 3. Understanding Score of Analyzing Data

Aspects assessed based on the project report	Achievement of the average score	
	Cycle I	Cycle II
Ability to choose statistical procedures that relevant to the case	67	85
Ability to process data according to the selected procedure	78	89
Ability to interpret the results of processed data	71	81
Ability to conclude the final results of data analysis activities	69	77
Average	71,25	83,00
Criteria	Moderate understanding	High understanding

Table 4. Description of Student's Test Results

Description	Cycle I	Cycle II
Minimum Score	63	70
Maximum Score	89	94
Variance	9,1	9,6
Average	67,2	84,1
Median	68,4	85,3
Classical Completeness	72,5	91,2

Table 3 shows that students' understanding of analyzing data increased from cycle I to cycle II. In the first cycle, the average score of student understanding is in the sufficient category, while in the second cycle it is in the high understanding category. The highest score is in the aspect of the ability to process data according to the selected procedure.

Table 4 shows that the average of students' test results has increased from the first cycle of 67.2 to 84.1 in the second cycle. The learning completeness also increased from

72.5% in the first cycle to 91.2% in the second cycle. This means that the application of PjBL learning can improve the students' test results.

PjBL is a constructivist technique that is suited for tackling difficult problems in a creative, collaborative, and independent way, according to research [18–21], which states that students are provided the stimulus to create new and solutions. Original to make effective decisions and achieve mutual objectives. Students are taught to actively participate and strengthen critical thinking skills through PjBL learning. Previous research, on the other hand, has only looked at the characteristics of student learning motivation and knowledge of data analysis in social studies. Encouraging learning activities and improving learning outcomes are critical in terms of motivation. Students' learning motivation is high with the implementation of PjBL learning.

Students are interested in studying statistics using the PjBL learning method, eager to re-read the recorded lessons, happy to complete the tasks given by the lecturer, feel disadvantaged if they do not participate in learning, and hope that the PjBL learning method will be maintained in class because students are easier to understand the material, especially when analyzing data, according to the questionnaire result. The majority of students support this learning because it is engaging, entertaining, and challenging.

Student project reports reveal that they did well in data analysis, including understanding the different types on data, selecting the proper statistical analysis, data processing techniques, and concluding. Students' test results improved as well. Students were able to discriminate between different forms of data and apply statistical approaches to diverse study topics. Students were also able to distinguish between independent and dependent sample groups, which they would apply to a variety of research scenarios. Active learning activities are those in which students are actively engaged in activities such as discussing, collaborating, and communicating with group friends, and collecting data in the field according to the project assignments that have been planned.

4 Conclusion

Students were very active in discussions, more competent at communicating, very collaborative, and capable of critical thinking to discover solutions, according to observation results. The findings of the survey revealed that their learning motivation was strong, with the majority of students agreeing that this learning was very fascinating, engaging, and challenging. Learning statistics becomes more real for pupils using PjBL, according to them, and helps them better understand statistical content. Student project reports reveal that they did well in data analysis, such as recognizing the different types of data, choosing the right statistical analysis, data processing techniques, and drawing conclusions. Students' test results improved as well.

Acknowledgments. We appreciate the academic staff at FKIP, Bengkulu University, for their assistance and cooperation in supplying academic data for this study.

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