

THE EFFECTIVENESS OF PROJECT-BASED LEARNING MODELS IN IMPROVING UNDERSTANDING OF STATISTICAL CONCEPTS

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Abstrak

Setiap mahasiswa di perguruan tinggi pasti akan mempelajari tentang statistika. Statistika merupakan pengetahuan mengenai pengumpulan data, klasifikasi data, penyajian, pengolahan, penarikan kesimpulan, dan pengambilan keputusan berdasarkan masalah tertentu. Dikarenakan statistik berkaitan dengan data sampel maka diperlukan kemampuan pemahaman dalam menafsirkan, memahami serta membuat keputusan yang baik terhadap data tersebut. Model Project Based Learning sangat cocok diterapkan untuk memecahkan masalah kompleks dengan cara yang kreatif, kolaboratif, dan mandiri seperti pada mata kuliah ini. Penelitian ini dilakukan untuk menganalisis efektifitas model pembelajaran PjBL dalam meningkatkan pemahaman konsep statistika. Subjek penelitian yaitu tujuh puluh mahasiswa yang mengambil mata kuliah statistika di Program Studi Pendidikan Matematika Universitas Bengkulu tahun 2021. Jenis penelitian adalah *quasi eksperiment* dengan menggunakan rancangan *one group pretest-posttest design*. Instrumen penelitian berupa lembar tes pemahaman konsep statistika, meliputi kemampuan memilih analisis statistika, kemampuan pengolahan data dan kemampuan menginterpretasikan hasilnya. Data dianalisis dengan menggunakan uji *t-paired sample* dan skor *N-Gain*. Berdasarkan hasil penelitian dapat disimpulkan bahwa penerapan model pembelajaran *Project Based Learning* cukup efektif untuk meningkatkan pemahaman konsep mahasiswa pada mata kuliah statistika di Universitas Bengkulu khususnya di program studi pendidikan matematika. Pemahaman konsep mahasiswa setelah diterapkan model PjBL lebih tinggi dibandingkan sebelum diterapkan PjBL.

Kata kunci: Pemahaman konsep, *project-based learning*, statistika.

Abstract

Every student in higher education will learn about statistics. Statistics is knowledge about data collection, data classification, presentation, processing, drawing conclusions, and making decisions based on certain problems. Because statistics are related to sample data, it is necessary the ability to interpret, understand, and make good decisions on the data. Project-Based Learning is very suitable to be applied to solve complex problems in a creative, collaborative, and independent way like in this course. This research is to analyze the effectiveness of PjBL learning in improving the understanding of statistical concepts. The research subjects were seventy students who took statistics courses at the Mathematics Education Study Program, Bengkulu University in 2021. This type of research is a quasi-experimental design using a one-group pretest-posttest design. The research instrument was a test sheet for understanding the concept of statistics, including the ability to choose statistical analysis, the ability to process data, and the ability to interpret the results. The data were analyzed using the *t-paired sample* test and the *N-Gain* score. Based on the results of the study, it can be concluded that the application of Project-Based Learning is quite effective in increasing students' understanding of concepts in statistics courses at Bengkulu University, especially in the mathematics education study program. Students' understanding of concepts after the PjBL model is applied is higher than before PjBL is applied.

Keywords: Concept understanding, *project-based learning*, statistics, effectiveness.



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INTRODUCTION

Mathematics is an branch of science that has a significant impact on people's life and serves as a foundation for other disciplines. Mathematics is one of the most important disciplines in schools, from elementary school to university, because of its importance (Yensy N. A., 2018). Because the subject provided in college mathematics is more abstract, it is more difficult to learn. One of the subjects studied at universities in each department is statistics. Statistics is knowledge about data collection, data classification, presentation, processing, drawing conclusions, and making decisions based on certain problems (Gundlach, 2015). This course focuses more on data processing practices and case studies, so it is more empirical. However, the facts on the ground show that students' understanding of statistical concepts is still low. They still have difficulty applying statistical procedures, especially in research involving many variables. In addition, students are still hesitant to interpret the results of data processing.

The learning model that is suitable for the characteristics of the course is project-based learning or PjBL for short (Prabowo, 2012). PjBL is a constructivist approach that is suitable for solving complex problems in a creative, collaborative, independent way, and is an approach that can raise quality of learning of university students in the Netherlands (Guo, 2020); (Torres, Sriraman, & Ortiz, 2017); (Rajan & Gopanna, 2019); (Rajan, Gopanna, & Thomas, 2019). In accordance with the results of research (Chiang & Lee, 2016) project-based learning can not only increase students' learning motivation but also facilitate their problem-solving abilities so that

this can provide real examples of PjBL to teachers.

PjBL encourages student engagement by allowing for knowledge exchange, information, and conversation, hence it is highly recommended for use in schools and colleges.(Almulla & Abdullatif, 2020); (Samsudi, 2019). Similar results by (Serin, 2019) concluded that the PjBL approach can enable students to discuss and work together and train them to think critically to solve problems. However, this is different from the results of research conducted by (Kizkapan & Bektas, 2017) that based on the structure of the content, there is no substantial difference in learning results between students who are given the PjBL approach and those who are given the standard approach.. Students and teachers must adapt before being given PjBL learning.

(Indrawan & Jalinus, 2018) have reviewed 15 articles of various research results related to the PjBL approach which students will learn to collaborate in groups, plan, organize, negotiate, and reach consensus on problems through project-based learning, according to the study. the tasks to be completed, who will be in charge of each activity, and how the data will be collected and presented in a scientific manner. This greatly affects the improvement of students' conceptual understanding. In line with 21st-century learning which advocates the use of a learner-centered learning approach, by incorporating aspects of knowledge and problem-solving skills in the real world both independently and with peers or educators, thus triggering students to think more critically.

In reality, most students still have difficulty understanding the concepts of statistical material, such as

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being inaccurate in interpreting or analyzing research data, including presenting data in the form of tables that are less meaningful (Yensy N. , 2019). Furthermore, (Yensy N. , 2020); (Chen & Yang, 2019) suggested that very few or only about 20% (6 out of 30) of studies on PjBL were reviewed in universities. Thus an understanding of mathematical concepts is very important to study. This is the reason to examine in more depth how the effectiveness of Project-Based Learning in improving students' understanding of concepts in statistics material.

METHODS

The type of research undertaken is quasi-experimental, which compares the learning outcomes of two separate class groups or two-time groups with the same class to see the effects of a treatment (Rukminingsih, Adnan, & Latief, 2020). The experimental group I (students used the conventional model, which was completed before the Mid-Semester Examination) and the experimental group II (students used the PjBL. model, which was completed after the Mid-Semester Examination) were employed in this study. As a result, the students in experimental group 1 and experimental group 2 were the same, but they studied at different times, namely before and after the mid-semester examination. As a result, the study used a one-group pretest-posttest design.

The research steps are as follows:

- a. Provide statistical material using conventional models for six meetings before students carry out the Mid-Semester Examination.
- b. Gives the Mid-Semester Exam test questions in the form of six Essay questions.

- c. Applying Project-Based Learning on simple and multiple linear regression material before the Final Semester Exam.
- d. Processing student project results related to their conceptual understanding.
- e. Gives the Final Semester Exam test questions in the form of seven Essay questions.
- f. Perform data processing on the results of the Mid-Semester Examination and Final Semester Examination.
- g. Doing hypothesis testing and make the conclusion.

The participants in this study were all fourth-semester students from Bengkulu University's Mathematics Education Study Program who took the Advanced Statistics course at the S1 level which amounted to 70 people. This is due to the fact that this class has an average value of learning outcomes that are generally similar. Because there are less than 100 people in the population, every single one of them is sampled. (Arikunto & Jabar, 2018). The results of the Mid-Semester Examination, namely for group 1, and the results of the Final Semester Examination, specifically for group II, were used to determine the students' concept knowledge. SPSS software is then used to process the data. (Machali, 2015) with the following steps:

1. Determines the mean, median, maximum, minimum, standard deviation, and skewness.
2. Examine the sample data for normality and homogeneity.
3. Calculate the average difference (using paired sample t-test). If the p-value (sig at output SPSS the PjBL model and after using the PjBL model meets the test conditions.

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Meanwhile, if the p-value (sig) is less than 0.05, there is no difference in students' conceptual knowledge before and after applying the PjBL model.

4. How to Work Out the N-Gain Score. If the paired-sample t-test reveals changes in students' knowledge of ideas before and after using the PjBL model, calculate the Gain score (N-gain), which is used to measure the success of the PjBL model.

$$N\ Gain = \frac{\text{posttest result} - \text{pretest score}}{\text{optimal score} - \text{pretest score}} \quad (1)$$

The maximum value that may be reached is known as the ideal score. Table 1 is the category of the N-gain score acquisition based on the N-gain expressed as a percentage.

Table 1. Interpretation of N-gain effectiveness

Percentage (%)	Description
< 40.00	Not Effective
40.00 – 55.99	Less Effective
56.00 – 75.00	Quite Effective
> 75.00	Effective

(Yensy N. , 2020)

RESULTS AND DISCUSSION

a. Concept Understanding Descriptive Analysis of Students

Table 2 are the findings of a descriptive examination of advanced statistics students' conceptual knowledge at Bengkulu University's Faculty of Teacher Training and Education's Mathematics Education Study Program.

Table 2. Description of student's concept understanding

Descriptive Analysis	Mid-Semester Exam Scores (before using the PjBL)	Final Semester Exam scores (after using the PjBL)
Minimum	59,00	70,58
Maximum	76,20	88,10
Standard Deviation	10,12	8,13
Mean	71,33	86,66
Median	68,07	85,14
Skewness	0,012	0,001
Varians	102,4	66,09

Table 2 shows that students' conceptual comprehension has improved from the Mid-Semester Examination (UTS) to the Final Semester Examination (UAS). On the other hand, the average student test scores after being taught using the PjBL Model climbed from 15.33 before being taught using the PjBL Model. Furthermore, the median value, which is nearly identical to the average, indicates

that the importance of students' conceptual comprehension tends to be in the middle of the data. The skewness value for both UTS and UAS is near to zero, indicating that the data on students' knowledge of ideas has a normal distribution descriptively.

Table 3 is the student's concept understanding score for each aspect of the assessment.

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Table 3. Student's concept understanding score during UTS and UAS

No	Aspects that are Assessed	Achievement Average score	
		UTS	UAS
1	Ability to choose statistical procedures that are relevant to the case	65	87
2	Ability to process data according to the selected procedure	76	89
3	Ability to interpret the results of processed data	70	86
4	Ability to conclude the final results of data analysis activities	68	85
Average		71,33	86,66
Explanation		Sufficient Understanding	High Understanding

It may be seen from table 3 that based on each aspect assessed, the achievement of the average score of student concept understanding always increases from UTS to UAS both in the ability to choose suitable statistical analysis techniques, the ability to process data, and interpret it and the ability to conclude in the data processing. The student's understanding of concepts during the Mid-Semester Examinations was in the sufficient category, while during the Final Semester Examinations the average score of students' understanding of concepts increased to be higher than before.

The data on pupils' conceptual comprehension was also checked for normalcy and homogeneity. The results of the two sample groups' data (UTS and UAS data) have a normal distribution (significance value = 0.643 more than alpha level 0.05) when utilizing the chi-square with the help of SPSS software. It was determined that both groups of data had the same variance or were homogenous using Fisher's test (significance value = 0.154 more than alpha level 0.05), hence the average difference was tested using the t-paired test.

b. Test of Average Difference (t-paired test)

The results of the average difference test utilizing the t-paired test obtained a significance value = 0.002 based on SPSS output, indicating that there is a significant difference in understanding the concepts of students who take advanced statistics courses before and after learning with the PjBL.

Furthermore, the N-gain Score indicates that the N-gain is 73.15 percent. This demonstrates that Project Based Learning is a good method for learning advanced statistics. Following with the opinion expressed by (Genc, 2015) that learning using the PjBL makes students more active and creative to explore information so that they try to find other learning sources to answer the problems asked, especially in the case of statistical data processing. Furthermore (Belagra & Draoui, 2018) also stated the same thing that the PjBL can motivate students to think more critically, independently and be able to work together with friends to solve problems or cases at hand. Students can be creative and provide ideas more easily than if they did not use Project-Based Learning. (Pitiporntapin & Kuhapensang, 2015) suggests that

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through project-based learning, students have direct experience to complete project activities in the real world, so that here they play the role of being a scientist to solve problems of everyday life related to the material being studied. Similarly, (Insani, 2018) states that PjBL learning can improve students' critical thinking skills and learning becomes more effective.

Although the results of this study found the fact that the PjBL learning model was more effective, there were still some weaknesses in learning, such as less efficient learning time, difficulty finding cases or topics relevant to the PjBL model, and less ability to observe student activities during learning, this is because their activities are mostly project activities, independent at home with their team. Following what was stated by (Sumarni, 2015) that the application of Project-Based Learning has its advantages and disadvantages. The strength in question is that the PjBL can increase student motivation and learning outcomes, improve collaboration and communication skills, increase creativity and literature study skills, create fun learning, improve problem-solving skills, and the ability to prepare learning resources. Furthermore, the weaknesses of the PjBL learning model include: it takes a lot of time to be devoted to solving complex problems and students who have no experience working in groups may have difficulty in negotiating and compromising.

The figure 1 is an example of an activity carried out when learning using the PjBL.

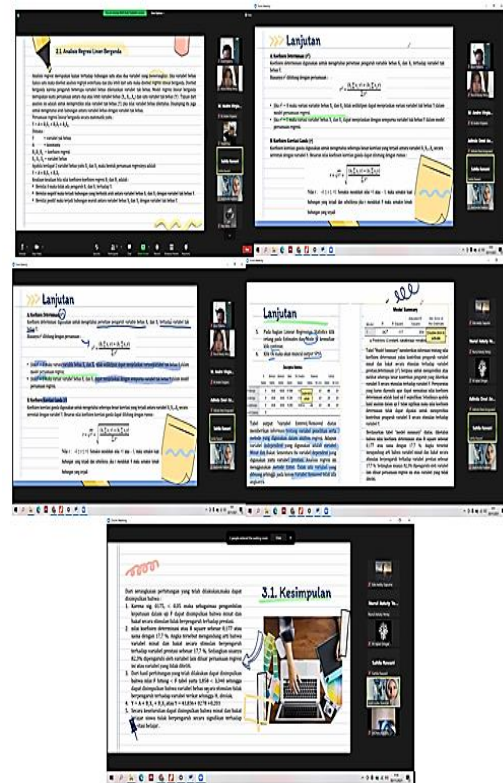


Figure 1. Student's Activities when presenting the Project Work

It may be shown in Figure 1 that students are presenting the results of their group work on multiple linear regression analysis via video conference or zoom meeting. There you can see how students present material systematically, from initial concepts about linear regression to case examples and data processing. They have been able to express their opinions or ideas based on their experiences and analyzed from various teaching sources. Furthermore, students are highly active in questioning and debating with lecturers content that they do not understand as well as data processing issues. Student activity can also be seen in the presence of students who are present on time when learning started. This is following what was stated by (Sadrina, Mustapha, & Ichsan, 2018) that the use of the PjBL learning paradigm helps pique students' interest

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and motivate them to learn so that they can discuss it with their peers and teachers. as well as foster students' critical thinking skills based on the experience they previously gained. The same thing was expressed by (Lee, 2015) that by allowing for knowledge exchange, information, and conversation, Project-Based Learning can boost student involvement. As a result, this method is highly recommended for students' educational use and should be supported in institutions. (Ismuwardani, Nuryatin, & Doyin, 2019) also said the same thing that Project-Based Learning is quite effective and has a significant effect on students' creativity and independence in learning so that students become more active in learning.

Based on the preceding description, it can be concluded that implementing Project-Based Learning improves student grasp of learning ideas, particularly statistical content connected to data processing. Students improve their ability to use various statistical analysis approaches based on the type of data and problem, as well as collect data in the field, analyze data, interpret results, and draw conclusions. Furthermore, student learning activities are expanding; they are more engaged in debates and passionate in responding to inquiries from classmates and lecturers. Furthermore, pupils become more self-reliant as they search for additional learning resources on the internet and in other places. The score of understanding student learning topics can also be seen when learning PjBL.

CONCLUSION

On the basis of the study's findings, it can be concluded that project-based learning is extremely effective in increasing the students'

understanding of concepts in statistics courses at Bengkulu University, particularly in the mathematics education curriculum of study. Students' understanding of concepts after the PjBL model is applied is higher than before PjBL is applied. Based on the findings of this research, it is recommended for further research to develop learning tools such as modules or teaching materials for PjBL-based statistics so that students' understanding of concepts increases.

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