

Implementation of Project-Based Learning For Improving a Student's Ability in Analysis, Critical Thinking and Systematic in Calculus

Riri Lestari^{1*,} Des Welyyanti¹

¹ Department of Mathematic, Faculty of Math and Science, Andalas University, Padang, Indonesia *Corresponding author. Email: <u>ririlestari@sci.unand.ac.id</u>

ABSTRACT

Calculus is one of the important subjects in the fields of science and engineering. This course explains the basic concepts of mathematics, so that this course tends to be boring. During the Covid-19 pandemic, courses were conducted online. It gave a lot of new problems. For these reasons, it is important to improve the way of teaching. The aim of this research is to implement the *Project-Based Learning* method in calculus courses to reduce existing problems so that this method can provide a better understanding of mathematical concepts for students and improve students' ability in analysis, critical thinking, and systematics. This is qualitative research. The research subjects were students of the calculus subject department of mechanical engineering, and the object of the research was the implementation of the *Project-Based Learning* method. The results of this study indicate that implementing the Project Based Learning method can provide a better understanding of mathematical concepts and improve students' abilities in analysis and critical thinking but still have problems with systematic.

Keywords: Implementation, Project Based Learning, Critical Thinking, Systematic.

1. INTRODUCTION

Project-Based Learning is a learning approach that gives students the freedom to plan learning activities, carry out collaborative projects, and ultimately produce work products that can be presented to others [1]. *Project-based learning* is a teaching approach built on learning activities and real-life tasks that challenge students to solve it in a group [2]. *Project Based Learning* approach creates a learning environment where students build their knowledge, and the lecturer becomes the facilitator.

Project Based Learning is a learning method that uses problems as the first step in collecting and integrating new knowledge based on experience and real activities. *Project Based Learning* is designed to be used on complex problems that students need to investigate and understand [3].

Based on some of the definitions above, it can be concluded that *Project Based Learning* is a learning method that uses projects as a learning medium. Projects are the essence of learning. *Project Based Learning* is done by giving assignments to all students, which are done individually or in groups by observing, reading, analyzing, concluding, and providing interpretations of

the projects they are working on and presenting them. Through the process in *Project-Based Learning*, namely the process of observing, reading, analyzing, concluding,

interpreting, and presenting it, it is hoped that students will get an increase in project/problem analysis skills to solve every solution and systematic thinking.

Calculus is one of the important courses in the fields of science and engineering. This course presents some of the basic concepts of mathematics. This course is presented in the department of math and other exact departments because mathematics is a tool to determine solutions for other fields of science, one of which is used in mechanical engineering. This course aims to review the basic concepts of mathematics that have been obtained from the previous education level and provide an understanding of basic concepts that have not been obtained at the previous education level.

Judging from the material given in the calculus course, namely the basic concepts of mathematics, this course tends to be boring, even though there are often discussions about solving the questions in its course. Covid-19 pandemic also has an influence, starting from the learning process with the results. This is because the course is conducted online. Students tend to have difficulty with online learning even though learning has been carried out using video conferencing platforms such as Zoom, Google meetings, Microsoft Teams, etc. Likewise, learning is carried out through learning videos, text, and online discussions. This Project Based *Learning method* is expected to reduce or eliminate student boredom and difficulties in learning the basic concepts of mathematics with the online learning system. The Project Based Learning method is also expected to encourage students to practice analytical, critical, and systematic thinking skills.

Based on the above background, the researcher is interested in implementing the *Project-Based Learning* method in the Calculus course in the mechanical engineering department to improve the ability to analyze, think critically, and systematically.

2. PROJECT-BASED LEARNING METHOD AND CHARACTERISTICS

Project Based Learning is a method that uses the project as the core of learning. This project is a real problem. This method trains students to observe, understand, analyze, and determine solutions to problems critically and systematically. This method is student-centered, which provides a meaningful experience.

The characteristics of *Project-Based Learning* are developing thinking skills for students, having creativity, encouraging students to work together, directing students to access information on their own, and demonstrating the information. This method requires students to participate voluntarily in learning activities and work in teams or groups [4].

In [5], the steps that must be taken so that the *Project-Based Learning* method can be successful are as follows: (1) Prepare important questions related to the topic to be studied, (2) Make project plans, (3) Make schedule, (4) Monitor the implementation of project-based learning, (5) Do an assessment, (6) Evaluate project-based learning.

This method also has advantages and

disadvantages. In [3], the advantages of *Project-Based Learning* include: (1) Increase motivation, (2) Improve problem-solving skills, (3) Improve communication skills and work in groups, (4) Improve skills in managing information resources, (5) Provide a learning experience that is designed for real-world problems, (6) Create a fun learning atmosphere.

In [6], this method also has weaknesses, including: (1) Takes much time to solve problems and produce products, (2) Requires adequate facilities, equipment, and materials, (3) Tot suitable for students who give up easily and do not have the required knowledge and skills, (4) Difficulty involving all students in group work.

3. METHODS

This is qualitative research. Qualitative research is research whose findings are not obtained through statistical procedures or other forms of calculation but seek to understand and interpret the meaning of an interactive event in a particular situation according to the researcher's own perspective. This research is used to investigate, find, describe, and explain the quality and features of an interactive event that cannot be explained, measured, or described through a quantitative approach [7]. The subjects of this study were students of Calculus course of department mechanical engineering. The object of research is the implementation of the Project-Based Learning method. The data collection technique used is through observation and documentation. To ensure the validity of the data, the researchers used source triangulation. The data analysis technique used several stages: data reduction, presenting, and conclusion.

4. RESULTS AND DISCUSSION

The implementation of *Project-Based Learning* in the Calculus course is carried out with the following steps. First, a question is determined on the topic to be discussed. The topics discussed are the real number system, absolute values, absolute value inequalities, equations of circles, equations of lines, the definition of the function, and trigonometric function. The question is what applications can be applied to these subjects. The application of this subject is called as the topic. This topic becomes the project to be analyzed. The topics chosen as the application of the subject are the analysis of facts and lies, making vehicle number plates, making bank account numbers, determining the temperature interval in the aquarium, determining the age of a person whose age difference is known, determining the distance between minimarkets, the speedometer case, determining the slope of the building, the estimated selling price of goods, the estimated price of land in the next few years, determining the population in the next few years, the equation of the circle a coin, blood grouping, grouping of test scores, installing a USB charger for cell phones with their cell phones, installing jars with lids, determining the width of the river during camping activities, measuring the height of trees, determining the position where the air balloon is flying, measuring the ceiling height of the house.

This project is informed to students in the third week, and it is completed in 4 weeks. Projects are done in groups, namely in small group discussions, with one group consisting of three to four students. In this group, students exchange opinions and share ideas to analyze and determine solutions to problems related to the subject is given or existing topics. During the project process, students are allowed to ask questions to the lecturer to ask for an explanation. Monitoring is still carried out during the project work time. After the fourth week, projects were collected and presented by means of video recording.

The following conditions were found at the time of implementation and the analysis results.

4.1. Understanding Of The Topic By Students

Based on the results of observations and data is obtained by researchers in the field related to an understanding of the subject and topics given, students have been able to understand every subject given even though learning is done online. Students are given the opportunity to ask questions if they find difficulties with the subject provided during the learning process. In addition, it is also known that students are quite able to determine solutions to the given topic. This category is sufficient because students can determine the solution to the given topic but unable to convey it systematically.

The results of this research are relevant to the research conducted by [8], which aims to see the improvement of the student's understanding ability in mathematics subjects using the *Project-Based Learning* method. The research results indicate that this method can improve students' critical abilities so that it is easier to understand the given subject.

4.2. Guiding Group Experience

Based on the results of observations and information obtained by researchers in the field, each group conducts discussions with its respective members. Each group member exchanges ideas, collects reference sources and determines solutions to the given topic. This is so that the information needed is sufficient to build ideas in determining the right solution for the topic. In addition, due to the condition of an online course, students experience difficulties among group members in communicating online.

The results of this research are relevant to research conducted by [9] which aims to see how effective learning is done in small groups. This research shows that learning done in small groups is more effective because the process of discussion and transfer of knowledge between members is easier to do so that each group member can understand the given subject and determine solutions to the given topic.

4.3. Presenting Project Results

The project results are the part that contains exposure to the results or solutions to the topic of the research activities that have been carried out. Based on the results of observations and information obtained by researchers in the field, each group member works together to understand the subject and determine topical solutions in order to produce a good and accurate project result. In presenting the project results, students explain the discussion results among group members. In addition, there are still groups of students who have difficulty presenting project results because courses and projects are carried out online or blended learning. This difficulty is because members in one group are in different locations, so the presented results are not presented accurately and adequately. However, in general, almost all groups can present the project results well, even though the project results are presented in a blended manner using video recording media. So the output of the project of determining the solution to a problem is in the form of a video that explains the solution to the given topic.

The results of this research are relevant to research conducted by [10] which analyzed the effect of *Blended Learning* and *Project-Based Learning* during online learning due to the covid-19 pandemic. This research indicates that the use of *Blended Learning* in *Project Based Learning* is quite influential in improving students' thinking



skills so that the student's project results can be presented properly and accurately.

5. CONCLUSION

Based on the research results conducted by researchers, it can be concluded that after implementing the Project-Based Learning method for Calculus students of department mechanical engineering, students are able to understand each the given subject and are quite able to determine solutions for the problem related to the given subject. This means that students have advantages in critical thinking but are less able to convey systematically. In addition, because the course is held online, students who are gathered in one group are in different locations. This causes students to have difficulties in communicating and discussing in their groups. This obstacle is also found in the presentation of the work and. The presentation of the work in a video recording can explain how to determine the solution to the given topic. Although the project results can be presented well, the production of the project results is also constrained because of online learning. The advantage of Project Based Learning in this online learning period is that this method can help and train students to think critically and systematically; besides, it can also train students' analytical skills on the solution-defining project.

AUTHORS' CONTRIBUTIONS

Riri Lestari-concept and design of the research, data collection, analysis and interpretation, and the first draft of the paper and further manuscript.

Des Welyyanti-concept and design of the research, analysis, and interpretation contribute to the paper's writing.

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REFERENCES

 I.W.E Mahendra, Project-Based Learning Bermuatan Etnomatika dalam Pembelajaran Matematika, in: Jurnal Kreatif Vol.6 No. 1 P-ISSN:2303-288X E-ISSN:2541-72007.

- [2] B.Goodman, J.Stivers, Project-Based Learning, Educational Psychology, ESPY 505, 2010.
- [3] Daryanto, Pembelajaran Saintifik Kurikulum 2013, in: Gava Media, Yogyakarta, 2013.
- [4] C.L. Chiang, H. Lee, The Effect of Project Based Learning On Learning Motivation And Problem-Solving Ability Of Vocational High School Students, in: International Jurnal of Information and Education Technology, Vol.6, No.9. DOI:10.7763/IJIET.2016.V.6.779. h.709.
- [5] Educational Technology Division Ministry of Education Malaysia, Project-Based Learning Handbook, "Educating Millenial Learner". in: <u>http://fliphtml5.com/ygry/apzb/basic</u>.
- [6] R.A.Sani, Pembelajaran Saintifik Kurikulum 2013, in: PT. Bumi Aksara, Jakarta, 2013.
- [7] G.R.Somantri, Memahami Metoda Kualitatif, in: Makara, Sosial Humaniora, Vol.9, No.2, Desember 2005: 57-65.
- [8] Riyah, Seruni, Peningkatan Kemampuan Pemahaman Peserta Didik Pada Mata Pelajaran Matematika Menggunakan Model Project Based Learning, in: JKPM, Vol.01, No.01, 01 Des 2015, hlm 76-90.
- [9] N.P. Aryani, Supriyadi, Implementation of Small Group Discussion as a Teaching Method in Earth and Space Science Subject, in: Journal of Physics, IOP Conf. Series 983 (2018) 012039 doi: 10.1088/1742-6596/983/1/012039.
- [10] Yustina, W.Syafii, R.Vebrianto, The Effect of Blended and Project Based Learning on Pre-Service Biology Teacher's Creative Thinking Through Online Learning in The Covid-19 Pandemic, in: Jurnal Pendidikan IPA Indonesia JPII 9 (3) (2020) 408-420.