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Study of the Application of Problem-Based Learning in Mathematical Statistics Lectures on Students' Concept Understanding

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ABSTRAK

Kemampuan memahami konsep merupakan kemampuan matematis yang harus dimiliki oleh mahasiswa agar dapat lebih memahami materi yang diajarkan. Dalam mempelajari statistika matematika, siswa dituntut untuk mampu menerapkannya dalam konteks kehidupan sehari-hari dan mampu memecahkan masalah. Pendekatan pembelajaran yang menggunakan permasalahan dunia nyata sebagai konteks bagi siswa untuk mempelajari berpikir kritis dan keterampilan pemecahan masalah, serta untuk memperoleh pengetahuan dan konsep esensial dari materi pelajaran adalah pembelajaran berbasis masalah (PBL). PBL digunakan untuk merangsang pemikiran tingkat tinggi dalam situasi berorientasi masalah. Penelitian ini bertujuan untuk menguji pengaruh penerapan model *Problem-Based Learning* (PBL) terhadap kemampuan pemecahan masalah siswa pada mata kuliah Statistika Matematika. Penelitian ini merupakan penelitian deskriptif kuantitatif dengan subjek penelitian mahasiswa Jurusan Matematika semester 4 tahun ajaran 2021/2022. Hasil penelitian menunjukkan bahwa pemahaman konsep siswa dalam memahami materi Statistika Matematika yang diajarkan dengan menggunakan model Pembelajaran Berbasis Masalah lebih tinggi dibandingkan dengan hasil belajar siswa yang diajarkan dengan menggunakan model pembelajaran langsung. Berdasarkan perhitungan interpretasi skor terhadap respon siswa terlihat bahwa respon siswa terhadap penggunaan model pembelajaran berbasis masalah adalah sebesar 86,16%. Begitu pula dengan rata-rata persentase aktivitas mahasiswa aktif dalam perkuliahan sebesar 84,37%. Dengan demikian, hasil analisis data yang diperoleh menunjukkan bahwa penggunaan model PBL dalam proses perkuliahan dapat meningkatkan pemahaman konseptual siswa dalam memahami konsep materi statistika matematika.

Keywords: Pembelajaran Berbasis Masalah, pemahaman konsep, statistika matematika

ABSTRACT

The ability to understand concepts is a mathematical ability that both pupils and students must have so that they will better understand and comprehend the material being taught. When studying mathematical statistics, students are required to be able to apply it in everyday life contexts and be able to solve problems. A learning approach that uses real-world problems as a context for students to learn critical thinking and problem-solving skills, as well as to obtain essential knowledge and concepts from the subject matter is problem-based learning (PBL). PBL is used to stimulate higher-order thinking in problem-oriented situations. This research aims to examine the effect of applying the Problem-Based Learning (PBL) model on students' problem-solving abilities in the Mathematical Statistics course. This research is a quantitative descriptive research carried out on students majoring in mathematics in the 4th semester of the 2021/2022 academic year. The results of the research showed that students' conceptual understanding in understanding Mathematical Statistics material taught using the problem-based learning model was higher than the learning outcomes of students taught using the direct learning model. Based on the calculation of the score interpretation regarding student responses, it could be seen that the student response to the use of the problem-based learning model was 86.16%. Likewise, the average percentage of student activity was 84.37% active in lectures. Thus, the results of the data analysis obtained show that using the PBL model in the lecture process can increase students' conceptual understanding in understanding the concepts of mathematical statistics material.

Keywords: Problem-based learning, conceptual understanding, mathematical statistics

INTRODUCTION

In general, every course at the tertiary level, especially in the mathematics department, cannot be separated from a problem-solving component. One of them is an introductory course in mathematical

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statistics. This course is mandatory for students and as a prerequisite students must master differential calculus, integral calculus as well as an introduction to real analysis. These prerequisite courses are abstract so they require in-depth study for each student. If students' problem-solving abilities are not developed, then students will have difficulty solving problems which will result in their ability to understand concepts also being low. So far there are still many students who still lack understanding of mathematical concepts. The aim of learning mathematics is stated in the Regulation of the Minister of National Education of the Republic of Indonesia Number 58 of 2014 that understanding mathematical concepts is competence in explaining the relationship between concepts and using concepts and algorithms, flexibly, accurately, efficiently, and precisely, in solving problems.

The ability to understand concepts is a mathematical ability that both pupils and students must have so that they will better understand and comprehend the material being taught. Problem-solving is often said to be the heart of mathematics, this is because problem-solving skills are very important in learning mathematics. In line with Cooney's opinion in La'ia (2019) possessing problem-solving skills helps students think analytically in making decisions in everyday life and helps improve critical thinking skills in facing new situations. According to NCTM (2000), problem-solving has two functions in learning mathematics, namely: firstly problem-solving is an important tool for studying mathematics and secondly problem-solving can equip students with knowledge and tools so they can formulate, approach, and solve problems.

Based on teaching experience in introductory mathematical statistics courses, students' ability to understand concepts is still very low. The way to solve exam questions is still not systematic, so the final results are wrong. This results in many students getting C grades in their final scores, even D grades. Observation results also show that during the lecture, only a few students were active, both asking and answering questions, most students were less active during the lecture process where they only tended to listen and take notes so the lecture process was still dominated by the lecturer. According to Suhendar & Ekayanti (2018), one indicator of concept understanding is the ability to classify concepts or algorithms for problem-solving. This means that if someone can apply a problem-solving algorithm, then they may understand the concept.

Many factors cause students' low mathematics learning outcomes, one of which is the inappropriate use of learning models used by teachers in class. Lecturers are required to encourage students to learn actively and improve their mathematical problem-solving abilities, which are an important factor in mathematics. According to Slameto (2003) in teaching and learning interactions, teachers must give a lot of freedom to students, to be able to investigate themselves, observe themselves, learn themselves, and look for their own problems. In solving questions, students are not supported by in-depth mastery of concepts. For this reason, several solutions are needed, related to the teaching and learning process, and an approach using challenging questions, so that students' mastery of concepts and understanding of mathematical statistics is good. When studying mathematical statistics, students are required to be able to apply it in everyday life (authentic) and be able to solve problems. A learning approach that uses real-world problems as a context for students to learn critical thinking and problem-solving skills, as well as to obtain essential knowledge and concepts from the subject matter is problem-based learning (PBL). In addition, Ibrahim and Nur (in Nurdin & Adrianto, 2016) stated that problem-based learning is a learning approach used to stimulate students' high-level thinking in real problem-oriented situations, including learning how to learn.

The Problem-Based Learning model requires students to be active and encourages students to learn to solve problems in introductory mathematical statistics and carry out investigations in solving problems. Lecturers act as facilitators or guides. Duch et. al. (2001) emphasized that learning using PBL can improve critical thinking and analysis skills, solve complex problems or real problems in everyday life, work together in groups, and demonstrate effective communication skills both verbally and in writing. Through the Problem-Based Learning model, students can construct mathematical concepts through adaptation and organization processes. The development of students' mental structures depends on the knowledge students gain through the assimilation and accommodation process so that there is a balance between the assimilation and accommodation processes (Rustina & Anisa, 2018)

In line with the statement (Hidayat & Sariningsih, 2018) it is revealed that problem-solving in mathematics learning is a core basic ability in the learning process. PBL is learning that provides a platform for students to think, be active, exchange ideas, and learn that comes to the surface in class

discussions or group study and provides motivation (Padmavathy & Mareesh, 2013). Therefore, this model is suitable for training students to solve problems with the knowledge they have. In line with this opinion, several opinions state that the PBL model emphasizes problem-solving activities in learning so that it can hone students' thinking skills (Gunantara, et al., 2014; Anugraheni, 2017).

Based on the problems above, the researcher wants to conduct research by applying the PBL model in lectures to examine students' conceptual abilities in mathematical statistics courses.

METHODS

The type of research used in this research is quasi-experiment, namely research that is used without isolating the characteristics of two groups which will later be given different treatments (Sugiyono, 2010). This quasi-experimental research will later be carried out by providing treatment in the form of a PBL model and direct learning methods. This research is included in qualitative descriptive research because the data obtained is more concerned with the process than the results. The data obtained in this research is in the form of a lecture process that takes place in the application of problem-based learning as an effort to develop the concept understanding abilities of students majoring in mathematics at FMIPA Unima. In the Introduction to Mathematical Statistics course

This research was carried out at the Mathematics Department, FMIPA Unima in the even semester 2021/2022, namely from March to June 2022. The subjects of this research were fourth-semester Mathematics Education students who took the Introduction to Mathematics Statistics course. In this research, there are two variables, namely:

1. Treatment Variables
   The treatment variables are the use of the PBL learning model and direct learning.
2. Response Variable
   The response variable is the result of students' understanding of concepts in the mathematical statistics course after being given treatment.

The data collection techniques used in this research are tests, documentation, and observation.

1. Test
   Tests are used to measure student learning outcomes after implementing the PBL learning model and direct learning. The test is given at the end of learning (post-test), in the form of essay questions.
2. Documentation
   Documentation is carried out by collecting data in the form of photographs during classroom learning. This is done to obtain actual information during the implementation of the research.
3. Observation
   Observations were carried out by other related lecturers, to measure the implementation of the learning model during the research process.

Data collection was carried out by researchers by interacting directly with research subjects. From interacting directly with research subjects, researchers obtained data in the form of students' views or opinions by applying problem-based learning to develop students' conceptual understanding abilities.

In this research, the measuring tool or instrument used is a test of student learning outcomes. Tests are carried out to measure students' mastery and abilities after they receive learning using the PBL model. The test given is in the form of essay questions. Before use, validity and reliability testing has been carried out by a team of experts.

Moreover, the data analysis technique applied was as follows:

1. Description analysis to assess students' concept understanding abilities
2. Inferential analysis to see differences, using a two-group difference test or T-test

The Processing Flow Data obtained from test results was processed through the following stages:

1. Providing pre-test and post-test answer scores for students' ability to understand mathematical concepts according to the answer key and scoring system used.
2. Making a table of pre-test and post-test scores on the ability to understand mathematical concepts for students in the experimental class and control class.

3. Increasing students' ability to understand mathematical concepts that occurred before and after implementing the PBL learning model and ordinary learners.
4. Carrying out a normality test to determine the normality of the gain data using the Lilliefors statistical test.
5. Testing the homogeneity of variance of the gain data using Fisher's test.
6. Testing the difference between two average gain data, in this case between experimental class gain data and control class gain data. The statistical test used was the t-test. All data processing used MINITAB software.

RESULTS AND DISCUSSIONS

The results and data analysis were made based on data obtained from research activities regarding student learning outcomes in the Mathematical Statistics course, student activities during lectures, and student responses to learning through the Problem-Based Learning (PBL) model and direct learning model. Implementation of lectures using PBL includes several stages, namely:

1. The preparation stage is where the lecturer prepares the *Rencana Pembelajaran Semester* (RPS) or semester learning plan and student activity sheets
2. The learning implementation stage uses a problem-based learning approach as an effort to develop students' critical thinking skills
3. The analysis stage includes evaluating and reflecting on the difficulties experienced by students in implementing the problem-based learning approach as an effort to develop students' critical thinking skills

The application of the Problem-Based Learning (PBL) learning model has 5 learning stages. The first stage orients students to the problem. At this stage, the researcher gives problem-based questions, after students have looked closely (observed the problem), the researcher asks leading questions to encourage students to predict or guess the answer to the problem. The second stage is organizing students to study. At this stage, researchers organize students in groups of 4-5 people. The researcher provides the problems contained in the Worksheet and the steps for solving them and asks students to collaborate to solve the problems in each group. The third stage is guiding individual and group investigations. At this stage, the researcher guides students who carry out investigations on the questions on the worksheet. The fourth stage is developing and presenting the results of student work, where at this stage, the researcher asks students to prepare a detailed, neat, and systematic report on the results of the group discussion. The fifth stage analyzes and evaluates the problem-solving process. At this stage, the researcher gave students from the presenting group the opportunity to provide additional explanations.

Statistical data for final semester exams for lectures using problem-based learning and direct learning models, (lectures conducted are lectures and regular group discussions), are presented in the following table:

Table 1 Descriptive Statistics of Final Semester Exam Scores

No	Statistics	Statistics score	
		PBL	Control Group
1	Minimum Score	1.986	0.675
2	Maximum Score	3.870	3.040
3	Mean ($\bar{x}$)	2.868	1.894
4	Variance (s^2)	0.396	0.546
5	Standard Deviation (s)	0.564	0.739
6	Median	2.760	2.079

From Table 1 above, it can be seen that the maximum score for classes that use problem-based learning in lectures is 3.870 and the minimum score is 1.986, with an average value of 2.868 and a data variance of 0.396. Meanwhile, for classes with regular lectures (control), the maximum score obtained was 3.040 and the minimum score was 0.675. The average obtained for the control class was 1.894, while the variance value was 0.739. Mathematically, the average student learning outcomes in understanding concepts in mathematics statistics lectures using problem-based learning are higher than the average student learning outcomes in the control class.

The test results using t-test statistics concluded that the average exam results of students taught using the PBL model were higher than the learning outcomes of students taught using conventional methods.

Calculating the interpretation of scores regarding student responses, it was obtained that student responses to the use of the PBL model were 86.16% which was in the range of 80% - 100% (Very Strong). This shows that students feel happy and interested in studying Mathematical Statistics using the PBL model. The results of observations of student activities during the lecture process using the PBL model show that no more time is wasted, for example, students who are sleepy during the lecture process. The quality of the lecture process can also be improved. With learning tools designed using student worksheets, students can improve their understanding of concepts in solving mathematical statistics questions and lecture activities, both cognitively and physically, as well as increase their understanding of the material being studied, thereby increasing learning motivation. Effectiveness can be seen in the average percentage of student activity, namely 84.37% active in lectures. In this way, the PBL model can increase student activity in understanding the concepts of mathematical statistics courses. Student responses to the use of this model are also very positive.

From a number of aspects asked, students felt happy with the lecture method using the PBL model, students felt bolder in expressing their opinions. And felt an increase in understanding of concepts. In general, the overall average percentage of student responses was 86.16%, this is classified as a very strong response according to the standards that have been set, namely $\geq 75\%$. Thus, the results of the data analysis obtained show that students' understanding of concepts in mathematical statistics courses is classically complete, student activities reach the criteria for success, and student responses to the lecture process are also positive. Based on this, lectures using the PBL model are said to be effective. These results are in line with the opinion of Norman & Schmidt (1994), that PBL can improve students' abilities in several ways, namely: Transferring concepts to new problems, integrating concepts, interest in learning, self-directed learning, and learning skills, as well Agustina (2018)'s research results show that students' level of classical learning completeness has indicated that through the application of the Problem-Based Learning learning model, they can improve students' ability to understand mathematical concepts.

From the research results of Oktaviana & Haryadi (2020), it was concluded that students whose learning used the PBL model improved their problem-solving abilities significantly better than students whose learning used direct learning, as well as the research results of Silalahi, et al. (2023) that the ability to understand students' concepts using the Problem-Based Learning (PBL) learning model is better than the conventional model in inverse function material.

CONCLUSIONS

Based on the result and discussion, it can be concluded that students' understanding of concepts in comprehending mathematical statistics materials taught using a problem-based learning model was higher than the student learning outcomes using a direct learning model. Based on the calculation of score interpretation regarding student responses, the student-level response use of problem-based learning models is 86.16%. Likewise, the average percentage of student activity was 84.37% in active lectures. The results of data analysis obtained using the problem-based learning model in the lecture process can increase students' understanding of concepts in mathematical statistics.

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