

Effects of problem-based learning model and collaborative learning model on the learning outcomes of mechanics engineering

J Silalahi¹ and R Abdullah¹

¹ Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Kampus UNP (Indonesia)

E-mail: silalahijunimans@gmail.com

Abstract. The ability of teachers to determine the right learning model will have an impact on the students' learning outcomes and the achievement of learning objectives. The low students' learning outcomes in Mechanics Engineering is influenced by the learning model used by the teacher in teaching. This paper aims to determine differences in the effect of problem-based learning model and collaborative learning model on the learning outcome in Mechanics Engineering. This method used in this research is a quasi-experimental method with a non-equivalent control group design. The study sample consisted of 62 people divided into two groups, namely the experimental group 1 and the experimental group 2. The sampling technique was carried out using random sampling, 31 people for the experimental group 1 and 31 people for the experimental group 2. Data collection using the learning result test (pre-test and post-test) in the form of objective questions for about 25 questions. Data obtained were analyzed using descriptive statistical analysis techniques and inferential statistical analysis techniques, namely the t-test. Based on data analysis, the results showed that there were significant differences in the effect of problem-based learning model and collaborative learning model on the learning outcomes in Mechanics Engineering. The experimental group 1 using problem-based learning model had higher learning outcomes than the experimental group 2 using collaborative learning model.

1. Introduction

One of the problems in learning in school is the low students' learning outcomes. Learning outcomes are influenced by several factors, both internal and external factors. Internal factors are physiological and psychological factors (eg achievement motivation intelligence and cognitive abilities), while external factors are environmental and instrumental factors (eg teachers, curriculum, and learning models) [1]. Learning outcomes are behavior changes that generally can be grouped into three categories namely cognitive, affective, and skill [2]. Three main factors that influence learning outcomes are cognitive ability, achievement motivation and learning quality. The quality of learning is the quality of learning activities carried out concerning the learning model used [3]. Models can be interpreted as a pattern used in compiling curriculum, designing and delivering teaching material, organizing, and choosing media and methods in a learning condition. The model describes the widest levels of learning practices that are used to select and develop learning strategies, methods, skills, and learning activities and put pressure on one topic of learning [4].



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In the field there are still teachers who master the subject matter well, but cannot carry out learning activities properly [5]. This happens because learning activities are not based on learning models that are in accordance with teaching material, so the learning outcomes obtained by students are low. The solution that can be sought to overcome the problem of low student learning outcomes is to determine the right learning strategy. Learning strategies are very useful for both teachers and students. For teachers, learning strategies can be used as guidelines and references to act systematically in the implementation of learning. For students, learning strategies can facilitate the learning process, because learning strategies are designed to facilitate the learning process of students [6].

One good learning strategy is to apply learning model that is compatible with teaching materials. Learning model is a form of learning series to encourage and stimulate student activities to be more enthusiastic in learning [7]. A teacher can apply several learning models that are appropriate to the subjects being taught, so that they can support learning activities [6]. The selection of learning models is influenced by the material taught so that when the learning model is appropriate, the expected goals in the learning process can be achieved to the maximum [2]. The learning model used as a strategy for presenting material must be in accordance with the characteristics of the material. It is expected that the models used in the learning process can affect student learning activities to become better. Learning models that are thought to be able to improve student learning outcomes in Mechanics Engineering subjects are problem-based learning model and collaborative learning model.

Problem-based learning is a learning model that is oriented towards the active role of students by exposing students to a problem in order for students' to be able to solve existing problems and then draw conclusions by determining their own steps [8]. Problem-based learning is a learning model that provides authentic experience in order to encourage students to learn actively, construct knowledge, and integrate the context of learning in school and learning in real life naturally [9]. Problem-based learning is a learning model that is based on many problems that require authentic investigation, which is the investigation that requires real solutions to real problems [10]. The general steps in implementing problem-based learning are as follows: (1) the teacher makes a discussion group and determines the learning objectives to be achieved, (2) the teacher gives a problem to students to be used as material for learning, (3) students identify learning issues based on problems and adapted to the purpose of learning, (4) students carry out self-directed learning to find various information to solve problems, (5) students evaluate the results and processes they performed in these activities [10].

Problem-based learning is one of the contextual learning models that emphasizes the learning process centered on students to find their own material. The learning process is oriented to direct experience of students' daily lives in the social environment [11]. Problem-based learning also emphasizes problem solving with student learning approach to the authentic problems. Students are strived to compile their knowledge, practice independence and self-confidence, and develop thinking skills in problem solving [12]. The main purpose of problem-based learning is not the delivery of a large amount of knowledge to students, but on the development of critical thinking skills and problem-solving abilities and at the same time developing students' ability to actively build their own knowledge [13].

Another learning model that is believed to be able to improve student learning outcomes in Engineering Mechanics subject is Jigsaw collaborative learning. Jigsaw is a face-to-face method, without technology support. This emphasizes the interaction between members of the work group [14]. Jigsaw [15] is a method intended to provide a collaborative learning environment. Jigsaw collaborative learning is a group learning process that each member contributes information, experience, ideas, attitudes, opinions, abilities, and skills they have together to enhance mutual understanding of all members [16]. Jigsaw collaborative learning allows each student to understand the whole section of the discussion, not like study groups that only cause certain students to understand certain material. This method also makes all students have an equal understanding of a discussion.

In implementing the Jigsaw learning model, students work in groups twice, in their own group and in the expert group. In the expert group they discuss the same material, then return to their own group

to explain their respective parts to their group mates [15]. Next the teacher gives a comprehensive test so students understand the whole material. Students work individually without anyone's help. Scores obtained from each member of the test results will determine the score obtained by their group. The Jigsaw collaborative learning model not only helps students contribute information, experiences, ideas, attitudes, opinions, abilities, and skills possessed, but also makes the process of interaction in forming new knowledge in each student [16]. It is expected that this model can change the way students learn from passively becoming active so that a sense of interest and understanding of the subjects given by the teacher appears.

The advantage of the Jigsaw collaborative learning model includes increasing the ability of students who do not understand a subject, especially the subject of Mechanics Engineering. Mechanics Engineering is one of the core competencies that is very underlying for understanding, mastering, applying, and developing various expertise in the field of building engineering [17]. Mechanics Engineering is a science that discusses statics and structural dynamics. Statics discusses all building structures that are fixed in nature which consist of certain static and uncertain static, while structural dynamics discuss all moving building structures [18]. Mechanics Engineering is a vocational subject that requires expertise on how to calculate forces in building structures. Mechanical Mechanics is a core subject in structural behavior that must be studied by vocational students in Building Engineering for two semesters. Mechanics Engineering teaching materials include understanding structural elements, understanding factors that affect the structure of buildings based on design and loading criteria, understanding various styles in building structures, understanding how to arrange forces in structures, analyzing internal forces (moments, shear and normal) in building structures, analyzing the balance of forces in simple beam construction, analyzing rod forces in simple frame construction, analyzing the stresses that occur in the beam, and evaluating simple beam strength based on the stresses that occur [19].

Based on the description above, the author is interested in conducting research on the effect of the problem-based learning model and Jigsaw-type collaborative learning model on the learning outcomes in Mechanics Engineering. This model is expected to provide a positive role that is to increase students' confidence in learning. In addition, students are expected to master the knowledge and skills through detailed explanations by the teacher. Students can exchange ideas through interaction with friends so that more knowledge is gained in learning. Students more easily understand teaching material and do assignments given by the teacher [14]. It is assumed that this model is effective for improving learning outcomes in Mechanics Engineering.

In this study, a comparison was made between the Mechanics Engineering learning outcomes taught by using problem-based learning model and those taught by using Jigsaw type collaborative learning model to see whether they had an effect or not on the learning outcomes in Mechanics Engineering. The characteristic of students is an important factor that must be considered carefully by a teacher because it is a determining factor for the successful use of the learning model. Thus, this study aims to study the effects of the problem-based learning model and Jigsaw-type collaborative learning model on the learning outcomes in Mechanics Engineering.

2. Method

This type of research is experimental research that is categorized into the type of quasi experiment research (pseudo experiment) [20]. The research design used a non-equivalent control group design, meaning that the sample selection is not random (different from pure experiment) but with a specific goal of seeing equality between experimental group 1 and experiment 2. The sample of the study was 62 people, divided into 2 groups namely the experimental group 1 and experimental group 2, each of which numbered 31 people. The learning model for the experimental group 1 was done using problem-based learning model, while for experimental group 2 with Jigsaw-type collaborative learning model. The initial test (pre-test) was carried out in the experimental group 1 and the experimental group 2 before being given treatment. After that, treatment was given to the experimental group 1 and experimental group 2. Furthermore, the final test (post-test) was carried out in the experimental group

1 and the experimental group 2. Data collection using the test results of learning (pre-test and post-test) in the form of objective questions of 25 questions. Data obtained were analyzed using descriptive statistical analysis technique and inferential statistical analysis technique, namely the t-test.

3. Results and discussion

The results of the analysis based on experimental group 1 and experimental group 2 obtained t-count of 2.581 with a probability of $0.05 > 2,000$. H_0 is rejected, meaning that the learning outcomes in Mechanics Engineering using problem-based learning model are significantly higher than the Jigsaw-type collaborative learning model. This research was conducted for four meetings for each group, where at the initial meeting each group was given an initial pre-test or initial test. After that, the next meeting treatment was given and at the end of the meeting in the fourth week was given a post-test with the same question. Data obtained in this study is in the form of Mechanics Engineering learning outcomes after being given treatment with a problem-based learning model for experimental group 1 and Jigsaw-type collaborative learning models for experimental group 2. The results of the descriptive analysis of the study can be seen in Table 1 below.

Table 1. Description of research data

| | Experimental Group 1 | | Experimental Group 2 | |
|--------------------|----------------------|-----------|----------------------|-----------|
| | Pre-test | Post-test | Pre-test | Post-test |
| Amount of Value | 1404 | 2560 | 1372 | 2440 |
| Mean (Average) | 45.29 | 82.58 | 44.26 | 78.71 |
| Highest Score | 56 | 92 | 56 | 92 |
| Lowest Score | 24 | 72 | 24 | 64 |
| Standard Deviation | 7.48 | 5.61 | 8.64 | 8.35 |
| Variant | 55.88 | 31.52 | 74.65 | 69.72 |

Table 1 shows that the average score of Mechanics Engineering learning outcomes in the experimental group 1 (pre-test = 45.29) and in the experimental group 2 (pre-test = 44.26) before receiving treatment. After being given treatment there are differences in learning outcomes, that is an increase, where the average score of the learning outcomes in the experimental group 1 (post-test = 82.58) and the experimental group 2 (post-test = 78.71). For the highest score in the experimental group 1 for pre-treatment or pre-test is 56, while in the experimental group 2 the highest score for pre-treatment or pre-test is 56. After given treatment in the experimental group 1 and being tested with post-test the highest score is 92, while for the experimental group 2 the highest score for the post-test is 92. The lowest score of the pre-test in the experimental group 1 is 24, while in the experimental group 2 is 24. After given treatment in the experimental group 1 and based on given post-test the lowest score is 72, and for the experimental group 2 the lowest score is 64. The results of the pre-test and post-test indicate an increase in student learning outcomes as shown in Figure 1.

Based on Figure 1 can be seen student learning outcomes after receiving treatment has increased. In the experimental group 1 the outcome has increased from an average score of 45.29 to 82.58. The experimental group 2 also experienced an increase in the average score of 44.26 to 78.81. Based on the score of Mechanics Engineering obtained, it can be concluded that the experimental group 1 has an almost equal increase with the experimental group 2, where the experimental group 1 has increased by 37.29 and the experimental group 2 has increased by 34.55. The increase in the average score of Mechanical Mechanics learning outcomes can be seen in Table 2 below.

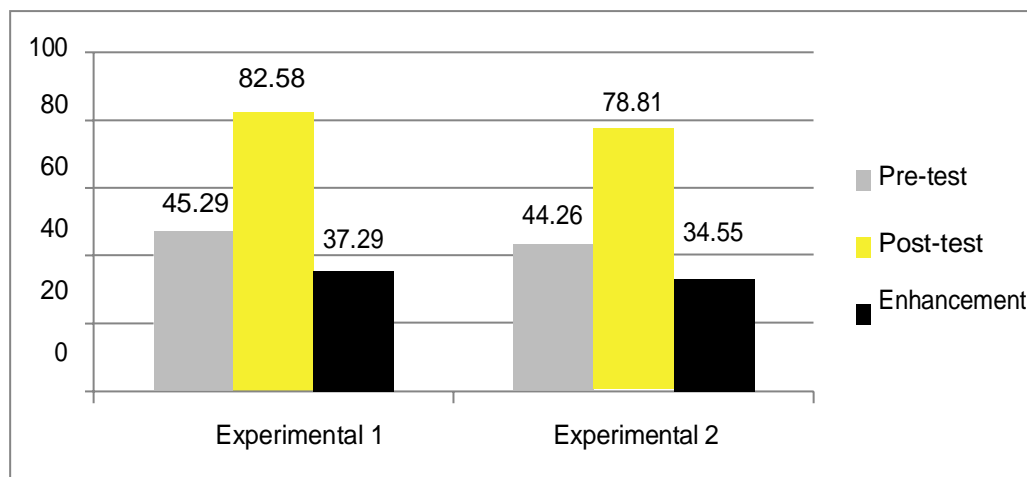


Figure 1. Graph of average scores of experimental group 1 and group 2 learning outcomes

Table 2. Average increased learning outcomes

| Group | Pre-test | Post-test | Enhancement |
|----------------|----------|-----------|-------------|
| Experimental 1 | 45.29 | 82.58 | 37.29 |
| Experimental 2 | 44.26 | 78.81 | 34.55 |

4. Conclusion

Students' learning outcomes using the problem-based learning model in Mechanics Engineering subject are higher than student learning outcomes of students using Jigsaw-type collaborative learning model. This can occur because of problem based learning in exploring student material presented problems to be solved in groups after getting some information from the teacher. The problems that have been presented will provoke students 'curiosity and arouse students' willingness to solve problems. The problems presented are related to real life so students can easily understand the subject matter. Conversely, the average results on the value of this type of cool learning Jigsaw lower can occur due to personal traits that want to stand out, or conversely the weak feel inferior and always dependent on others. In addition, there are times when student questions can deviate from the subject matter, and conclusions are sometimes difficult to reach. However, both of these models have a positive influence in improving learning outcomes in Mechanics Engineering.

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