The Effects of Collaborative Learning Models on Engineering Mechanics Learning Outcomes

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Abstract. The low learning outcomes in Engineering Mechanics are influenced by the learning model used by the teachers in teaching. The ability of teachers to determine the right learning model will have an impact on the success of student learning and the achievement of learning goals. This paper aims to reveal the influence of Collaborative Learning models on learning outcomes of Engineering Mechanics. The method used in this research is a quasi-experimental method with Non-equivalent Control Group Design. The study sample was 46 people divided into two groups, namely the experimental group and the control group. The sampling technique was carried out using random sampling, 23 people for the experimental group and 23 people for the control group. Data collection using the learning result test (pre-test and post-test) in the form of objective questions for about 25 questions. The research data were analysed quantitatively using a parametric statistical analysis test with the t-test. Based on the data analysis, the results of the study show that there was a significant effect using the Collaborative Learning model on the learning outcomes of Engineering Mechanics. The experimental group using the Collaborative Learning model had higher learning outcomes than the control group using conventional learning model.

Key words: Collaborative Learning, Outcomes, Engineering Mechanics

1. Introduction
One of the problems in learning at school is the low learning outcomes. Learning outcomes are influenced by various factors, both internal and external factors. Internal factors are physiological and psychological factors (e.g. the intelligence of achievement motivation and cognitive abilities), while those that include external factors are environmental and instrumental factors (e.g. teachers, curriculum, and learning models) [1]. Learning outcomes express behaviour changes which can generally be classified into three categories, namely cognitive, affective, and psychomotor [2]. Three main factors that influence learning outcomes are cognitive ability, achievement motivation, and the quality of learning. The quality of learning is the quality of learning activities carried out and this concerns the learning model used [3]. Models can be interpreted as a pattern used in compiling curriculum, designing and delivering material, organizing, and choosing media and methods in one learning condition. The model describes the widest level of learning practices and contains the orientation of the learning philosophy, which is used to select and develop learning strategies,
methods, skills, and learning activities to provide emphasis, to focus on certain element of learning (content topic) [4].

It is often found in school that the teacher masters the subject matter but cannot carry out learning activities well [5]. This happens because these activities are not based on a particular learning model so that the learning outcomes obtained by students are low. Solutions that can be sought to overcome the problem of low student learning outcomes is by making learning strategies which is how to use all learning in an effort to teach students. Learning strategies are very useful, both for teachers and students. For teachers, strategies can be used as guidelines and references to act systematically in the implementation of learning. For students, the use of 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 models that are in accordance with the material being taught. A teacher can apply several learning models according to the subjects being taught, so that they can support learning activities [6]. The learning model that is used as a strategy for presenting material must be in accordance with the characteristics of the material. The learning model is a form of learning series to encourage and stimulate student activities to be more enthusiastic in the learning process [7]. The material is taught in the learning process by the teacher to students, so that it can affect students' learning activities to be better. The choice of learning model is influenced by the material taught so that if the learning model is appropriate, the expected goal in the learning process can be achieved in maximum [2].

A teacher can apply several learning models in accordance with the subjects taught, so that they can support learning activities. The learning model is used as a strategy for presenting material so it must be in accordance with the characteristics of the material. Of the many existing learning models, one that can be applied is the Collaborative Learning - Jigsaw type. Jigsaw is a face-to-face method, without technology support. This emphasizes the interaction between members of the work group [8]. Jigsaw [9] is a method intended to provide a collaborative learning environment.

Jigsaw type - Collaborative Learning model is a group learning process that each member contributes for information, experience, ideas, attitudes, opinions, abilities, and skills that they have, so that together enhance mutual understanding of all members [10]. The Jigsaw collaborative learning allows each student to understand the whole section of the discussion, unlike the learning groups we have known whereas only certain students understand certain materials. This method also makes all students have an equal understanding of a discussion.

In implementing the Jigsaw learning model, students work in groups for twice, which is in their own groups and also in the expert groups. In the expert group they discuss the same material, then return to their own group to explain their respective parts to their group mates [9]. 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 will determine the score obtained by their group.

The Jigsaw collaborative learning not only helps students contribute information, experiences, ideas, attitudes, opinions, abilities, and skills possessed, but also makes the interaction process in forming new knowledge in each student [10]. It is expected that this model can change the way students learn from passively becoming active so there will be a sense of interest and understanding of the subjects given by the teachers.

The advantages of the Jigsaw type Collaborative Learning model include this model is expected to improve the ability of students who do not completely understand or have not yet understand a subject,
especially the subject of Engineering Mechanics. Engineering Mechanics is one of the core competencies that is very fundamental for understanding, mastering, applying, and developing various expertise in the field of building engineering [11]. Engineering Mechanics is a science that discusses statics and structural dynamics. Statics discusses all building structures that are fixed in nature that consist of certain static and uncertain static, while structural dynamics discuss all moving building structures [12]. Engineering Mechanics is a vocational subject that requires expertise on how to calculate forces in the structure of building. Engineering Mechanics is a core subject in structural behaviour that must be studied by SMK students in Building Engineering for two semesters. Engineering Mechanics teaching materials include understanding the structural elements, understanding factors that affect the structure of the building based on design and loading criteria, the various styles in building structures, understanding how to arrange forces in structures, analysing internal forces (moments, shear and normal) in building structures, analysing the balance of forces in simple beam constructions, analysing rod forces in simple frame construction, analysing the stresses that occur in beams, and evaluating simple beam strength based on the stresses that occur [13].

Based on the situation above, the writer is interested in conducting research on the use of Jigsaw type Collaborative Learning model. This model is expected to provide a positive role that is to increase self-confidence and self-esteem, in addition students can master the knowledge and skills rather than through detailed explanations by the teacher. Students can exchange ideas and interact with their friends so that more knowledge is gained in learning and it is also easier to understand the material and do the assignments given by the teacher [8]. It is assumed that this model is effective for improving learning outcomes in Engineering Mechanics.

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

2. Method
This type of research is the experimental research that is categorized into the type of research Quasi Experiment (quasi-experimental) [14]. The research design used was Non-equivalent Control Group Design, meaning that the sample selection was not random (different from pure experiment) but with a specific purpose that is seeing equality between the control group and the experimental group. The study sample was 46 students, divided into 2 groups, namely the experimental group and the control group, each of which is about 23 students. In the experimental group of learning, the Jigsaw type Collaborative Learning model was conducted, while for the control group was a conventional learning model. The initial test (pre-test) was carried out in the experimental group (Q1) and the control group (Q3) before treatment was given. After that, treatment was given in the experimental group. At the end, the final test (post-test) was carried out in the experimental group (Q2) and the control group (Q4). Data collection using the test results of learning (pre-test and post-test) in the objective question form of 25 questions. Data were analysed quantitatively using the parametric statistical analysis test with the t-test.

3. Results and Discussion
The results of the analysis based on the experimental group and the control group obtained t-count 2.525 with a probability of 0.05> 2.017. Ho is rejected, meaning that there is an influence of Jigsaw
Collaborative Learning on the learning outcomes of Engineering Mechanics. This research was conducted for 4 meetings for each group, where at the initial meeting each group was given a pre-test or initial test. After that the next meeting treatment was given, and the end of the meeting in the fourth week post-test was given with the same question. The data obtained in this study express the Engineering Mechanics learning outcomes after being given treatment using the Collaborative Learning model for the experimental group and conventional learning in the control group. The analysis results of the study can be seen in Table 1 below.

**Table 1. Description of Research Data**

|                | Experimental group | Control group |
|----------------|--------------------|---------------|
|                | Pre-test           | Post-test     | Pre-test      | Post-test     |
| Amount of Score| 980                | 1844          | 996           | 1676          |
| Mean (Average) | 42.61              | 80.17         | 43.30         | 72.87         |
| Highest score  | 56                 | 92            | 64            | 92            |
| Lowest score   | 24                 | 64            | 20            | 52            |
| Standard Deviation | 8.49            | 8.13          | 11.48         | 11.63         |
| Variant        | 69.02              | 63.27         | 126.12        | 129.33        |

Table 1 shows the student learning outcomes in Engineering Mechanics subject in the experimental group (pre-test = 42.61) and the control group (pre-test = 43.3) before receiving treatment. After treatment, there are differences in results, that is an increase, where learning outcomes in the experimental group (post-test = 80.17) and in the control group (post-test = 72.87). The highest score in the experimental group for the initial treatment or pre-test was 56 while in the control group the highest score for the pre-test was 64. After given treatment in the experimental group the highest score for the post-test was 92 while in the control group the highest score for the post-test was also 92. The lowest score of the pre-test for the experimental group was 24 while in the control group it was 20. After given treatment in the experimental group, it can be seen from the results of the post-test, the lowest score was 64 and in the control group the lowest score was 52. The results of the pre-test and post-test showed an increase in student learning outcomes as shown in Figure 1.

**Figure 1. Graph of Average Experimental and Control Group Learning Outcomes**

Based on Figure 1, it can be seen that student learning outcomes after receiving treatment with a Jigsaw type Collaborative Learning model are increased. In the experimental group there was an increase from an average score of 42.61 to 80.17. While in the control group with conventional learning also experienced an increase in the average score of 43.30 to 72.87. Based on the score of Engineering Mechanics obtained, it can be concluded that the experimental group had a higher increase than the control group, the experimental group increased by 37.56 while the control group only had 29.57. The increase in the average score of Engineering Mechanics can be seen in Table 2.
Table 2. Average Increased Learning Outcomes

| Group    | Pre-test | Post-test | Enhancement |
|----------|----------|-----------|-------------|
| Experimental | 42.61    | 80.17     | 37.56       |
| Control  | 43.30    | 72.87     | 29.57       |

4. Conclusion

Student learning outcomes using the Jigsaw type Collaborative Learning model in Engineering Mechanics subjects are higher than the learning outcomes of students who use conventional learning models. This proves that the Jigsaw type Collaborative Learning model has a positive influence on the learning process, so that it can provide increased learning outcomes in the subject of Engineering Mechanics.

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