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Abstract. This paper aims to describe the mind-mapping learning model employed in the Robotics course and the results of its learning process. Used the classroom action research, the study was conducted in four meetings in the Electrical Engineering Education Department of the Faculty of Engineering Yogyakarta State University (YSU). The research participants were 21 students of the Robotics course. The data were collected by questionnaires and tests, the pre- and post-test, and analyzed descriptively. The results stated that the mind-mapping learning model, which was delivered in form of videos, could increase students' understanding of the Robotics course with an average score of 3.6 out of the 4.0-Likert scale. The average post-test score indicating the students' mastery learning of Robotics was 92.

1. Introduction

Technology has developed in various fields predicted to advance rapidly. Used in these fields, the forward-looking technology includes the robotics that involves industrial and human assistant robotics, Internet of Think (IoT) built to assist people to keep their tasks on track, and Blimps involving the hot air balloon development for long-term transportation [1]. One of them, robotics, has been known to enter Indonesia's world of industry, automotive, and even education.

Robotics in the world of education has become either a course subject or a study program or expertise specializing in the science of Robotics. Robotics as a course concerns on the matters in the world of Robotics consisting of mechanics, electronics, and computers. These three topics are consequently delivered as a unity in the Robotics so that this course as a whole has a broad coverage of topics. Despite this broad coverage of topics, the knowledge they have is so interrelated that they cannot be separated from each other.

Whilst effective learning methods in Robotics are still on search, some attempts have been made to improve students' learning achievement. They comprise the use of multimedia, demonstration, and game. These are carried out in order that Robotics knowledge can be understood well by the students and then they are used to support the technology development in Indonesia.

For teachers or educators, choosing an appropriate learning model is necessary. Some considerations on the students' learning needs and the target learning materials and sources are among those that should be accommodated so that a certain kind of learning model can be applied effectively and support the success of students' learning. Furthermore, teachers are expected to have the motivation and the spirit of renewal in the learning process he lives. Sardiman [2] states that competent educators are those who are able to manage the teaching and learning process. The term managing has a broad meaning concerning how educators master basic teaching skills, such as opening and closing the lessons, giving

explanations, using various media, asking questions, and giving reinforcement, to name a few. It also deals with how educators apply strategies, teaching and learning theories, and create conducive learning.

In line with this, Marsh [3] adds that educators should possess teaching competencies, motivate their learners, create instructional models, manage their classes, maintain communication with their learners, as well as plan and evaluate the lessons. All of these support the success of educators in teaching. One of the current learning models that have been developed to improve students' understanding of science learning is the mind-mapping model. Mind-mapping is the way of developing thinking activities in all directions and capturing various thoughts in various angles. It develops divergent thinking and creative thinking. Mind-mapping, also well known as the concept map, is a very powerful tool for the organizational thinking which also resembles the easiest way to put information into the brain and retrieve that information when needed [4].

Concerning this, some of the general courses in the Electrical Engineering Education Department of Faculty of Engineering YSU have implemented this learning model. The results are believed to improve the students' understanding and memory on the information that had been conveyed. However, this model has never been applied in the courses Engineering Science. Thus, it is expected that this learning model can improve the students' ability to understand and store information taught in Robotics.

2. Research Method

This study was carried out in the Class A and Class D of the Control concentration in the Electrical Engineering Education Department Faculty of Engineering YSU. The participants were 21 students who were taught by one of the authors, Herlambang Sigit Pramono. This study used a Classroom Action Research (CAR) method with several stages in each cycle. (1) Plan - The first stage was planning that involved all researchers consisting of experts in the field of Robotics, multimedia, and mind-mapping to decide the course design with the mind-mapping learning model incorporated in, the learning material to cover, and the right technique in applying the model. (2) Do - the action or implementation stage was carried out in the classroom, with one model of an educator who delivered the material by the mind-mapping model. (3) Check - the last stage was the evaluation and reflection on the implementation of the learning process. The data were collected by means of questionnaires and tests and were analyzed descriptively.

3. Findings and Discussion

3.1. Findings
The planning stage was carried out through discussions for deciding the materials used in Robotics, ranging from the underlying discipline materials to the techniques to apply the mind-mapping model. It was planned that the course would be delivered mostly in the lecture delivery model, with the mind-mapping model for teaching the basics of Robotics. Using the help of Inspiration 9.0.3 software in the delivery, Robotics was used as the basis of the materials to be developed. The following is the presentation of the concept map or diagram of Robotics developed by using the software.
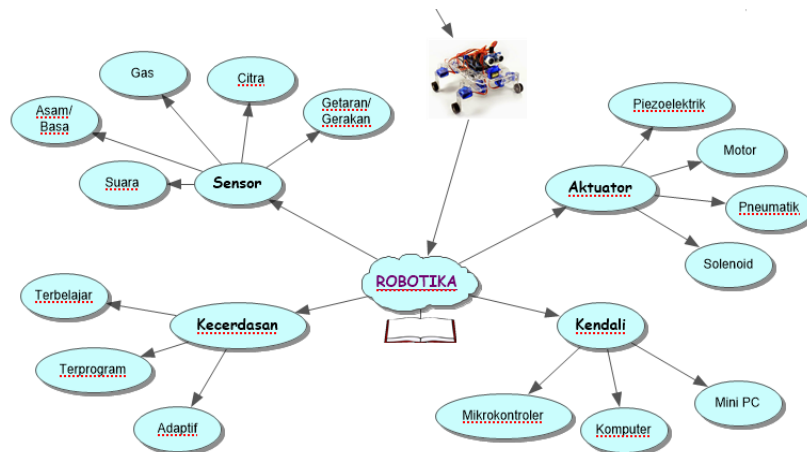
Figure 1. The Mind Map of Robotics

In the implementation stage, unexpectedly only a few students participated eagerly. There were only three active students answered and discussed the notions of Robotics. Nevertheless, the results of the post-test increased significantly compared to those of the pre-test. The following is an overview of the results of the pre- and post-test.

Table 1. The Students' Results of the Pre- and Post-test in Cycle 1

Student	Pre-test	Post-test
1	76	94
2	85	96
3	78	90
4	64	82
5	80	96
6	78	90
7	76	88
8	78	86
9	82	96
10	68	86
11	64	86
12	84	98
13	82	96
14	76	92
15	72	90
16	78	92
17	72	88
18	80	96
19	78	86
20	84	94
21	76	86
Mean	76.71	90.86

The improvement of the post-test scores shows that there was an increase in the students' understanding of the materials delivered. Meanwhile, it was evaluated that the students' participation was still low. Thus, in the next cycle, the researchers decided to improve their participation by using the actual instruments or tools of Robotics instead of the diagram. The next topic of the presentation materials was the actuator in robotics.

In the second meeting or the second cycle, unfortunately, the teaching and learning process got unsatisfactory results, as the students' participation was still low. However, there were six students participated actively during the lesson, indicating an increase in terms of the number of students participating in. The increase occurred because they were interested in the media that were brought so that they began to question or show the desire to find out more about the robot working principles and the procedures to operate the robot actuators.

The results post-test scores increased compared to those on the pre-test, with the pre-test mean score of 84.62 and 92.76 as that of the post-test. This improvement is because the material used was the exam blueprint on the robot actuators some of those have already given in the previous courses. The results of this second phase evaluation were used as a consideration to increase the participation of learners.

Then, on the planning stage for the third cycle, it was triggered that the students would be the ones who made the mind map of the determined topic. This idea was believed to be the solution to significantly increase the students' participation. In addition, it can enhance the students' cooperation in that they discussed the materials, shared ideas, and made decisions together with other students.

The third stage, consequently, was carried out by involving students to create a mind map of a set of the subject-related knowledge of Robotics. By the method of a group discussion and a determined deadline, students made a groove mind map about the Robotics Sensor. In this stage, students were divided into four groups with each 4 to 5 members and were assigned to make a concept map on the topic of Robotics Sensor on their own as provided in Figure 2.

The learning outcomes of this cycle show an increase in the students' participation, namely, they expressed their opinions, decided the form of the mind map, and asked something they did not know about the topic presented. The final product of this third cycle is the mind map on the Robotics Sensor itself. Although when viewed from the data the compatibility of results of the mind map with the answer key gain only 70%, the students' participation increased as planned, namely 21 active students participated in the group work and their learning interest was high.
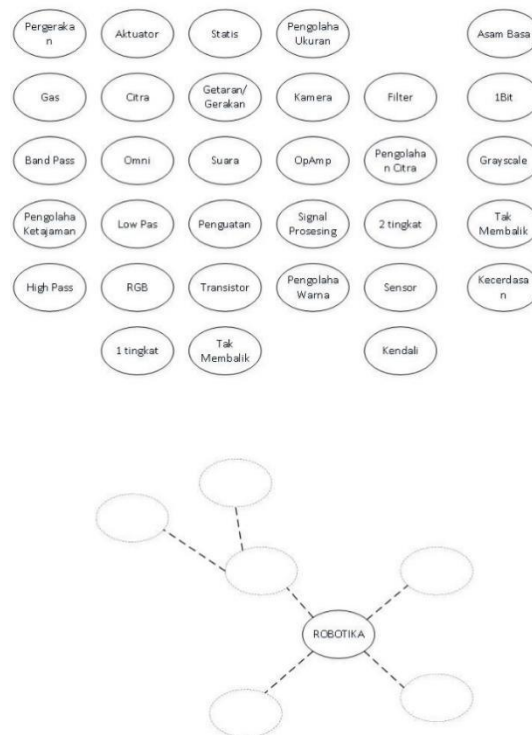
Figure 2. The Interactive Concept for the Mind Map of Robotics Sensor

The results of the third cycle were used as an evaluation to plan the fourth phase. In the fourth stage, the topic of Robotics Image Processing was delivered by the lecturing and student discussion. New terms in the topic were introduced to make the students more active in finding out the meaning of the new terms appeared. The evaluation was done at the beginning and end of the meeting to see if the results increased with the method applied.

The final results of the implementation of the fourth meeting of the learning process are very satisfactory, indicated by the pre-test mean score of 88.34 and the post-test mean score of 93.43. At the fourth meeting, questionnaires were also used to evaluate the students' comprehension of the subjects delivered by using the mind-mapping learning model. Of the 21 students, the average score obtained from the questionnaire is 3.6 out of the 4.0-Likert scale. The following is the summary of the questionnaire data from the 21 participants.

Table 2. Students' Comprehension Scores Collected through Questionnaires

Student	Scores
1	3.4
2	3.8
3	3.5
4	3.8
5	3.8
6	3.6
7	3.6
8	3.5
9	3.8
10	3.8

11	3.6
12	3.6
13	3.8
14	3.4
15	3.8
16	3.8
17	3.8
18	3.2
19	3.6
20	3.5
21	3
Mean	**3.60**

3.2. Discussion

The data obtained show that the mean score for the improvement on the students' understanding is 92.35, taken from the three post-test results that had been conducted. This shows that the students' understanding of the engineering lecture materials can be improved by the mind-mapping learning model. Meanwhile, to apply this learning model, educators should decide the potential topics that can be developed into concept maps. It is believed that arranged flow of thought presented in the mind maps will facilitate the understanding and memory of the students on the topics.

Furthermore, the average score of the students' understanding at the end of the meeting is 3.6 out of a 4.0-scale, demonstrated the two third of the students' understanding of the topics in the subjects, which in other words shows that they gained a good understanding of the learning materials. This improvement occurred because of the mind maps that were well organized, starting from the basic units of the maps to their branches. This certainly affects the students' ability to memorize challenging learning materials.

The mind-mapping learning model, thus, may be combined with other learning methods to improve the results of the learning process. For example, in this study, the learning model was combined with the lecture method, simulation/modeling, and discussion. Each combination should have certain goals to achieve in the learning process.

Based on the results of this study, some steps should be done to maximize the impacts of an effective mind-mapping learning model. They include the followings. (1) Educators (teachers or lecturers) tell the students the learning objectives of every topic. (2) Educators (teachers or lecturers) tell the students the learning methods and models they are going to apply. To gain effective learning process and results with the mind-mapping learning model, students' participation during learning is vital. (3) Educators (teachers or lecturers) divide the students into small groups consisting of 3-4 students. (4) Each group should work on a certain problem chosen from the determined topics with the introduced terminologies. (5) Students are required to discuss the problem to propose solutions by looking for information or the meaning of the terms from the given topics. (6) Each group should make a summary in the form of a mind map, and then the group members are chosen randomly to present their mind map. (7) Educators provide the answer key or the solutions to the problems discussed. (8) Students and educators come to kinds of shared conclusions on the learning topics.

Besides, this study has both products in the form of reports and articles and learning videos which can be used as one of the references in the implementation of the mind-mapping learning model. Videos were uploaded to a free video service provider so that readers can retrieve or download them for free.

4. Conclusion

From the research that has been done, some conclusions can be drawn. They are as follows. (1) The mind-mapping learning models can improve the students' understanding, with a mean score of 3.6 out of a 4.0-scale. (2) The results of the learning process delivered by the learning model attain a very good learning mastery with a mean a score of 92 taken from the three post-tests in three different cycles. (3) The output of this study can be used as one of the references in producing learning videos applying the mind-mapping learning models.

5. References

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