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Validity of Cooperative-Discovery Learning Model to Improve Competencies of Engineering Students

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ABSTRACT

The students of the Civil Engineering Undergraduate Study Program in Institut Teknologi Padang lacked in mastering the competencies of their field of study. One of the causes is the current learning model does not seem effective to improve the competencies of the student in their field of study. In this study, a learning model combining cooperative learning and discovery learning is proposed as a solution to the problem. The learning model was developed using the ADDIE model, which consists of five stages which are analysis, design, development, implementation, and evaluation. This study has proceeded to the stage of the development stage. The products developed in this study are model book, course lesson plan, learning materials, guideline book for the lecturer, and guideline book for students. The products were developed for Highway Pavement Design Course in the Civil Engineering Undergraduate Study Program. All products were validated using the validation sheet filled out by experts. The results of this study showed the products satisfied the criteria of validity; thus, it can be implemented in learning activities.

Keywords: *ADDIE, course, design, development, higher education.*

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INTRODUCTION

Higher education as one of the educational institutions should be able to produce graduates who have competencies to enter the workforce, highly competitive, responsive to the technological change and adaptive to the work environment, and can achieve career goals in his life. The existence of a gap between the capabilities possessed by graduates with the demands of the world of work or industry (competency gaps) is one of the main problems of higher education in Indonesia.

The Civil Engineering Undergraduate Study Program at the Padang Institute of Technology (ITP), Indonesia is aimed to produce professionals in the field of Civil Engineering. Highway Pavement Design Course is one of the subject areas of expertise in the ITP Civil Engineering Undergraduate Study Program, is intended to equip students with work competencies in the field of highway pavement works. However, at present, the learning objective of this course cannot be fully realized.

The results of a preliminary observation on the Highway Pavement Design Course in the ITP Civil Engineering Undergraduate Study Program revealed that in the last five years, there was no significant increase in student grades (see Table 1). Table 1 shows that there was only a slight increase in student scores from one academic year to the next and the average grade of the students was only B, which means that the students' performance in this course didn't reach the mastery level.

Table 1. The score of Highway Pavement Design Course of Students in the Undergraduate Civil Engineering Department at ITP

No.	Academic Year	Average Score	Number of Student with Grade*)					% of Student with Grade				
			A	B	C	D	E	A	B	C	D	E
1	2014/2015	59,25	0	28	4	3	7	0	66,7	9,52	7,14	16,67
2	2015/2016	60,83	1	30	3	1	6	2,44	73,17	7,32	2,44	14,63
3	2016/2017	60,99	0	29	5	0	5	0	74,36	12,8	0,0	12,8
4	2017/2018	59,95	0	23	9	0	10	0	54,76	21,4	0,0	23,8
5	2018/2019	62,52	0	17	11	1	13	0,0	40,48	26,2	2,4	30,95

*) Grade A = score 80–100, Grade B = score 65–79, Grade C = 55–64, Grade D = 45–54, Grade E = score 0–44.

Based on evaluations conducted on various learning opportunities by one of the authors, it was observed that many students in the ITP Civil Engineering Undergraduate Study Program lacked in mastering the competencies of their field of study, as well as the low mastery of life skills. When the students were asked about their understanding of their works in the Highway Pavement Design Course, they were not able to express it clearly. This is in line with the statement of Furuta (2010)(Yang et al., 2020) which confirms that there are clear differences in the achievement of knowledge and skills, depending on the academic field (scientific discipline), where students in the natural sciences and engineering fields tended to evaluate themselves lower than art students (humanities and social sciences).

In addition, from observations in the learning process in the Highway Pavement Design Course, some lecturers have tried to create student-centered learning through implementing a cooperative learning model by assigning some group works. However, it appeared that there is no synchronization between one student and another (individual work is more prominent) and the sense of responsibility towards the group is low.

These showed that the current learning does not seem to provide improvement of mastery of the competencies in the field of study that they are supposed to master, besides that current learning is also less able to improve their life skills. Based on finding from the observation described above, the authors have a concern that the education and training provided to the students at this time (especially in Highway Pavement Design Course), is not effective to achieve objectives and learning outcomes. One of the alternative solutions to create to improve the competencies of the students is the application of an innovative learning model. In this study, the Cooperative-Discovery Learning Model is proposed as a solution. The development of the Cooperative-Discovery Learning model is an effort to combines the jigsaw type Cooperative Learning model with the Discovery Learning for the Highway Pavement Design Course in ITP Civil Engineering Undergraduate Study Program.

LITERATURE REVIEW

According to Slavin (1995, 2009), cooperative learning is a learning model that has long been known, in which the teacher encourages students to collaborate in certain activities such as discussion or teaching by peers (peer teaching). Cooperative learning has a significant effect on improving the achievement of the students compared to individual learning (Johnson and Johnson, 2002). Jigsaw type cooperative learning model is a cooperative learning model that focuses on group work in the form of small groups. As mention by Johnson (1999), the Jigsaw type Cooperative Learning model has three characteristics, they are: a) learning activities in small groups, b) learning experiences, c) students learn and work together to achieve maximum learning experience. Past and recent studies (Lou et al.,1996, 2001; Yamarik, 2007; Adeyemi, 2008; Killic, 2008; Doymus, 2008; Bertuci et al., 2010; Slavin, 2011; Khalid and Metersad, 2016; Trisniawati et al., 2016) have confirmed that cooperative learning in small groups is effective to improve the learning outcomes and life skills of students in different level of educations and different field of studies. However, this learning model has some problems in the implementation, where the dominant students understand the learning topic while the other students do not understand the learning topic (Sugandi, 2013: Sitinjak and Mawengkang, 2018).

Meanwhile, discovery learning is inquiry-based and considered a constructivist learning approach. Real-life scenarios are given to students where they face challenges to solve their own problems. Students interact with the world around to seek as much data as possible to process the concepts and to solve the problems (Dorier & Garcia, 2013; Alfieri et al., 2011, Novaliendry et al., 2015). The learning model demands students to have a sense of responsibility for their own learning, as well as making learning more desirable. This makes the learning materials acquired by the student will sustain longer (Hammer, 1997; Mayer, 2004; Verawardina, et al, 2020). Several studies (Putri et al., 2017; Rosdiana et al., 2017; Suendarti, 2017: Anggraini et al., 2018; Resmawati et al., 2018; Kamaluddin and Widjajanti, 2019; Vitriani, et al, 2020, Bandri, et al, 2020) have confirmed that discovery learning is effective to improve learning outcomes of students in different levels of educations. However, this learning model is difficult to be implemented for the students with low and average academic levels (Gijler and de Jong, 2005; Feladi, et al, 2020; Hendriyani, et al, 2020) and it is not effective for the students who cannot understand the new concept and new information instantly (Ausubel in Cahyo, 2013).

The combination of the Collaborative Learning model and the Discovery Learning model aims to take advantage of both learning models and reduce or eliminate the disadvantages of each learning model as described above. The combination of these two models, called the Cooperative-Discovery Learning model, can be a solution to the difficulties of students in mastering the course learning materials and improve the competencies.

Few studies have been conducted related to the effectiveness of the combination of the Collaborative Learning model and the Discovery Learning model in elementary school and high school (Widodo et al., 2015; Paja, 2017; Asrul et al., 2018).

METHODS

This study is a research and development (R & D) to develop the Cooperative-Discovery Learning model in Highway Pavement Design Course. The products of the development are model handbook, course lesson plan, learning materials in the form of a module, guideline book for the lecturer, and guideline book for students. A new syntax is developed for the Cooperative-Discovery Learning model.

The development of the model used the Design, Development, Implementation, and Evaluation (ADDIE) model (Branch, 2009, Novaliendry et al., 2020). The ADDIE method consists of five stages according to its name, which is analyzing, designing, developing, implementing, and evaluating. This study has proceeded to the stage of the development stage. A focus group discussion was conducted with experts in the related field to receive their comments and suggestions of the developed products. Based on the results of the focus group discussion, the draft of the products was revised. Then, the products were validated using the validation sheet filled out by experts.

The instrument used for the validity test was the validation sheet filled out by the experts to determine the validity of the developed products. The questions in the validation sheets were made using a Likerts scale (Likerts, 1932) with a scale of 1 to 5 (strongly disagree to strongly agree). The validity was determined by Aikens's V Value (Aiken, 1980, 1985). The Aikens's V Value has a range in value from 0 to 1. The validity category was determined according to Azwar (2015), where the valid category is when the Aikens's V Value ≥ 0.6.

RESULTS AND DISCUSSIONS

The validation was conducted for all products of the Cooperative Discovery Learning model, which are model handbook, course lesson plan, learning materials (module), guideline book for the lecturer, and guideline book for students. The products will be employed to improve the competencies of ITP Civil Engineering Undergraduate students on the Highway Pavement Design Course.

A new syntax that combines the jigsaw type Cooperative Learning model with the Discovery Learning was described in the model handbook. The syntax consists of five steps as follows:

1. Orientation
   In this step, the lecturer gives introduction materials on the problems to be discussed.
2. Hypotheses generation
   The students formulate hypotheses related to the given problems.
3. Discussion in expert groups
   The students were divided into 4-6-person jigsaw groups. Each student in a jigsaw group is given a problem. The students with the same problem discuss in an expert group to find the solution.
4. Hypotheses testing
   The students design and conduct experiments to prove the hypotheses that have been formulated or complete the assignment. Then, selected groups give a presentation in the class.
5. Conclusion
   The students analyze, evaluate, and conclude the results from the hypothesis testing.

Validation of the model handbook was conducted on the construct and content of the model. The construct aspect consists of the syntax of the model, quality of learning, reaction principle, support system, and instructional impact. The content aspect consists of the quality of content and quality of learning. The model book was validated by three experts, which are experts in the learning model.

The validity of the course lesson plan, learning materials (module), guideline book for lecturer, and guideline book for student's language was measured on aspects of content, construct, and language. These products were validated by five experts consisting of experts of the learning model and experts of content (material).

Table 2 presents the results of the validation of the products of the Cooperative Discovery Learning model. The average V value for each product of the cooperative discovery learning is greater than 0.6 with a valid category. It can be concluded that the products of the development of the learning models are valid and can be used in the Highway Pavement Design Course for Undergraduate Civil Engineering students.

Table 2. Results of Validation of the Products of Cooperative Discovery Learning Model

Product	Number of Validators	Average Aiken's V Value	Category
Model book	3	0,885	Valid
Course learning plan	5	0,862	Valid
Learning materials (module)	5	0,890	Valid
Guideline book for lecturer	5	0,886	Valid
Guideline book for students	5	0,868	Valid

CONCLUSION

Based on the result of the validation by experts as explained above, it can be concluded that the products of the Cooperative Discovery Learning model, which include model handbook, course lesson plan, learning materials (module), guideline book for lecturer, and guideline book for students, are valid. Therefore, the products can be implemented in learning activities.

The developed products can be a role model in the development of Cooperative-Discovery Learning to improve the competencies of higher education students in the field of engineering.

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