

The Combination of Project-Based Learning (PjBL) and Case-Based Learning in Engineering Design Course for Undergraduate Student in the Department of Mechanical Engineering, Andalas University

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Abstract: Engineering design is one of the main course in The Department of Mechanical Engineering, Andalas University that must be understood by student. The study of engineering design courses will provide an understanding of theories or applied sciences related to the science of design/ engineering. The student outcomes of this course is an ability to identify, formulate, and solve mechanical engineering problems. To reach the student outcome is needed the appropriate learning method that suitable with the characteristics of courses. This research is aim to combine the project-based learning (PjBL) and case-based learning (CBL) in the engineering design course. The main purposes of PjBL and CBL for engineering course are to relate student's experiences with the real engineering case to create logical thinking as the student when they accept the new knowledge. The results of the present study showed that the combination of both methods is successfully implemented in the engineering design course. Students have the ability to solve a common engineering problem and acquire professional competencies for applying in the engineering field in the future.

1 INTRODUCTION

Engineering design is one of the course in the Department of Mechanical Engineering that must be understanding by the student. Engineering design will give some knowledge about theoretical or practice related to the engineering field. For the field of applied science engineering design, the subject of which is the focus of learning are the design concept design, product realization processes, methods of design, clarifying objectives, embodiment function, choose alternatives to the design and selection of materials and process. Due to the many subjects that were taught caused some students not able to understand the main objective of the course properly. For solving this problem, it is needed a learning strategy that suitable with the characteristics of the subject that contains in the engineering design course. Based on the characteristics of the topic that it is learned by student, the approach of the case based learning (CBL) and project based learning (PjBL) is chosen.

Case-based learning (CBL) is an established approach used multi disciplines knowledge where

students apply their knowledge to real-world scenarios, promoting higher levels of cognition.

In CBL classrooms, students typically work in groups on case studies, stories involving one or more characters and/or scenarios. The cases present a disciplinary problem or problems for which students devise solutions under the guidance of the instructor. CBL has a strong history of successful implementation in medical, law, and business schools, and is increasingly used within undergraduate education, particularly within pre-professional majors and the sciences (Herreid, 1994). This method involves guided inquiry and is grounded in constructivism whereby students form new meanings by interacting with their knowledge and the environment (Lee, 2012). Project Based Learning is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge (Douladeli, 2014; Mansyurdin, et.al, 2014). The CBL method will guide the student to play an active role in determining the concept scenario in the design through a given case study, while the PjBL method

will help the students to complete the design assignment (Lina et.al, 2018)

2 METHODOLOGY

Based on the background described above, the research subject focused on changes in learning methods for improving the quality of the learning. In the previous semester learning plan, lectures were conducted for 16 weeks, then conducted an assessment at the time of project work evaluation, Midterm Examination (UTS) and Final Semester Examination (UAS). Project evaluation criteria have not been defined in detail, the active role of students in carrying out projects that are still lacking, so that the ability of new students can be known after the learning process ends. Case-based learning is intended to improve students' understanding in identifying appropriate problems and methods through discussion of real topics in the field of engineering design. Project-based learning methods are applied to increase student participation through teamwork and assist in the process of monitoring and evaluating project tasks carried out. The implementation of the learning method that mentioned above was carried out for Engineering Design students in the Odd Semester 2017/2018 with 51 students

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2.1 Planning

- a. *Establishment of collaborative working groups*
At this stage, the identification of knowledge and skills should be identified before the work on the project should be owned by students. This aims of this stage are to determine the effective and collaborative group division according to the ability of students in working on the project.
- b. *Presenting topics that correspond to real cases*
At this stage, students will discuss in detail the case studies that will guide students in carrying out project tasks. At this stage, students will discuss in detail the case studies that will guide students in carrying out project tasks. In presenting the project topics / tasks to be selected, the following matters should be considered:

- Check the competence or learning outcomes of the course. The curriculum documents may only contain general competencies; if it is necessary to do an elaboration to determine its specific competence.
- Arrange criteria and standards (products and processes).
- Formulation of authentic tasks or projects; make sure that the projects are in line with the expected competencies in the curriculum (can be done together with students)

- c. *Set parameters for completing project implementation*

Lecturers and students collaboratively arrange a schedule of activities in completing the project. Activities at this stage include: (1) creating a timeline to complete the project, (2) making the deadline for project completion, (3) directing students to find suitable methods, (4) identifying the material needed in project work (hardware, software, internet, literature and other networks)

- d. *Consultation and monitoring (input / feedback)*

The lecturer is responsible for monitoring the activities of students during project completion. Monitoring is carried out by facilitating students in each process. In other words, the teacher plays a role as a facilitator for student activities. From the results of the consultation and monitoring there will be input / feedback from the lecturer on the progress of the implementation of project tasks carried out by students.

- e. *Assessment and Evaluation*

Assessment is carried out to assist lecturers in measuring standard achievement, play a role in evaluating the progress of each student, giving feedback about the level of understanding that has been achieved by students, helping teachers in developing the next learning strategy. The assessment process is carried out by asking each group to present the results of the implementation of the project assignment and the final report on the project's work. At the end of the learning process, the lecturer and students reflect on the activities and results of the project that has been carried out. The reflection process is carried out both individually and in groups.

2.2 Action

The implementation of class actions begins with formulating implementation activities that will be carried out by Lecturers and Students.

a. Observation

Observations were made through daily reports reported by each group. Daily reports contain progress on the work of the task and the constraints faced. These constraints are then discussed at class meetings with lecturers.

b. Evaluation

Evaluation of the learning process is carried out by assessing the ability of students to master engineering design.

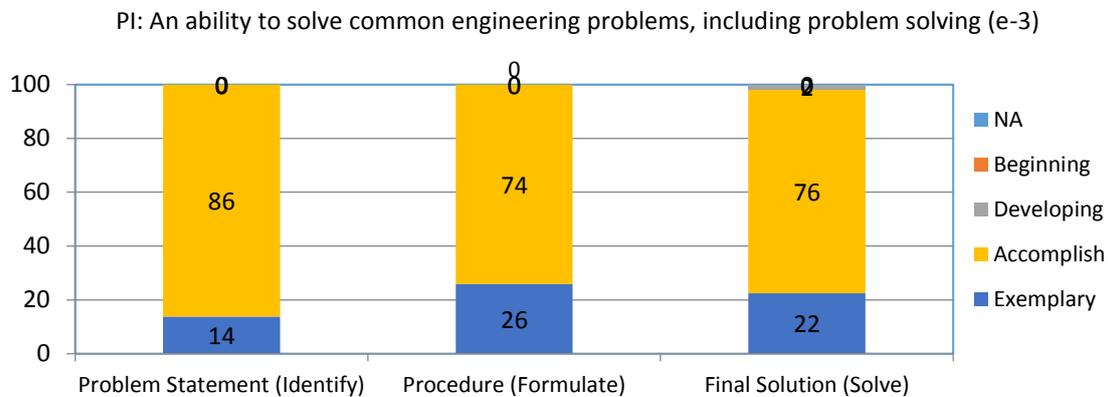
3 RESULT

To implement the Case Study and PjBL learning strategies, subject curriculum documents are needed. The curriculum document is a formulation of the survey results of the needs of graduate user stakeholders as well as derived from the vision and mission of the study program. The results of this formulation are then translated into the form of graduate competencies (learning outcomes). The identification of graduate competencies is translated into several appropriate subjects and is able to accommodate the achievement of the graduates' competencies. Based on the graduates' competency / LO, the appropriate learning method is determined to achieve the graduate competencies that have been determined. The competency of graduates / LO which is accommodated through technical design courses can be seen in Table 1.

Table 1. Combination Model Of Learning Methods On Achieving Competence In Engineering Design Courses.

General Competency	Special Competencies	Tutorial	Self-activities	Project based-learning	Case based-learning
System of mechanics	Design of mechanic systems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Design and manufacture	Concept design formulation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Product realization process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Design methods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Evaluation of alternative design	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Selection material and process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Technical and economic analysis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Communication	Engineering Drawing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Speaking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Writing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Team Workd	Drawing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Leadership ability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Responsibility	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Planning and coordinating team	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ethics	Decision making	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Professional	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Discipline	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 1 The results of the assessment of the ability of students.



4 DISCUSSION

A rubric is arranged to assess the ability of students according to student outcome standard that set by the Department of Mechanical Engineering, Faculty of Engineering, Andalas University.

In Figure 1 it is seen that the ability of students to identify, formulate and solve problems is very good. More than 80% of students have been able to identify the problem well so that at this stage the proper problem formulation will be the goal of the design task. The ability of students to do formulations looks good, where more than 70% of students are able to get the design concept that is in accordance with the formula that has been obtained previously. In terms of providing solutions to solutions, students have been able to evaluate alternative solutions and choose the right solution and in accordance with some considerations of customer requests and technical aspects to realize the solution. The conclusion is the ability of students to identify problems, formulate and find the final solution for the 2017/2018 engineering design course is very good.

5 CONCLUSION

The case based learning (CBL) and project based learning (PjBL) methods have been implemented in Engineering Design courses in the Department of Mechanical Engineering, Faculty of Engineering, Andalas University. The combination of these two methods is considered more effective to be applied in order to increase student knowledge in understanding engineering design courses.

The results of the evaluation of the learning process with the application of these two methods indicate that there is an increase in the ability and knowledge of students who are very good at identifying problems, formulating and finding the final solution in the 2017/2018 engineering design course.

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