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# Development of Course Module Machine Element Design Based On Project – Learning

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***Abstract*—In designing a machine based on effectiveness of technology, students have difficulty in integrating the theories that have been learnt and the type of engine that will be made (project). Hence, it takes course module machine element design to help them design the machine. It is expected that by using this course module they are motivated and easily accomplish their project. The properness was determined through validation of 3 expert lecturers (education, language and machinery construction) and the responses of 10 students that have been taken machine element course. Developing course module machine element design is according to 4D models Thiagarajan (1974). The fourth stage are definition, designing, development and deployment (disseminate). The deployment was not accomplished due to limited research time. The result showed (1) the percentage of the average module validation is 87.61% (very good); (2) students showed a positive response to learning process, i.e. 87%; (3) students feel satisfied and motivated by using this course module that include the trainer. Based on validation of 3 expert lecturer and 10 responses of students the module can be used.**

***Keywords—Course module machine element design, project – learning, development 4D***

## I. Introduction

Learning process consist of four main components namely lecturer, student, text book and the room. The lecturer has very important role because he is the communicator. The text book from the lecturer must be learnt by all students after their learning process dismissed. The dramatic growth in practical applications for machine learning over the last ten years has been accompanied by many important developments in the underlying algorithms and techniques. [1]. The semantics of module networks describe an algorithm that learns the modules' composition and their dependency structure from data [10]. Engineering education focuses chiefly on students' ability to solve problems. While most engineering students are proficient in solving paper questions, they may not be proficient at providing optimal solutions to pragmatic project-based problems that require systematic learning strategy, innovation, problem-solving, and execution[4].

University is the place to educate the student to be able to master knowledge and technologies through theories from each department. Machine element design is one of the course in mechanical engineering department, Faculty of Engineering, State University of Surabaya (UNESA) to fullfill the necessary of industrial development. Especially correlate with the course of torque, power, shaft diameter, chose the electrical motor, gearbox, pulley, belt and transmission which is used for effectiveness technology at medium scale business.According to that issues, mechanical engineering department, faculty of engineering UNESA need the proper text book for machine element design to help students comprehend easily. Hence, researcher tried to create the text book that can motivate the student whose title is Development Course Module Machine Element Design Based On Project Learning.

In project-based learning, students engage in real, meaningful problems that are important to them and that are similar to what scientists, mathematicians, writers, and historians do. A project-based classroom allows students to investigate questions, propose hypotheses and explanations, discuss their ideas, challenge the ideas of others, and try out new ideas [6].

PBL has many benefits including sustained inquiry and investigation (which helps learners remember and absorb knowledge in a much deeper way) and authenticity (which inherently boosts engagement since what students are working on has meaning and purpose beyond the classroom walls)and its empowering, especially when students are solving problems or digging deep into questions they really want to understand [3].

Project-based learning offers promise as an instructional method that affords authentic learning tasks grounded in the personal interests of learners [5].

## II. Method

This study is development research based on develpoment model of 4 – D that consist of : (1) Define, (2) Design, (3) Develop, (4) Disseminate. It was only reached to the third stage (develop) in this research because of the limited time. The 4 – D model is showed at Figure 1.

Research Instrument :

### *A. The Sheet of Modul Validation*

This instrument is used to collect assessment data of expert lecturer and students to the developed module. The result of assessment data will be used as the reference to revise the developed module. As for the aspect of module assessment refer to the list made in the sheet module validation by expert lecturer.

## B. *The Questionnaire of Students Responses*

This questionnaire contains a number of written statement expressing the attitude and opinion of students about the module. Filling and disseminating the quistionnaire was conducted after the study dismissed. As for the filling of questionnaire, the students were asked for selecting the appropriate answer to their opinion or feedback about the developed module by checking the column given.

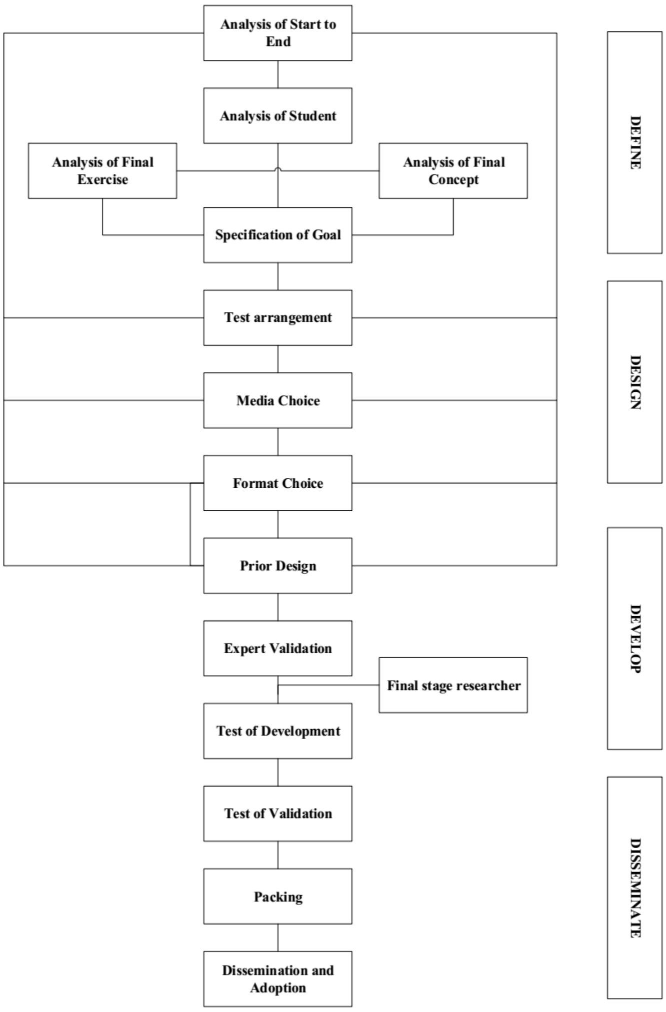



Fig. 1. Research Design [13]

This study used action research which has spiral form from one cylcle to the other one. It contained planning, action, observation and reflection. The next one include revised planning, action, observation and reflection. Before reaching the first one, it is followed with preliminary action in the form of problem identification. Spiral form of each step of action research can be seen as follow

## III. RESULT AND DISCUSSION

## A. *Front Analysis*

It is structure analysis to present the subject in accordance with the outline of the machine element design syllabus in Mechanical Engineering Department, Faculty Of Engineering, State University Of Surabaya.

## B. *Students Analysis*

a. Age and Maturity

The subjectsof this research are S1 Mechanical Engineering Students at the Department Of Engineering Education, Faculty Of Engineering, by taking sample at S1 Engineering Production which consist of 10 people. Their average age are 20 to 21 years.

b. Students Educational Background

Their educational background that become the object in Development of Machine Element Design is shown in table I below.

TABLE I. STUDENTS EDUCATIONAL BACKGROUND

| No | Student ID | Educational Background | Description |
|---|---|---|---|
| 1 | 125754220 | Machining Vocational High School | Already received machine element design lesson |
| 2 | 125754210 | Machining Vocational High School | Already received machine element design lesson |
| 3 | 095524308 | Machining Vocational High School | Already received machine element design lesson |
| 4 | 125754231 | Machining Vocational High School | Already received machine element design lesson |
| 5 | 125754217 | Machining Vocational High School | Already received machine element design lesson |
| 6 | 12574257 | Machining Vocational High School | Already received machine element design lesson |
| 7 | 095524310 | Machining Vocational High School | Already received machine element design lesson |
| 8 | 085524303 | Machining Vocational High School | Already received machine element design lesson |
| 9 | 095524305 | Machining Vocational High School | Already received machine element design lesson |
| 10 | 125754221 | Machining Vocational High School | Already received machine element design lesson |

c. Students Academic Background

There is requirement in this sample to develop Course Module Machine Element Design. They must pass the certain course to be able to learn this module. The requirement is in Table II as follows

TABLE II. STUDENTS ACADEMIC BACKGROUND

| Courses | Description |
|---|---|
| 1. Occupational Safety and Health (K3) | because in the module using a trainer tool that requires caution, there is a need for K3 to be obtained during the K3 course. |
| 2. Machining Thoery | Because in the module there are material designing systems whose theories are obtained during machining theory courses. |
| 3. Engineering Drawing I and II | Because in the module there is a drawing of the design of a machine whose theories are obtained during the drawing I and II courses. |
| 4. Applied mathematics I and II | Because in the module there are calculations in designing machines with trigonometry and geometry obtained during the Applied Mathematics I and II courses. |
| 5. Machine element | Because in the module there are formulas and design calculations that are very closely related to machine elements. |

## C. *Concept Analysis*

Concept analysis has been carried out by identifying the main concepts discussed. It will be taught in the development module based on project – learning related to the syllabus of engineering design course. The result of concept analysis is shown below

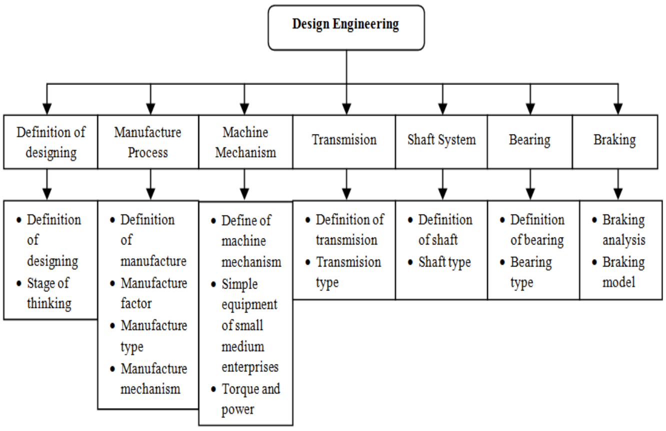



Fig. 2. Syllabus scheme

### D. Assignment Analysis

It is structural analysis to present the outline of the subject related to syllabus of engineering design course at S1 Engineering Education, Faculty Of Engineering, State University Of Surabaya.

### E. Learning Objectives

It is common and specific learning goals from the module which is developed in accordance with the syllabus.

### F. Learning Objectives Analysis

General Learning Objectives (GLO) and Specific Learning Objectives (SLO) from the developed module related to syllabus is proper.

1) General Learning Objectives (GLO) 1
Without opening the book, 80% the students comprehend the definition of engineering design well.
Specific Learning Objectives (SLO) :
a) 80% Students can identify the definition of engineering design independently.
b) Without opening the book, 80% students can mention the stage of thinking engineering design.
c) Without opening the book, 80% students can describe each stage of engineering design.

2) General Learning Objectives (GLO) 2
The students know the kind of manufacture methods, especially the machine based on effectiveness technology.
Specific Learning Objectives (SLO) :
a) 80% students can explain the definition of manufacture process independently.
b) 80% students can define manufacture factors independently.
c) The students can define the kind of manufacture process.
d) Without opening the book, the students can explain the mechanism of manufacture process of effectiveness technology.

3) General Learning Objectives (GLO) 3
Without opening the book, the students know how to define type and machine mechanism will be designed with the calculation too.
Specific Learning Objectives (SLO) :
a) Without opening the book, 80% students can define manufacture mechanism of machine designed.
b) 80 % students can mention the kind of machine at the medium scale business independently.
c) The students can calculate torque, power, rotation and motor selection to design the machine independently.

4) General Learning Objectives (GLO) 4
Without opening the book, the students can explain the kind of transmission system clearly.
Specific Learning Objectives (SLO) :
a) 80 % students can explain the definition of transmission independently.
b) 80 % students know the kinds of transmission independently.

5) General Learning Objectives (GLO) 5
Without opening the book, the students know the kind of shaft type clearly.
Specific Learning Objectives (SLO) :
a) 80 % students can explain the definition of shaft independently.
b) The students can calculate the torque of the shaft independently.
c) The students can calculate the bending moment of the shaft.
d) The students can calculate the bending moment and torque of the shaft.
e) The students can complete the calculation of the shaft as the result of V-belt Force and pulley.
f) The students can complete the calculation of the shaft as the result of flat belt and pulley.
g) The students can complete the calculation of the shaft as the result of chain sprocket force.

6) General Learning Objectives (GLO) 6
Without opening the book, the students can explain the kind of bearing and how to use it well.
Specific Learning Objectives (SLO) :
a) 80 % students can explain the definition of bearing well independently.
b) 80 % students know the kind of bearing independently.

7) General Learning Objectives (GLO) 7
Without opening the book, the students can explain braking system analysis well.
Specific Learning Objectives (SLO) :
a) 80% students can explain the definition of braking analysis independently.
b) 80 % students know the kind of braking independently

Table III below is the cognitive test result

TABLE III. COGNITIVE TEST RESULT

| Specific Learning Objectives 1 | Cognitive Domain | Score` |
|---|---|---|
| 1. Explain the meaning of the Designing Technique! | C1 | 20 |
| 2. What things should be considered in designing! | C3 | 20 |
| 3. Mention and explain the stages of thinking by age and create a flow chart! | C1 | 20 |
| **Specific Learning Objectives 1** | **Cognitive Domain** | **Score`** |
| 4. Mention steps to achieve needs analysis in the order of designing thinking! | C1 | 20 |
| 5. Mention and explain the purpose of the evaluation in the design process! | C1 | 20 |
| **Total Score** | | **100** |
| **Specific Learning Objectives 2** | **Cognitive Domain** | **Score`** |
| 1. Explain the meaning of the production process According to Indriyo Gitosudarmo (2000: 2)! | C2 | 20 |
| 2. What factors are involved in the production process! | C3 | 20 |
| 3. Types of production processes! | C1 | 20 |
| 4. Weaknesses and advantages of continuous production processes! | C2 | 20 |
| 5. Weaknesses and advantages of interrupted production processes! | C2 | 20 |
| **Total Score** | | **100** |
| **Specific Learning Objectives 3** | **Cognitive Domain** | **Score`** |
| 1. Mention what must be considered before designing a machine! | C2 | 25 |
| 2. Mention what simple tools you know all along that are used by Indonesian SMEs for the production process! | C2 | 25 |
| 3. Calculate engine speed (rpm) and motor power (Watt) counted! | C4 | 50 |
| **Total Score** | | **100** |
| **Specific Learning Objectives 4** | **Cognitive Domain** | **Score`** |
| 1. Explain the meaning of the transmission system! | C1 | 20 |
| 2. Mention and explain the kinds of v-belt type transmission systems! | C1 | 20 |
| 3. What do you know about sprocket transmission! | C1 | 20 |
| 4. Mention and explain the types of gear transmission systems! | C1 | 20 |
| 5. Mention the types of materials used in making gears! | C1 | 20 |
| **Total Score** | | **100** |

TABLE III. CONT.

| Specific Learning Objectives 5 | Cognitive Domain | Score` |
|---|---|---|
| 1. Explain the meaning of the shaft! | C1 | 20 |
| 2. What variables must be considered in determining the axis! | C2 | 20 |
| 3. Mention and explain the types of loads that occur on the shaft! | C2 | 20 |
| 4. Design the shaft shape and calculate the minimum shaft diameter required! | C4 | 40 |
| **Total Score** | | **100** |
| **Specific Learning Objectives 6** | **Cognitive Domain** | **Score`** |
| 1. Explain the meaning of bearing bearings! | C1 | 20 |
| 2. Explain the function of the bearing bearing! | C1 | 20 |
| 3. Any load that occurs on the bearing treatment! | C2 | 20 |
| 4. Mention and explain the types of bearing bearings! | C2 | 20 |
| 5. Mention factors that cause damage to the bearing! | C1 | 20 |
| **Total Score** | | **100** |
| **Specific Learning Objectives 7** | **Cognitive Domain** | **Score`** |
| 1. Explain the meaning of braking! | C1 | 20 |
| 2. explain the main function of the braking system! | C1 | 20 |
| 3. What considerations should be considered in determining braking! | C3 | 20 |
| 4. Mention the types of braking that you know! | C2 | 20 |
| 5. Determine the forces that occur in the belt and calculate the braking torque! | C4 | 20 |
| **Total Score** | | **100** |

### *G. Media Selection*

Media selected in Machine Element Design is the Design Trainer. It is used to make the students comprehend clearly how to define mechanism and torque calculation, power and manufacture capacity.

### *H. Prior Module Design*

a) Format Selection
   1. Paper size is A4 portrait orientation, the margin as follows : top 3 cm, bottom 3 cm, right 3cm and left 3 cm.
   2. The cover is glossy photo paper and for the module is A4 70 gram.
   3. The font used is Book Antiqua with proportional size, it follows the use for Title, Sub-Title, Competence, Sub-competence, Competence Content, number of table and figure.
   4. Use proportional header and footer, it follow the size and type of paper.
   5. Easy symbol. The objective is to emphasize the important things. They are figure, table, bold, underlined and italic fonts.

b) Modul Draft
   1. The title of the module describes the content on it.
   2. The procedure of the module must be applied by the students to learn it.

3. Competence and sub-competence will be obtained after learn it.
4. The learning objectives achieved after they learn it.
5. The content of the module consist of knowledge, skill and character must be learned by them.
6. Test which consist of several quiz. It must be accomplish by them
7. The answer key to guide them.

## *I. Module Validation*

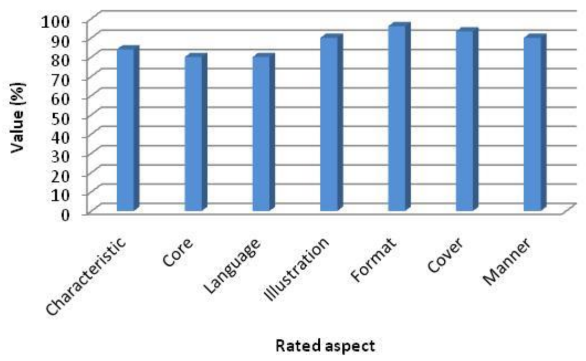


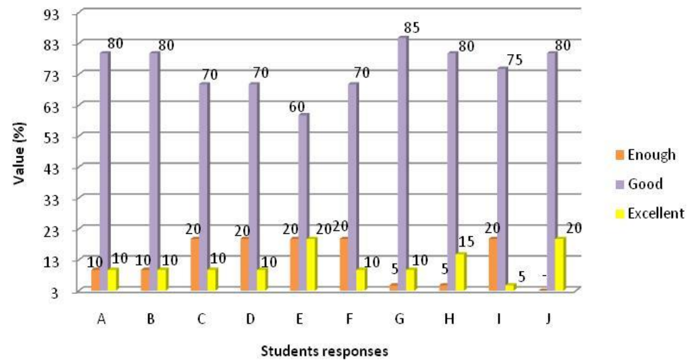

Fig. 3. Module Validation

The average percentage of the seven aspects of evaluation module validation at 87.61.%. The percentage obtained if interpreted in a Likert Scale, showed that the module-based project learning developed is proper in accordance with criteria. On validation sheet also accompanied by feedback column to revise it. Revision is needed to complete (make it perfect) machine element design related to project learning. Table IV below shows the feedback from validator.

TABLE III. FEEDBACK FROM VALIDATOR

| No | Feedback | Revision | Description |
|---|---|---|---|
| 1 | Several typos in writing | Correct wrong writing | Feedback from validator III |
| 2 | Re-check the suitability between learning objectives and evaluation at the end of the learning activities whether they are appropriate | Suitability between learning objectives and evaluation at the end of learning activities has been checked and justified | Feedback from validator III |
| 3 | Add learning objectives to each competency | Literature has been added | Feedback from validator III |
| 4 | Attach Syllabus | Syllabus is attached | Feedback from validator III |
| 5 | Give the source in each picture in the module | The picture is equipped with a source | Feedback from validator II |
| 6 | Provide key answers, rubrics and evaluations for each competency | Justified | Feedback from validator II |
| 7 | The arrow in the explanation of the picture is given a text to make it clear | Answer keys, rubrics and evaluations are attached to the module | Feedback from validator II |
| 8 | Each picture is given clear information | The arrow on the explanation of the picture has been given a text to make it clear | Feedback from validator II |
| 9 | The writing system was improved and more foreign language writing was examined | The picture has been given information | Feedback from validator I |
| 10 | The material of the production mechanism with calculations is separated | Justified | Feedback from validator I |

## *J. Students Questionnaire Respones*




Description:

A. Module component
B. Module material
C. Teaching using modules
D. Understanding of the notion of designing techniques
E. Understanding of the production process
F. Understanding of torque calculation, shaft rotation, and power usage
G. Understanding of various types of transmissions
H. Understanding of various types of shafts
I. Understanding of various types of bearing bearings
J. Understanding of various types of braking

Fig. 4. Students Questionnaire Responses

Based on the data in the table above, it can be seen that the percentage of student responses to learn engineering design use machine element design module consists of 10 statements were greeted good enough 13%, 75% good and 12% excellent. It can be stated that 87% is good.

## IV. CONCLUSION

According to the research, it can be concluded that :

The course module machine element design based on project – learning is proper and can be used at S1 Engineering Education, Mechanical Engineering Department, Faculty of Engineering, State University of Surabaya. This module will ease all students to comprehend engineering design well.

The properness of this module related to :

a) The result of 3 lecturer validation

The results of 3 expert lecturer percentage values obtained an average of 87.61%. It has been obtained from 7 aspects such as: the characteristic aspects feasibility of a percentage 84.00%, the content of a percentage feasibility aspects of 80.00%, a percentage viability of the language of 80.00%, a percentage illustrative aspects of the feasibility of 90.00%, the aspect format gets eligibility percentage 96.00%, the appearance aspect (cover) got 93.33% percentage feasibility aspects of etiquette module gets eligibility percentage 90.00%

b) The result of students' questionnaire responses

Students' responses consisting of 10 statements were greeted good enough 13%, 75% good and 12% excellent. That can be rounded to 87% better. With the results of these responses, module design is a feasible technique used in the learning process of designing engineering courses.

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