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Developing Module Handbook in Outcome-Based Education (OBE) Curriculum for Undergraduate Mechanical Engineering

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ABSTRACT
The development of the world of education is required to be more competitive and have quality following international standards, including the Mechanical Engineering Undergraduate Study Program. This study program continues to develop graduates who can compete globally. The stage that must be passed is to follow system standard Outcome-Based Education (OBE), which focuses on what students should have or should do in achieving graduation. In the OBE method, learning outcomes are carried out by an identification process and continued with an assessment process and learning methods adapted to these outcomes; it is one of the orientations of Merdeka Belajar Kampus Merdeka (MBKM). The main issues are that the study program still does not have a handbook module that follows the OBE curriculum. The aim of this research is to develop a module handbook that is adapted to the OBE curriculum and validated. This type of this study is development research using Research and Development (RnD) with a 4-D Models. This procedure is defined, designed, developed, and disseminated. The defined stage is the stage regarding the characteristics of learning activities. The design stages are media and formats used in module development. Develop stage purpose The goal of the development stage is to produce a final draft and the disseminate distribution of module development. The result of this study is that learning activities of the program's learning objectives are formulated into Program Learning Outcomes (PLO), and each handbook module has defined it. The design results are module handbook content according to the OBE curriculum. Two validators have validated the developed result with a percentage 89%%, 88 % students readability validation and 83.32% lecturers readability validation. The readability test was carried out on 19 students and seven peer lecturers to see if the handbook module was appropriate. From these criteria, the module handbook is appropriate to be distributed. In order to support teaching during the COVID-19 pandemic, the distribution of the handbook module through the upload process to the website of the mechanical engineering department.

Keywords: *module handbook, outcome-based education, Research and Development (RnD), 4-D models, 4-Likert scale*

1. INTRODUCTION

The development of the world of education is required to be more competitive and have quality following international standards, including the Mechanical Engineering Undergraduate Study Program. This study program continues to improve to create graduates who can compete globally. The stage that must be passed is to follow the Outcome-Based Education (OBE) system standard. A learning system that has an external orientation (Outcome-Based education) is a method that focuses on what students should have or should do in achieving graduation.

Outcome-Based education in engineering education aims to empower engineering students with essential characteristics required to switch themselves into the engineering profession as global and professional engineers. The research focuses on exploring the philosophical and theoretical basis of Outcome-Based education and challenges in implementing the OBE

framework in engineering education [1]. In the OBE method, learning outcomes are carried out by an identification process and continued with an assessment process and learning methods adapted to these outcomes. One of the central aspects of this learning process is the module handbook. A module handbook is a document issued by the university that includes all critical information about the courses in a study program. Part of the module handbook includes the total workload, content, time needed for the independent learning process and with teachers, references and media used in the learning process.

The critical factors for producing graduate students are qualified in their capability. In this case, Higher Education Institutions (HEIs) become the key to producing qualified graduates. Higher Education System certifies that on Law No 12 the Year 2012, one of the aims that should be fulfilled in HEIs is to produce graduates master Science and Technology to actualize national concern and increase national competitiveness. This implies that Higher Education Institutions become the location for students to learn soft skills and hard skills[2].

The policy of Merdeka Belajar Kampus Merdeka (MBKM) was launched by the Indonesian Minister of Education and Culture (now Republic of Indonesia Ministry of Education, Culture, Research, and Technology) in February 2020. The main objective of the Merdeka Belajar Kampus Merdeka is to give independence to Higher Education Institutions and produce quality graduates [3], [4]. This outcome is important to give opportunity for students graduates to be more competitive. Merdeka Belajar Kampus Merdeka is the first stage of High Education Institutions independency. The Indonesian Minister of Education and Culture (now the Republic of Indonesia Ministry of Education, Culture, Research, and Technology), Nadiem Makarim, suggested focusing on education outcomes [5].

The research of this study reported that Merdeka Belajar Kampus Merdeka's new policy aims to improve graduate workability. Based on the Minister of Education and Culture Regulation (now Minister of Education, Culture, Research, and Technology) No. 3/2020 on National Standards of Higher Education, this policy should be implemented by all Higher Education Institutions in Indonesia. In an arrange to prepare the implementation and based on the concept of quality graduates such as position, possession, and process. High Education Institutions have to prepare various activities so that they can be implemented successfully [6].

The curriculum is the core of education so it necessary to carry out an ongoing evaluation in accordance with the development of science and technology. In learning activities, the curriculum is a plan that contains objectives, teaching materials, content, and guidelines for learning activities so that the objectives of education can be achieved in accordance with the context of the Unitary State of the Republic of Indonesia. The curriculum is not only a formality but as an individual concept of nation and state [7]. At this time, especially in the Industrial Revolution 4.0 era, universities must pay close attention to the profile of graduates and the qualifications of learning outcomes so that there is a need for alignment in determining the profile of graduates into learning outcomes and subject learning outcomes. In responding to this, the definition of the curriculum should be as a document that is constantly changing where the courses may be the same, but the content of the curriculum must continually be refined, which shows one's competence in adapting to change (lifelong learning). Adapting to this gave rise to output-based education (OBE), which became one of the orientations of the independent learning curriculum [7].

Outcomes-Based Learning (OBE) has been used throughout the world at various levels. Countries that have used this method are Australia, South Africa, the UK, the USA, Hong Kong, Sri Lanka, Turkey, and China. The characteristics of OBE are the focus on learning outcomes that must be met until the end of the lesson, overall curriculum design to ensure the fulfilment of learning outcomes, using assessment to ensure each student has met the learning achievement criteria, and remediation and enrichment. OBE principles regarding Course Learning Outcomes (CPMK), where one of the facilities used is the handbook module. Modules are lecture materials in the form of a set of materials with a systematic, specific, precise, and exciting arrangement. The module's scope is in the form of lecture material content, sample questions, and test samples [8].

The preliminary review in Pakistan showed several factors and the importance of the educator section in formulating the curriculum, such as sustainable learning, encouraging the students, increasing knowledge from each other, and giving feedback. The review focused that OBE approaches show effects concerns in improving competencies. However, more studies with large sample size and strict methodology still need to be carried out [9]. OBE curriculum focuses on a definite results orientation, although implementation and development require experience and resources at both internal and external levels [10].

The study reported that OBE means have function effects on the communication skills of undergraduates. Based on this curriculum model, the educator stimulated the body and mind of students by improving teaching methods, optimizing the teaching structure, and creating a good teaching environment. At the same time, educators give inspiration and motivation to students to maintain the initiative and spirit in learning, increase learning confidence, upgrade communication skills and contribute to the progression of teaching quality in Guangdong Ocean [11].

In this study, the module handbook was made according to the OBE curriculum. Modules are lecture materials in the form of a set of materials with a systematic, specific, precise, and exciting arrangement. The module's scope is in the form of lecture material content, sample questions, and test samples [12].

The module handbook was made according to the OBE curriculum with the ASIIN standard template in this study. The development of this handbook module uses the 4D-Models approach. This research is a Research and Development (R&D) research using the Four-D Models approach, which includes Define, Design, Develop and Disseminate. Activities in this stage are preliminary analysis, student analysis, material analysis, task analysis, and specification of learning objectives. The purpose of the Design Phase is to produce a learning device design. The results at this design stage are called the initial draft (draft I). Activities at this stage are media selection, format selection, and initial design. Development Phase (Develop) The purpose of the development phase is to produce a final draft of a good learning tool. Activities at this stage are expert validation and readability test. Dissemination Stage, The purpose of this stage is to conduct validation tests on learning tools that have been tested and revised, then distributed to the field [13].

From the previous explanation, the main issue is that the study program still does not have a handbook module following the OBE curriculum. Lectures are still carried out using traditional learning methods where the topics taught are determined by the lecturer in charge of the course then on the topic, the outcomes are only identified, no handbook module matches the OBE in the Undergraduate Mechanical Engineering study program, and the handbook module in the Undergraduate Mechanical Engineering Education Program has not been validated. This research aims to develop a module handbook adapted to the OBE curriculum using Research and Development (RnD) research with a 4-D or Four-D Models, and the module handbook on Undergraduate Mechanical Engineering Study Program has been validated. Validation using the 4-Likert scale.

2. RESEARCH METHODS

2.1. Types of Research

This type of research is a type of development research because this research has the aim of developing and validating a product using the 4-Likert scale. In this case, the product is a module handbook for all courses in the Undergraduate Mechanical Engineering Education Study Program. The module handbook will be developed following the module handbook for the learning needs of the Undergraduate Mechanical Engineering Study Program. This research used Research and Development (R&D).

2.2. Research Procedure

This research has four steps, namely preparation, implementation, data analysis, and report. This type of research is Research & Development (R&D) and uses 4-D models. The development of the module handbook through four steps:

1. Define
   Initial - final analysis which is the stage regarding the characteristics of learning activities in the Mechanical Engineering Undergraduate Study Program that uses the OBE curriculum and is in accordance with the Mechanical engineering Collaboration bureau (BKSTM) standard. Material analysis is the basis in the preparation of learning objectives. This material analysis is also useful in determining the parts of the material to be studied in learning.
2. Design
   Media selection. The media used for developing this module handbook is in the form of a book consisting of a collection of handbook modules for all subjects in the Mechanical Engineering Undergraduate Study Program Format selection. At this stage, the researcher chooses a format for designing content, selecting learning strategies and learning resources that follow the principles, characteristics, and steps in accordance with the learning model used. In this study, according to the OBE and ASIIN templates. Initial design. They were first adjusted to the handbook module for the Mechanical Engineering Education Study Program.
3. Develop
   The purpose of the development stage is to produce a final draft of a good learning tool. Activities at this stage are:
   a. Expert validation. Two validators validated the results of the initial design (draft I), and the revision was used as the basis for improving learning tools to obtain draft II.
   b. Readability Test. The readability test was carried out on 19 students and seven peer lecturers to see if the handbook module was appropriate.
4. Disseminate
   The purpose of this stage is to conduct validation tests on learning devices that have been tested and revised, then distributed.

The data analysis techniques used in this study are as follows [14], [15] :

Expert validation analysis is carried out by:

a. Calculating the validity score from the expert validators results using the formula:

$$\text{Validity} : \frac{total\ validation\ score\ 2\ validators}{max\ total\ score} \text{ x } 100\% \quad (1)$$

Calculating the validity score from the students (readability)

$$\text{Validity} : \frac{total\ validation\ score\ 19\ students}{max\ total\ score} \text{x} 100\% \quad (2)$$

Calculating the validity score from the students (readability)

$$\text{Validity} : \frac{\textit{total validation score 7 lecturers}}{\textit{max total score}} \text{ x } 100\% \quad (3)$$

b. The results of the validity of which the percentage is known can be matched with the criteria validity as presented :

Table 1. Module Handbook Validity Criteria

No	Score	Validity criteria
1.	85,01 - 100,00 %	Very appropriate (implementation)
2.	70,01 - 85,00 %	Appropriate (implementation)
3.	50,01 - 70,00 %	Fairly appropriate (Revision)
4.	01,00 - 50,00 %	Hardly appropriate (Change)

3. RESULTS AND DISCUSSIONS

3.1. Product Description

This product of research and development is the module handbook. It contains a systematic explanation of each subject taught in the mechanical engineering undergraduate study program. The handbook module produced has adapted the OBE curriculum. The number of courses and the load is in accordance with the MBKM curriculum. The module consists of:

a. Module name
b. Module-level, if applicable
c. Code, if applicable
d. Semester (s) in which the module is taught
e. The person responsible for the module
f. Lecturer
g. Language
h. Relation to curriculum
i. Types of teaching and learning, class size, attendance time (hours each week each semester), forms of active participation, workload,
j. Structured Assignment /practice self-assignment.
k. Total workload
l. Credit points requirements according to the examination regulations
m. Recommended prerequisites
n. Module objectives/intended learning outcomes
o. Content
p. Study and examination requirements and forms of examination
q. Media employed
r. Reading list

3.2. Product Validation

Data from the validation in this research consisted of two validators. According to OBE and MBKM curriculum, assessments are focused on content, display according to PLO (Program Learning Outcomes), CO (Course learning Outcome), and format.

Verbal data in the below form of criticisms, comments, and suggestions were tabulated to facilitate revision of the product.

Table 2. Verbal Data of Validators

Validator	
1.	a. Added learning models and methods used. b. The application of the method in the learning activity phase. c. Assessment techniques and strategies that are in accordance with learning to find out d. Student learning outcomes.
2.	There are some suggestions including: 1. Add the learning model column used 2. It is better to give attachments about assignments, mid-exam, final exam so that it can be seen the compatibility between the learning objectives and the questions given.

Table 3. Expert Validation and Empirical Validation

No	Expert Validator	Score
1.	Validator 1	72
2.	Validator 2	78
Total score	150	
Max total score	168	

Based on table 3, validator 1 gives the score of 72 and validator two is 78, and the total score is 150 while the maximum score is 168. The following calculation determines the percentage of eligibility:

$$\text{Validity} : \frac{\textit{total validation score 2 validators}}{\textit{maximum total score}} \text{ x } 100\% \quad (4)$$

$$\frac{150}{168} \text{ x } 100\% \quad (5)$$

$$: 89.28\%$$

From the calculation results and matched with the 4-Likert scale, the product of the handbook module is found to be 89.28%. It is indicated that the qualifications of this product are very appropriate (table 1) [14], [15] and

eligible to develop to final draft. This is in accordance with Arikunto opinion [16], [17].

3.3. Readability Test.

The readability test was carried out on 19 students and seven peer lecturers to see if the handbook module was appropriate.

Table 4. Students Validation

Student	Score
1	35
2	46
3	43
4	47
5	40
6	48
7	39
8	48
9	48
10	46
11	41
12	45
13	40
14	40
15	42
16	35
17	41
18	39
19	40
Total Score	803
Max Score	912

Based on table 4 percentage of eligibility is determined by the following calculation:

$$\text{Validity} : \frac{total\ validation\ score\ 19\ students}{max\ total\ score} \text{x}100\% \quad (6)$$

$$: \frac{803}{912} \text{x}100\%$$

: 88 %

Table 5. Lecturers Validation

Lecturer	Score
1	34
2	32
3	43
4	41
5	40
6	46
7	44
Total Score	280
Max Score	336

Based on the table 5 percentage of eligibility is determined by the following calculation:

$$\text{Validity} : \frac{total\ validation\ score\ 7\ lecturers}{max\ total\ score} \text{x}\ 100\% \quad (7)$$

$$: \frac{280}{336} \text{x}\ 100\%$$

: 83.32 %

From the calculation results and matched with the 4-Likert scale, the readability of the handbook module is found to be 88% validation from students and 83.32% from lecturers. It is indicated that the qualifications of this product are very appropriate and appropriate (table 1) [14], [15] and eligible for actual implementation. This is in accordance with Arikunto opinion [16], [17]. In order to support teaching during the COVID-19 pandemic, the handbook module is distributed by uploading it to the website of the mechanical engineering department. This link can be found at https://drive.google.com/drive/folders/1lrCNt2HRYgqdpGMcFB9xJyP2NOIXiL_M?usp=sharing

4. CONCLUSION

The module handbook is a concise handbook that is used as a support in the learning process, which contains an overview of the discussion topics in each course. The development of the handbook module is needed to facilitate students—the results obtained in this study module handbook follow the Outcome-Based Education curriculum. The module handbook for the undergraduate mechanical engineering study program has been validated with 89%, 88 % students readability validation and 83.32% lecturers readability validation. From these criteria, the module handbook is appropriate to be distributed. This process is called dissemination. In order to support teaching during the COVID-19 pandemic, the handbook module is distributed by uploading it to the website of the mechanical engineering department.

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