Development of the maintenance and repair module for mechanical engineering education courses

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Abstract. This study aims to develop a Dictation of Machine Maintenance and repair that is able to support the learning of the subject of Maintenance and Repair of the Department of Mechanical Engineering Education and determine the feasibility of the Maintenance and Repair Module of the Department of Mechanical Engineering Education. This research is a research and development which refers to the research and development steps of Sugiyono including identification of potential and problems, data collection, product design, design validation, design revisions, product trials, product revisions, trial use, product revisions and mass production. The results of the study show that the dictation of maintenance and machine repair of the Department of Mechanical Engineering Education, Faculty of Engineering, Yogyakarta State University has been developed with reference to the research and development steps of Sugiyono and it is feasible to be used in the Department of Mechanical Engineering Education, Faculty of Engineering, Yogyakarta State University.

1. Introduction
Educational institutions have a duty to develop the intellectual life of the nation and prepare qualified human resources as development agents. The national education system functionalized to develop capabilities and shape the character and civilization of a dignified nation in the context of educating the life of the nation, aiming at developing the potential of learners to become human beings who believe in and have faith in God Almighty, have noble, healthy, knowledgeable, capable, creative, independent, and become citizens of a democratic and responsible.[1]

According to Law on the National Education System (No. 20/2003) concerning Higher Education, Higher Education is a level of education after secondary education which includes diploma programs, undergraduate programs, master's programs, doctoral programs, and professional programs, as well as specialist programs, which are organized by universities based on Indonesian culture. Higher Education stated that Higher Education aims: the development of the potential of students to become human beings who believe and fear God Almighty and have noble, healthy, knowledgeable, capable, creative, independent, skilled, competent, and cultured for the benefit of the nation, produced graduates who master the branches of Science and Technology to meet national interests and increase national competitiveness, the generation of Science and Technology through Research that pay attention to and apply the value of the Humanities to benefit the progress of the nation, as well as the progress of civilization and welfare of humanity, and the realization of Community Service based on reasoning and research work that is useful in advancing public welfare and intellectual life of the nation[2].
In the 2014 Department of Mechanical Engineering Education Curriculum it was stated that the Faculty of Engineering Yogyakarta State University is part of the higher education institution that has the task of carrying out the tri dharma of higher education, namely organizing education and teaching, research, and community service. In the field of education and teaching, the Faculty of Engineering Yogyakarta State University organizes 2 (two) educational program pathways, namely the Strata 1 (S1) level education pathway and, the non-educational level diploma level 3 (D3). In this case, the Faculty of Engineering Yogyakarta State University has the dual task of preparing educational and non-educational staff in the technical and vocational fields which need to be managed in an integrated and synergistic manner [3].

The quality of education can be improved if the learning process is carried out effectively and efficiently. The Definition of Learning in accordance with Law on the National Education System (No.20/2003) concerning the National Education System, is the process of interaction of students with educators and learning resources in a learning environment [1]. Learning can be said to be effective if it reaches the targets or objectives set in the learning plan. There are various factors that influence the learning process, both from the students themselves and from other factors such as educators (teachers/lecturers), facilities, environment, methods, and learning media [4].

The learning that is carried out in the Department of Mechanical Engineering Education is designed referring to the Indonesian National Qualification Framework level 6. The learning objective is to provide students with the ability to master theoretical concepts in the field of vocational education in mechanical engineering and be able to apply education and mechanical engineering to solve problems that will be encountered in the work environment [5]. One of the courses given to support learning is the Machine Maintenance and Repair (PPM) course.

The Machine Maintenance and Repair Course is a course that facilitates students to gain basic knowledge and competencies in carrying out maintenance and repair activities. The lecture activities consist of theory and practice. Theory lectures are conducted in large classes, including discussing: Understanding Machine Maintenance and Repair, Machine Maintenance/Repair Functions in Industry, Classification of Care, Lubricants and Lubrication Systems, System Maintenance, Component Maintenance, Maintenance Management, Maintenance Cycles, Total Productive Maintenance, Diagnosis Machine Damage, and Electrical Maintenance. On the other hand, practical lectures are conducted in small classes, practical material includes, disassembly practices, preventive maintenance practices (lubrication practices, inspections, belt adjustments, brake adjustments, sling tuning), and component repair practices [6].

Based on the results of the interviews, it was found several problems in learning Machine Maintenance and Repair courses, namely: lack of student awareness of the importance of learning resources, lack of learning resources for students, causing students to be less able to study independently, still limited learning media that support lecture activities especially for theoretical activities, and available teaching materials are not supported with the syllabus of the Machine Maintenance and Repair course.

Based on the explanation above, the procurement of learning resources to support the improvement of the quality of the learning process of the Machine Maintenance and Repair course is something that needs to be implemented. The existence of learning resources can make it easy for students to be able to understand the material delivered by the lecturer in a maximum way.

2. Methods

This research is research and development. Research and development is a research method that produces certain products and tests the effectiveness of these products. The steps taken in the research and development of the maintenance and engine repair dictates refer to the research and development steps, namely: identification of potentials and problems, data collection, product design, design validation, revision design, product testing, product revision, trial run, product revision and mass production [7].
Research on the development of the Maintenance and Repair Module of this Machine was carried out in the 2018/2019 school year starting from February 7 to May 7, 2019, in the Department of Mechanical Engineering Education, Faculty of Engineering Yogyakarta State University.

The subjects of this study were students of the Department of Mechanical Engineering Education in the class year 2018-2019. The product validation was carried out by the lecturers of the Department of Mechanical Engineering. Determination of the test subjects in this study, that if the subject is less than 100 it is better to take all of it so that the research is a population study. However, if the subject is larger, it can be taken between 10-15% or 20-25% or more, depending at least on the researcher's ability in terms of time, energy, and funds; the breadth of the area of observation of each subject, because it involves a lot of data at least; the size of the risk borne by researchers. For studies with large risks, of course, if a large sample, the results will be better [8].

Based on this, this study uses 20% of the sample population or 20% of 138 students, 28 of which are used for testing (large classes). And 20% of the sample use trials (large classes) or 20% of 28 students namely 6 students for limited trials (small classes).

Products that have been validated cannot be directly tested but must be repaired again so that the product is ready to be trialed. Product designs that have been revised are then tested on 6 students for product trials and 28 students for trial use.

This research instrument is intended to assess the feasibility of the Maintenance and Repair Module Machine. The research instruments on the development of the Maintenance and Repair Module Machines were made in three groups, namely for the subject matter Engine Maintenance and Repair, for learning media experts, and for students. Data obtained through questionnaires are divided into two forms of data, namely qualitative data in the form of comments, criticisms, and suggestions from respondents, which are concluded as input to improve/revise the textbook products developed. While quantitative data obtained through the assessment questionnaire will be analyzed by quantitative descriptive analysis using a Likert scale to determine product quality.

The technique used to analyze data is the quantitative descriptive analysis technique revealed in the distribution of scores against the specified rating scale category. The results of the assessment from material experts, media experts, and students in the form of qualitative data are then converted into a score form using a Likert scale [9]. Then the interval is determined and a product classification table is made to assess the resulting dictates as in Table 1.

| Average Score | Category     |
|---------------|--------------|
| >3.25 - 4.00  | Very good    |
| >2.50 - 3.25  | Good         |
| >1.75 - 2.50  | Not good     |
| 1.00 - 1.75   | Not very good|

3. Results and Discussion

The final product produced in this research development is the Dictation of Machine Maintenance and Repair. This textbook is in the form of a book with a size of B5 (182 x 257) mm, which is printed using 80-gram HVS paper for the contents and 260 grams for ivory paper for the cover. The Machine Maintenance and Repair Toolkit contains theories about Machine Maintenance and Repair, including basic concepts of care, types of care, maintenance management, diagnosing damage, work and hand tools, lubrication systems, and engine maintenance and repair.

In accordance with the results of the assessment that has been done, the Module Maintenance and Machine Repair that was developed was appropriate to be used in learning the subject of Maintenance and Machine Repair in the Department of Mechanical Engineering Education. The results of the Module Machine Maintenance and Repair assessment get a total average of 3.39 and are in very good classification. Data on the results of the dictation assessment are presented in Table 2.
Table 2. Module assessment results

| Assessment Aspects       | Average Score | Category   |
|--------------------------|---------------|------------|
| Material Expert          | 3.34          | Very Good  |
| Media Expert             | 3.58          | Very Good  |
| Limited Product Trial    | 3.27          | Very Good  |
| Trial Usage              | 3.38          | Very Good  |
| Average Total            | 3.39          | Very Good  |

Material experts state that the average aspect of the content of the material is 3 and is in good classification, the average aspect of the learning strategy is 3.67 and is in very good classification, and for the overall average in terms of material in the Maintenance and Repair dictation of this Machine is 3.34 and is in a very good classification. Data validation results from material experts are presented in Table 3.

Table 3. Results of expert material validation

| Assessment Aspects   | Average Score | Category |
|----------------------|---------------|----------|
| content material     | 3             | Good     |
| Learning strategies  | 3.67          | Very Good|
| Average Total        | 3.34          | Very Good|

Media experts stated that the average aspect of communication was 3.5 and it was classified as very good, the average aspect of attraction was 3.5 and it was very good, the average aspect of the display format was 3.75 and it was very good, and for the overall average in terms of media in the Dictation of Machine Maintenance and Repair is 3.58 and is in a very good classification. Data validation results from media experts are presented in Table 4.

Table 4. Media expert validation results

| Assessment Aspects   | Average Score | Category   |
|----------------------|---------------|------------|
| Communication        | 3.5           | Very Good  |
| Attractiveness       | 3.5           | Very Good  |
| Display Format       | 3.75          | Very Good  |
| Average Total        | 3.58          | Very Good  |

Limited product trial results state that the average for the material content aspect is 3.33 and is in a very good classification, the average aspect of the learning strategy is 3.5 and is in a very good classification, the average aspect of communication is 3.06 and is in a good classification, the average aspect of attractiveness is 3.04 and it is in good classification, the average aspect of display format is 3.42 and is in very good classification, and for the average of all aspects in the limited trial is 3.27 and is in very good classification. Data on the results of limited product trials are presented in Table 5.

Table 5. Results of limited product trial data analysis

| Assessment Aspects   | Average Score | Category   |
|----------------------|---------------|------------|
| Content material     | 3.33          | Very Good  |
| Learning strategies  | 3.5           | Very Good  |
| Communication        | 3.06          | Good       |
| Attractiveness       | 3.04          | Good       |
| Display Format       | 3.42          | Very Good  |
| Average Total        | 3.27          | Very Good  |

The results of the trial use stated that the average aspect of the content of the material was 3.52 and was in a very good classification, the average aspect of the learning strategy was 3.37 and was in a very good classification, the average aspect of the communication was 3.45 and was in a very good classification, the average aspect of attractiveness is 3.11 and it is in good classification, the average
aspect of the display format is 3.43 and is in very good classification, and for the average of all aspects in the trial use is 3.38 and is in very good classification. Data on the results of the trial use are presented in Table 6.

Table 6. Results of data analysis of product usage trials

| Assessment Aspects      | Average Score | Category  |
|-------------------------|--------------|-----------|
| Content material        | 3.52         | Very Good |
| Learning strategies     | 3.37         | Very Good |
| Communication           | 3.45         | Very Good |
| Attractiveness          | 3.11         | Good      |
| Display Format          | 3.43         | Very Good |
| Average Total           | 3.38         | Very Good |

4. Conclusions

Machine Maintenance and Repair Module Department of Mechanical Engineering Education, Faculty of Engineering Yogyakarta State University has been completed with 10 steps of development, namely: identification of potential and problems, data collection, product design, design validation, design revisions, product trials, product revisions, trial trials, revisions product, mass production.

The final product produced in this research development is the Dictation of Machine Maintenance and Repair. This textbook is in the form of a book with a size of B5 (182 x 257) mm, which is printed using 80-gram HVS paper for the contents and 260 grams for ivory paper for the cover. The Machine Maintenance and Repair Toolkit contains theories about Machine Maintenance and Repair, including basic concepts of care, types of care, maintenance management, diagnosing damage, work safety and hand equipment, lubrication systems, and engine maintenance and repair.

The results of the feasibility of the Machine Maintenance and Repair Module are determined by 4 assessment activities namely: validation of material experts, validation of media experts, limited trials, and trials of use. It is hoped that further researchers can continue research on the Dictation of Maintenance and Machine Repair to find its effects on learning or compare with other learning media.

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