Development of computer aided manufacturing learning module for Magelang vocational high school students

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Abstract. This study aims to develop computer aided manufacturing (CAM) learning modules for students, find out the feasibility of learning modules for students, and find out student assessments of modules. The research method used is 4D (Define, Design, Development, Dissemination). Data collection using a questionnaire. The results showed the feasibility of teaching materials by material experts who get a percentage of 84.17% with a very decent category, from CNC learning practitioners get a percentage of 85.83% with a very feasible outcome category, and assessment of students in class XII machining at Vocational High School 1 Magelang obtained a percentage of 85.28% which is included in the very feasible category. Based on the results of the assessment by material experts, CNC learning practitioners, and student assessments, this module is included as a very feasible use as teaching material for vocational students.

1. Introduction

Vocational High School is one of the providers of vocational education in Indonesia to prepare human resources who have the ability skills and can compete in the world of work. Vocational High School (VHS) 1 Magelang is a school with qualified facilities to support learning in schools, especially in the engineering expertise program. One of the leading subjects at Vocational High School 1 Magelang is computer numerical control (CNC) and computer aided manufacturing (CAM) and is equipped with a variety of sufficient CNC machine facilities [1].

Based on interviews obtained from subject teachers and the experience of writers at VHS 1 Magelang, students do not have teaching materials in the form of modules. So many students have difficulty understanding the subject matter and ultimately think that the subject of CNC Machining Engineering is difficult. Students only rely on their notes based on the explanation given by the teacher. Even though this is still very lacking, considering that the CNC material is understanding not memorizing. Hence, it is necessary to have an additional reference in the form of a module because, with the module, it is easier for students to understand the CNC material. After all, students can more often do the exercises contained in the module itself. The existence of modules is expected to improve student achievement [2].

Taking into account some of the things mentioned above, it is necessary to develop teaching material in the form of modules for the subject of CNC Machining Engineering. The module is expected to help students and teachers in carrying out the teaching and learning process. This teaching material was first
tested in class XII of the Mechanical Engineering Expertise Program at VHS N 1 Magelang, 2019/2020 academic year.

The TU-2A Basic CNC Module, which was developed, could improve the learning achievement of class XII students of Mechanical Engineering VHS 1 Magelang. This can be seen after the data is analyzed and tested with the paired sample t-test (Paired-Samples T-Test). The results obtained are $t$ count (-5.887) $\Rightarrow$ 5.887 (absolute value) with a significance value of Sig (2-tailed) (0.000) $<$ (0.05) so that the amount after treatment increases, compared to before treatment [3].

The application of the CNC and CAM milling learning module can be carried out because the modules are arranged according to the needs and the equipment available at VHS [4]. The application of the CNC and CAM milling modules increased students’ competence with the results of practice exams rising by 52.38%, and the results of written examinations rising by 51.53%. Activeness increases with 21 students willing to read the module, 14 students understand the material quickly, eight students respond to the material, and nine students who can provide tutorials to their friends. This study aims to develop teaching materials in the form of a CAM learning module, determine the feasibility of a CAM learning module material, and determine the assessment of class XII students of Machining Vocational High School 1 Magelang against the CAM learning module.

2. Method
The subject of this research is the CAM learning module. The module is divided into 4 stages at the development stage, namely Define, Design, Development, and Dissemination. In the Define and Design Stage (needs analysis and design) is carried out by researchers, at the Development stage researchers carry out the Development of teaching materials, and teaching materials are subject to feasibility tests by material experts and learning practitioners, and assessed by 38 students of class XII VHS Machining 1 Magelang.

Research procedure carried out is 4D, including the Define stage (needs analysis), which includes analysis of student needs, analysis of instructional and competency standards, suitable learning materials to be developed in CNC and CAM subjects are CAM teaching materials; the Design stage, which includes design making, material preparation, questions, discussion, and cover design; Development stage, namely making teaching materials, making material feasibility assessment instruments, feasibility assessments by material experts, revision of teaching materials, and feasibility assessments by learning practitioners or CNC teachers to make improvements/revisions to the teaching materials developed. Dissemination ,this stage has not been carried out due to limited time in conducting research [5].

The data collected in this study consisted of two data, namely, qualitative data and quantitative data. Qualitative data is data about the Development of teaching materials in developing teaching materials, criticism, and suggestions from material experts, CNC learning practitioners, and students. Quantitative data is data for assessing the feasibility of CAM learning materials from material experts, CNC learning practitioners, and students. The instrument in this study used a questionnaire with a Likert scale. Questionnaires are used to assess teaching materials based on material experts, learning practitioners, and students.

The data obtained from material experts and students were then analyzed by converting qualitative data into quantitative data. The collected data were analyzed by calculating the percentage of the assessment level. The calculation of the percentage level of the assessment obtained was quantitative data then converted back into qualitative data. It was qualitatively interpreting the average number of scores for each aspect using the five-scale conversion criteria obtained qualitative criteria as Very Feasible, Feasible, Enough, Inadequate, and Unworthy [6].

3. Result and Discussion
This study aims to develop teaching materials in the form of CAM learning modules on CNC and CAM subjects for class XII Machining students of Vocational High School 1 Magelang, knowing the feasibility of the CAM module being assessed by material experts and CNC learning practitioners of
Vocational High School 1 Magelang, and knowing the assessment of class XII students. Machining of Vocational High School 1 Magelang on the CAM learning module on CNC and CAM subjects.

The CAM Learning Module was developed through 4 stages, namely the define stage (needs analysis) [7]. At this stage, a needs analysis was carried out with students and teachers and reviewed the curriculum at Vocational High School 1 Magelang. The results of class observations made, most students did not understand the icon in the Mastercam application because the teacher only explained it without providing a handbook explaining all the instructions in the application. They were coupled with the inactivity of students in recording material taught by the teacher. The stage of reviewing the curriculum is carried out by studying the syllabus in the Mechanical Engineering of Vocational High School 1 Magelang related to competency standards (CS) and basic competencies (BC), which will be included in the cam learning module. The CAM Milling programming simulation material in the Master CAM application is following the competency standards (CS) and Basic Competencies (BC) of CAM Milling.

The design stage is the stage of designing the module content and making the module display develop. Module design has three main parts: the introduction/pre-content section, the core/material content, and the closing/post-content section. The development stage at this development stage aims to produce the final module after going through the revision process. At this stage, the development of the module design is carried out. The finished module is then printed for consultation/validation by material experts and CNC learning practitioners. Then it is revised or corrected based on suggestions from material experts and CNC learning practitioners, and the next stage is tested and at the dissemination stage. This stage has not been carried out due to limited time in conducting research [8].

Validation carried out by material experts, seen from the content feasibility aspect, obtained an assessment result with a percentage of 85.71% which was included in the very appropriate category, from the presentation feasibility aspect, the assessment results obtained with a percentage of 84.29% which was included in the very appropriate category, and from the aspect of presentation feasibility. Language feasibility results obtained by the assessment with a percentage of 81.54%, which is included in the very appropriate category. The assessment results from the aspects of the feasibility of content, presentation and language obtained an average percentage of the results in the evaluation of material in learning media by the UNY lecturer material expert of 84.17%. These results indicate that the CAM learning module material developed is in the very appropriate category for use in learning. The results of material expert validation can be seen in Table 1. The results of the validation of the FT UNY Lecturer Material Expert can be seen in Figure 1.

| Table 1. Recapitulation of Material Expert Validation Results |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Aspect          | Score obtained  | Score Ideal     | Appropriateness | Category        |
| Content         | 90              | 105             | 85.71%          | Very Worth it   |
| Presentation    | 59              | 70              | 84.29%          | Very Worth it   |
| Language        | 53              | 65              | 81.54%          | Very Worth it   |
| Total           | 202             | 240             | 84.17           | Very Worth it   |
Validation carried out by learning practitioners (teachers) of vocational high school 1 Magelang seen from the aspect of content feasibility obtained the results of the assessment with a percentage of 86.67%, which was included in the very appropriate category, from the element of presentation feasibility obtained the results of the assessment with a ratio of 88.57% which was included in the very appropriate category. The language feasibility aspect got an assessment result with 81.54%, which was included in the very appropriate category. The overall assessment results by learning practitioners of vocational high school 1 Magelang obtained an average of 85.83%. These results indicate that the content, presentation, and language in the CAM learning module developed are included in the very appropriate category for use as teaching materials in VHS. At the validation stage by learning practitioners of vocational high school 1 Magelang, there were no revisions or improvements to the CAM learning module that was developed. The results of the assessment by learning practitioners of vocational high school 1 Magelang can be seen in table 2 below. The validation of learning practitioners at vocational high school 1 Magelang can be seen in figure 2.

Table 2. Recapitulation of the validation results of CNC learning practitioners

| Aspect       | Score obtained | Score Ideal | Appropriateness | Category      |
|--------------|----------------|-------------|-----------------|---------------|
| Content      | 91             | 105         | 86.67%          | Very Worth it |
| Presentation | 62             | 70          | 88.57%          | Very Worth it |
| Language     | 53             | 65          | 81.54%          | Very Worth it |
| Total        | 206            | 240         | 85.83%          | Very Worth it |

The assessment of class XII Machining Vocational High School 1 Magelang from the aspect of appearance obtained a percentage of 87.29%, which is included in the very appropriate category. The part of presenting the material got a rate of 84.57%, which is included in the very appropriate category, on the benefit. Aspect benefits obtained a percentage of 84.79% included in the very appropriate
category. Overall, the CAM learning module received a rate of 85.28%, which is included in the very appropriate category for use as teaching material. Student assessments can be seen in Table 3 and the results of student assessments can be seen in Figure 3.

| Aspect      | Score obtained | Score Ideal | Appropriateness | Category      |
|-------------|----------------|-------------|-----------------|---------------|
| Display     | 838            | 960         | 87.29%          | Very Worth    |
| Presentation| 1759           | 2080        | 84.57%          | Very Worth    |
| Benefits    | 814            | 960         | 84.79%          | Very Worth    |
| Total       | 3,411          | 4,000       | 85.28%          | Very Worth    |

Figure 3. Student Assessment Bar Chart of Vocational High School 1 Magelang.

4. Conclusion

The development of CAM teaching materials, using the 4D development model, includes definition (needs analysis) includes analysis of student needs, analysis of competency standards, design which includes making designs, compiling materials, questions, discussion, and cover design, development namely making teaching materials, making material feasibility assessment instruments, feasibility assessments by material experts, revision of teaching materials, and feasibility assessments by learning practitioners or CNC teachers to make improvements / revisions to the teaching materials developed, and dissemination. Dissemination has not done because of limited time in conducting research.

The feasibility assessment of the CAM learning module by material experts and CNC learning practitioners is in a very feasible category. This can be seen in the assessment of material experts and learning practitioners. The feasibility assessment of the CAM Learning Module based on Material Experts obtained a percentage of all aspects of 84.17% which was included in the very fit for use as teaching material. Based learning practitioners CNC or Master CNC vocational high school 1 Magelang obtained percentage of 85.83% of all aspects included in the category of most eligible used as teaching materials.

The results of the research development of learning modules for subjects CAM CNC machining techniques and CAM vocational high school 1 Magelang obtain the percentage of eligibility of 85.28% which is included in the category of very worth used as teaching materials in vocational school.

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