E-Module Development using the Four-D Model in Computer Systems Subjects for 10th Grade of Computer and Network Engineering Expertise Program at SMKN 3 Malang

Vearen Dika Sofirudin¹, Admaja Dwi Herlambang*², Satrio Hadi Wijoyo³
¹,²,³Brawijaya University, Malang
¹vearendikas@student.ub.ac.id, ²herlambang@ub.ac.id, ³satriohadi@ub.ac.id

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Abstract. This research aims to explain the results of needs analysis in development e-module using the four-d model in computer systems subjects and explains the results of measuring the success rate of implementing e-modules using the four-d model in computer systems subjects. E-Module is a type of digital learning media that is arranged systematically and attractively by utilizing electronic devices. The method used is research and development or the R&D four-d model. The model research four-d consists of four stages of development, including (1) definition, (2) design, (3) development, and (4) dissemination. The subjects of this study were students of 10th grade majoring in 1st Computer and Network Engineering at Vocational High School 3 Malang, while the research instruments used were validation e-module sheets, pre-test and post-test question sheets, assessment sheets, and student response questionnaires. Based on the results of the study, it was found that: (1) In developing e-module products, researchers have adjusted to the characteristics of students who find it difficult to understand theoretical material, especially in computer systems subjects. So that the presentation of content e-module is in the form of text, images, and videos to make it easier for students to learn the material independently. (2) The results of measuring the success rate of application e-module through the Paired Sample T-Test by comparing the pre-test and post-test results, namely a significance value shown in the sig column (2-tailed) is 0.000. The acquisition of a significance value that is less than 0.05 means that there are differences in learning outcomes before and after using the e-module.

Keywords. development, e-module, computer systems, Four-D models

1 Introduction

Vocational High School is a vocational level educational institution that aims to provide knowledge in the form of abilities or skills in certain fields of work in accordance with the world of work. One of the SMKN 3 Malang has a Computer and Network Engineering department. Computer and Network Engineering is a fundamental education model in Information and Communication Technology related to capabilities in learning programming algorithms, computer networks, and operating software, and the internet [1]. Computer and Network Engineering students are expected to be able to master material related to computers and networks in order to carry out practices according to the competencies that must be mastered.
The learning process, especially in the Computer and Network Engineering department at SMKN 3 Malang, still uses conventional methods, namely lectures and only utilizes learning media in the form of PowerPoint to deliver material. Students do not get teaching materials that can be re-studied at home. If students do not get a module that contains material that has been delivered, students will find it difficult to be able to read the material again during the learning process.

One of the goals of successful education that must be achieved is the use of appropriate media. Besides being expected to be able to select and apply appropriate teaching methods, a teacher can also select and use media to facilitate delivery of subject matter to students. One type of media that can be developed is e-modules. E-Module itself is a type of digital learning media with an interesting and systematic arrangement using electronic devices [2]. Through this e-module, it is hoped that students can be motivated and satisfy their curiosity about the material presented, so that it has an impact on improving learning outcomes. E-Modules can also influence and increase student interactivity according to the character of multimedia, namely as a medium that can be seen, heard, and touched.

Learning outcomes are a description that explains the ability of students to understand subject matter, both in the knowledge and skills aspects [3]. The measurement of learning outcomes in this study was obtained based on the knowledge aspect of the multiple choice test items given to students. Student learning outcomes can be known based on the test results obtained before and after the implementation of the e-module. The e-module developed in this study is expected to be able to provide an overview of students' abilities before and after the application of e-modules in learning activities.

E-Module itself is a form of digital module that is arranged systematically and attractively by utilizing electronic devices [2]. The e-Module developed in this study is different from the soft copy PDF module. The difference lies in the features contained in the e-module. Usually in the soft copy PDF module, the material presented is only text and images. The developed e-module is equipped with audio and video in its presentation. The PDF soft copy module can only be accessed offline, so its accessibility is limited. Meanwhile, the e-module developed in this study can be accessed online via a link shared by the teacher.

This study uses a Four-D Model with four stages of development, namely define, design, develop, and disseminate. The Four-D Model was chosen because it is appropriate for the development of learning tools in which there are systematic explanations for the steps that are in accordance with the educational curriculum [4]. Research of Masyhadi and Soeprajitno said that the application of e-modules as teaching materials for students has an effect on improving student learning outcomes [5]. The selection of e-module based learning media on computer system subjects is expected to be a learning guide for students. Besides that, it can also present material better because of the visualization form of the e-module which can display various media elements that are not found in the print module. In use, the e-module can be used easily if the learning process is based on the conditions of the student's learning room.

2 Method

The research was carried out at SMKN 3 Malang, Malang City, East Java Province. While the time of the research was carried out in the 2020/2021 school year in class X Computer and Network Engineering 1 at State Vocational High School 3 Malang. The type or method used in this research is a Research and Development (R&D) four-d model. The four-d model is an appropriate model to use in development research such as developing e-modules. A four-d model consists of several steps of development activities that refer to the types of research methods R&D, namely, define, design, develop, and disseminate.

In research and development research there are six stages of implementation of activities including, observation and interview, analysis of needs, manufacture of teaching materials, validation test sheets, application of teaching materials as an effective product for learning activities, and test questions. Each stage in the implementation of the research activities is carried out sequentially. The general research process showed in Figure 1.
This study the population was students of 10th grade majoring in Computer and Network Engineering at SMKN 3 Malang. The total number of 10th grade in Computer and Network Engineering are 61 students, 32 students of 10th grade majoring in 1st Computer and Network Engineering, and 27 students of 10th grade majoring in 2nd Computer and Network Engineering. While the samples were students of 10th grade majoring in 1st Computer and Network Engineering taking computer systems subjects in the 2020/2021 school year. This study will take a sample of 34 students. Based on the number of samples, there is a possibility that the number of samples will change according to the conditions at the time of the pre-test and post-test.
In this research and development, the instrument used is a needs analysis sheet through interviews with teachers and students. Other research instruments are product-related validation sheets to experts, student response questionnaires, learning tools, and test questions. The research instrument is used as one of the requirements in validating the products produced. Each stage in the implementation of research activities is carried out sequentially.

The define stage or in other models is often referred to as the needs analysis stage, starting with observing the characteristics of students in the form of academic potential and student motivation, especially 10th grade majoring in Computer and Network Engineering at SMKN 3 Malang. The definition stage is carried out to determine the competencies that will be applied in e-module development. At the definition stage, the researcher analyzed the needs needed to identify the problems that exist in SMKN 3 Malang, especially those faced by teachers and students of 10th grade majoring in Computer and Network Engineering at SMKN 3 Malang. The steps of the definition stage include initial analysis, analysis of student characteristics, task analysis, concept analysis, specification of learning objectives, and preparation of research instruments.

The design stage is carried out with the aim of designing a product based on the results of the initial definition stage, namely the analysis of the curriculum and computer system materials. In the context of e-module development, the design stage is carried out by compiling RPP, teaching materials, and initial design in the form of e-module prototypes which are then submitted to experts for validation first. The validation results are related to the e-module design, then the researcher revises it according to expert suggestions and opinions.

The development stage on a product is carried out by conducting a validation process to test the content of the material and media developed. Media experts are first lecturer supervisor, second lecturer supervisor, and computer system subject teacher, while materials experts are second lecturer supervisors and computer system subject teachers. The validation test results obtained are advice from experts namely are second lecturer supervisor and computer system subject teacher to be used in improving the development of e-modules before they are applied to schools.

The dissemination stage of the developed product is carried out by conducting media experiments on learners. The goal is for researchers to know whether the developed media is effective for use. This is done based on the acquisition of test scores. By comparing the results before and after the implementation of e-modules in the learning process, it can be known the success rate of the application of e-modules in learning activities.

3 Results

3.1 Definition Stage

At the definition stage includes facts and a series of needs during the implementation of computer system learning activities at SMKN 3 Malang. Initial analysis conducted with interviews to teachers of computer systems subjects. Based on the results of the interview, that the learning process of computer systems is conducted online through LMS (Learning Management System) such as Google Classroom, teachers have never developed learning resources, and frequently used learning media are modules in PDF and PowerPoint format. Analysis of student characteristics is obtained that students of 10th grade majoring in Computer and Network Engineering
who have constraints with data packages and tool limitations in the form of PCs/laptops and mobile phones/smartphones to support the learning process. Task analysis is that researchers summarize material tasks on e-modules based on predetermined competencies. The subject matter specified is the characteristic material of memory and semiconductor memory. Concept analysis is related to the concept to be taught and has been systematically arranged in accordance with basic competencies and competency achievement indicators. The specification of learning objectives conducted by researchers has been based on the Standard of Competency and Basic Competencies in the Curriculum 2013. Research and development instruments are prepared in the form of syllabus, RPP, computer system e-module feasibility sheet for material experts and media experts, and questionnaires of students’ responses to e-modules.

3.2 Design Stage

The design stage is used to design the product or initial draft as a learning medium. The initial activity in the design stage is to arrange tests based on the criteria of each student to know their abilities. The next activity in the design stage is the selection of learning media based on the content of the lesson material and the characteristics of the students. The final activity carried out at the design stage is to simulate the material to be contained in the e-module that has been designed. Selection of research products at the design stage, namely researchers make product designs in the form of e-modules used in computer system learning. In addition to format selection, the language selection used in the e-module is Bahasa Indonesia. The initial media design at the design stage is made using the principle of conceptual design. The design includes the division of space and layout, as well as the main interface [7]. Here are some examples of results from the design stage.

3.3 Develop Stage

At the development stage, experts validate the e-modules that have been designed. Drafts that have been validated and have been improved can be applied in schools by involving students of 10th grade majoring in Computer and Network Engineering at SMKN 3 Malang. The development stage is carried out in two stages, namely validation results of media expert and material expert, as well as analysis of the results of pre-test and post-test students [6]. Validation of e-modules by media experts consists of 5 aspects, including the display of screen design, ease of use, consistency, usefulness, and graphics. While the validation of e-modules by material experts consists of 3 aspects, including materials, questions, and languages. The results of validation of media experts and material experts on computer system e-modules are presented in Figure 2 and Figure 3.

In the validation results of media experts obtained on average from teacher expert by 95%, lecturer expert 1 by 85%, and lecturer expert 2 by 89%, with all three included in the Very Good criteria. While the results of validation by material experts obtained on average from lecturer expert by 85% and teacher expert by 89%, with both included in the Very Good criteria. Validation results of media experts and material experts are both included in the Very Good criteria to be applied in 10th grade majoring in Computer and Network Engineering at SMKN 3 Malang.

Table 1. Examples of result from the design stage
Figure 1. Validation Results of Media Expert
Figure 2. Validation Results of Material Expert

Table 2. Product Improvement Results Based on Validator Suggestions and Feedback

| Suggestions and Feedback:                                      | Repair:                                |
|----------------------------------------------------------------|----------------------------------------|
| a. Font type and color ideally are 3 kinds                      | a. Has changed the font type and color to 3 kinds |
| b. Include e-module title in the header Section In              | b. Have listed the e-module title in the header |
| c. The important material section can be marked in bold         | c. Has been marked with bold on the important material section |

| Material Aspect | Test Aspect | Language Aspect |
|-----------------|-------------|-----------------|
| Lecturer Expert 1 | 94%         | 100%            | 100%            |
| Lecturer Expert 2 | 88%         | 92%             | 83%             |
| Teacher Expert   | 100%        | 100%            | 92%             |

Suggestions and Feedback: a. The arrangement of the material can be added dialogue to students

Repair: a. The arrangement of the material can be added dialogue to students
b. At the end of the material is added Summary and Practice Problem

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Table 1. Product Improvement Results Based on Validator Suggestions and Feedback

| Suggestions and Feedback: | Repair: |
|--------------------------|---------|
| After The Exercise Problem can be added Self-Evaluation | Has been added Self-Evaluation after Exercise Problem |

According to the validation results by media experts, the validator states that the e-module designed is feasible to be applied in SMKN 3 Malang, especially in 10th grade majoring in Computer and Network Engineering, but needs to be improved first. Validator suggestions and feedback along with revisions of products are shown in Table 1.

### 3.4 Disseminate Stage

Dissemination or dissemination of computer system e-modules is carried out by applying e-modules at 10th grade majoring in Computer and Network Engineering, with a total of 32 students. Implementation at the dissemination stage begins with giving pre-test to the students, before they later get learning using e-module. In the next meeting, post-test is conducted on students to measure their understanding of learning materials. In conducting an e-module effectiveness test that is based on the results of tests (pre-test and post-test) obtained [8]. The hypothesis test used is the T-Test Paired Sample Test. The results of the hypothesis test (T test) test data are shown in Table 2. The standard deviation result in hypothesis testing using T-Test Paired Sample test is 7,147. The degree of freedom symbolized by df is obtained from the number of samples minus 1, so a large degree of freedom is obtained by 31. In the Test Paired Sample T-Test
displays different test results of pre-test and post-test after being given treatment in the form of learning using e-module. Based on calculations using SPSS, the gain of pre-test and post-test data significance values shown in the sig column. (2-tailed) is 0.000 (> 0.05), then H_0 rejected. The 2-tailed significance value shown in Table 2 is 0.000 which means it is less than 0.05, so H_0 rejected. Thus, it can be concluded that there are differences in the learning outcomes of students before and after the treatment in the form of learning using e-modules. This means that there is an influence resulting from the application of e-modules in computer system learning activities.

| Paired Pretest - Posttest | Paired Differences |
|---------------------------|--------------------|
| Std. Deviation            | df                 | Sig. (2-tailed) |
| instead of 7,147          | instead of 31      | instead of 0,000 |

4 Discussion

Activities in the development of a teaching material such as e-modules are validation by experts, revisions based on the advice and input of experts, and implementation by conducting effectiveness tests on e-modules developed. In this stage of development, limited trial activities in learning by adjusting learning conditions in the classroom cannot be carried out. This is due to limited time and place of implementation. Therefore, in developing products based on the results of analysis of student characteristics and problems faced during learning activities are carried out to the maximum. Validation performed by media experts and material experts is done only once. The revised results are based on the advice and opinions of experts used in making improvements to the e-module. In addition, the effectiveness of learning media developed has also been conducted trials to students of 10th grade majoring in Computer and Network Engineering at SMKN 3 Malang.

Based on the value of significance obtained from the hypothesis test, it is informed that there are differences in students' learning outcomes before and after the implementation of e-modules in learning activities. The difference in learning outcomes makes e-modules effective to be applied in teaching and learning activities. E-Module is said to be effective in its use when it has a good impact on students' learning outcomes. The result of achieving the goals obtained in dissemination activities is that students look enthusiastic in learning activities using e-modules. In addition, students are also perceived to have made e-modules as teaching materials that can be re-studied independently. The enthusiasm of the students of 10th grade majoring in Computer and Network Engineering at SMKN 3 Malang in towards the e-module is shown based on the results of the student's response to the e-module.

5 Conclusions

1. In the development of e-module products, researchers have adapted to the characteristics of learners who find it difficult to understand theoretical materials, especially in computer system subjects. So that the presentation of e-module content is in the form of text, images, and video to facilitate students in learning
2. The results of measuring the success rate of e-module implementation through T-Test Paired Sample by comparing pre-test and post-test results, i.e. obtained a significance value of 0.000. Gaining a significance value of less than 0.05 makes for differences in learning outcomes before and after using e-modules.

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