Analysis of industry based microprocessor learning module design

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ABSTRACT

The Microprocessor course is a mandatory course that must be taken by every PVTE undergraduate student, in understanding the material contained in this course, the researcher assumes to develop a learning module. The purpose of this study is to facilitate student understanding in learning microprocessor material. In this thesis research, using R&D research with the aim of developing learning media in the form of Microprocessor Course Learning Modules in order to determine the effectiveness and quality of microprocessor learning modules so as to add insight and interest in reading for 4th semester students of the PVTE Study Program, FKIP Sultan Ageng Tirtayasa University. The method used in this research is the research and development method by Sugiyono. The research stage is limited to 5 stages, namely: (1) potential and problems, (2) data collection, (3) product design, (4) product validation, and (5) trial use in order to determine the feasibility of this module learning media. The results of the development of learning media for the Microprocessor Course Module are for the results of the assessment of the media expert validator to get a percentage result of 90% where these results have entered the "very feasible" category. while for the results of the Material expert validator, the percentage result is 89%, which indicates that the content of the material in the Microprocessor Course learning module can be categorized as Very Appropriate.

KEYWORDS

Analysis; Module; Learning; Microprocessor

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Introduction

In the Indonesian Big Science Dictionary (KBBI), one of the intermediaries for achieving a learning goal is the learning media which is a tool for teaching and learning processes. Everything that can be used to stimulate the thoughts, feelings, attention, and abilities or competencies of students so that it can encourage the learning process. In the use of learning media can help students to more easily understand. One form of learning media is a module. The module is a complete measuring tool and is a unified program that can measure objectives. Modules can be viewed as program packages arranged in the form of certain units for learning purposes. The Ministry of National Education defines a module as a unified learning material that is presented in the form of "self-instruction", meaning that the learning materials arranged in the module can be studied by students independently with limited assistance from the lecturer.

Learning is an effort that can influence a person's emotions, intellectual, and spirituals to learn at their own will. Through learning, there will be a process of developing religious morals, activities, and student creativity through various interactions and learning experiences. Media is the plural form of the word "medium", etymologically means intermediary or introduction. Based on the results of observations that have been made with lecturers at Sultan Ageng Tirtayasa University. The Electrical Engineering Vocational Education Study Program shows that there is no learning module that helps students understand the materials in the Microprocessor Course, so that learning that occurs in the Electrical Engineering Vocational Education Study Program does not fully understand this subject. In the learning process, the average student still does not understand the material in the
Microprocessor Course delivered by the lecturer. In the Microprocessor Course in the Electrical Engineering Vocational Education Study Program, there is no specific module available for that course. The use of modules in learning is intended as an intermediary to achieve the goals desired by the supporting lecturer. Therefore, this module is needed to support effective learning activities in order to achieve the objectives to be achieved in this course. Based on the above problems that have been presented, the objectives of this research are: (1) Knowing the process of designing learning modules for Microprocessor Courses in the Electrical Engineering Vocational Education Study Program, and (2) Knowing the feasibility test of Microprocessor Course learning modules.

The meaning of the word "media" comes from the Latin word "medium". Literally the word "medium" means "intermediary", namely the intermediary of the message source with the recipient of the message. Has many experts and organizations that provide limits on understanding media learning media is composed of two elements, namely elements (hardware) in this learning media is as a means or equipment used to present the message / instructional materials, and elements of the software (software) is information or teaching materials that will be delivered to students. From the various opinions above, it can be concluded that: (a) learning media is a message container, (b) the material to be conveyed is a learning message, and (c) the objectives to be achieved in the learning process.

According to Arsyad, A (2019) states that learning media has four learning functions, including: (a) attention function, (b) affective function, (c) cognitive function, and (d) compensatory function. Each of the learning media functions mentioned above have differences and their respective explanations are as follows: (1) Attention Function, the attention function has a function to attract and focus students' attention to be able to concentrate on the content of the lesson related to the visual meaning displayed. This is because many students are not interested in the material presented. With interesting images or visualizations displayed through a projector, they will be easier to accept and remember the learning content delivered. (2) Affective Function, the affective function of a visual media can be seen from the level of enjoyment of students when learning activities take place. This happens because the image or visualization can arouse emotions and from the student. (3) Cognitive Function, cognitive function in a visual media can be seen from what was found by researchers who revealed that visual symbols can facilitate students to be able to understand and remember the information contained in the image, and (4) Compensatory Function, compensatory function can help provide understanding more quickly and can help students who have weaknesses to recall what has been learned. In other words, this function can meet the needs of students who are weak and slow in accepting and understanding the learning content delivered.

It can be concluded that the function of the learning media is as a reference or guide for teaching designers and teachers in carrying out learning so that the message to be conveyed by the teacher can be easily accepted by students. The selection for the learning model is certainly influenced by the nature of the material being taught later, the objectives to be achieved in the learning and finally the level of achievement of the students.

The module is a form of teaching material that is packaged in a complete and systematic way, in which it contains a set of learning experiences that are planned and designed to help students master specific learning objectives. The minimum module contains learning objectives, learning materials/substances, and evaluation (Rahdiyanta, D, 2012). The writing of the module aims to:

1. Clarify and simplify the presentation of the message so that it is not too verbal.
2. Overcoming the limitations of time, space, and senses, both students and teachers.
3. Can be used appropriately and varied, such as:
   a. Increase motivation and passion for learning for students.
   b. Develop students' ability to interact directly with the environment with other learning resources.
   c. Allows students to learn independently according to their abilities and interests.
   d. Allows students to be able to measure and evaluate their own learning outcomes.

From the usefulness of the module described above, the module also has a function as learning material used in student learning activities. With the module students can learn more directed and systematic. Students are expected to master the competencies required by the learning activities they participate in. The module is also expected to provide learning instructions for students during their education. To produce a module that is able to increase learning motivation, module development must pay attention to the characteristics needed as

1. **Self Instruction**

   Self Instruction is an important characteristic in the module, with this character enabling one to learn independently and not depend on others. To fulfill the character self-instruction, the module must: (a) Have clear learning objectives, and be able to describe the achievement of Competency Standards and Basic Competencies. (b) Includes learning materials that are packaged in small/specific activity units, making it easier to learn. (c) There are examples and illustrations that support the clarity of the presentation of learning materials. (d) There are practice questions, assignments and the like that make it possible to evaluate students. (e) Contextual, namely the material presented related to assignments or the context of activities and the student’s environment. (f) Using simple and communicative language. (g) There is a summary of learning materials. (h) There is an assessment instrument, which allows students to conduct self-assessment. (i) There is feedback on student assessment, so that students know the level of mastery of the material. (j) There is information about references, enrichment, and references that support the learning materials in question.

2. **Self Contained**

   The module is said to be self contained if all the required learning materials are contained in the module. The purpose of this concept is to provide opportunities for students to study the learning material completely, because the learning material is packaged into a unified whole. If it is necessary to divide or separate material from one Competency Standard/Basic Competency, it must be done carefully and pay attention to the breadth of Competency Standards/Basic Competence that must be mastered by students.

3. **Stand Alone**

   Stand alone are characteristic module that does not depend on materials / other media, or should not be used in conjunction with teaching materials / other media. By using the module, students do not need other teaching materials to study and or do assignments on the module. If students still use and depend on other teaching materials other than the modules used, then the teaching materials are not categorized as stand-alone modules.

4. **Adaptive**

   Modules should have a high adaptability to the development of science and technology. Is said to be adaptive if the module can adjust the development of science and technology, and flexible / flexible use in a wide range of hardware.

5. **Friendly / Familiar (User Friendly)**

   Modules should also meet the rules of user friendly or friendly / familiar with the wearer. Every instruction and information presentation that appears is helpful and friendly to the user, one form of user friendly is to make it easier for the user to respond and access as desired. Use of simple, easy-to-understand language, and use commonly used terms.

   Rahdiyanta, D, said that in the module development process, there are a number of principles that need to be considered. The module to be developed must be based on the results of the analysis of needs and conditions. To determine with certainty the learning materials that will be compiled into a module, how many modules will be used, who will use it, what resources are needed and are available to support the use of the module, and other matters deemed necessary.

   Next, develop a module design that is considered most appropriate with various objective data and information based on an analysis of needs and conditions. The form, structure and components of the module can meet various needs and existing conditions. Based on the design that has been developed, the required modules are compiled. The module development process consists of three main stages. Purwanto, et al (2007) explained that modules can be developed in various ways, including through adaptation, compilation and writing yourself. The following are various ways of developing modules:
Adaptation
Adaptation modules are learning materials developed based on existing books. Before learning takes place, teachers, lecturers, or widyaiswara identify existing books such as bookstores, libraries whose contents are relevant to the material to be taught. After that the teacher, lecturer or widyaiswara chooses one of the books as learning material that will be used for one subject. The book is used in learning activities in whole or in part with a study guide. The development of study guides serves to supplement the book with some kind of instruction to study it. Compilation modules are study materials developed on the basis of books on the market, scientific journal articles and pre-existing modules. Compilation is carried out by teachers, lecturers or widyaiswara using the outlines of the learning/training program or syllabus that was prepared previously. Compilation can be done in the following ways: (a) Collect all books, scientific journal articles, modules and other reference sources used in the subject as listed in the Bibliography. (b) Determine the parts of books, scientific journal articles, modules and parts from other reference sources that are used per subject. (c) Photocopy of all parts of the source used per subject. (d) Choose the photocopy-based on the subject matter. (e) Make/write an insulating page for each topic, and (f) materials that have been completed with an insulating page for each topic then be neatly bound (subsequently copied to be distributed to students).

Rahdiyanta, D (2012) revealed that to produce a learning module that is able to play its function and role in effective learning, the module needs to be designed and developed by taking into account several elements that require it, namely: format, organization, attractiveness, font size, blank space, and consistency.

Format
Some things to note regarding the module format are as follows:

a. Use a proportional (single or multi) column format. The use of single or multi columns must be in accordance with the shape and size of the paper used. If using multi-column, the distance and comparison between columns should be proportional. b. Use the proper paper format (vertical or horizontal). The use of paper formats vertically or horizontally must pay attention to the layout and typing format. c. Use signs (icon) that are easy to catch and aim to emphasize things that are considered important or special. Signs can be images, bold, italics or others.

Organization
a. Display a map/chart depicting the scope of the material to be covered in the module.
b. Organize the contents of the learning material in a systematic order and arrangement, making it easier for students to understand the learning material. c. Arrange and place manuscripts, pictures and illustrations in such a way that the information is easily understood by students. d. Organize between chapters, between units and between paragraphs with an arrangement and flow that makes it easy for students to understand. e. Organize headings, subtitles and descriptions that are easy for students to follow.

Attractiveness
The attractiveness of the module can be placed in several sections such as:

1. The front cover, by combining colors, images (illustrations), matching fonts and sizes.
2. Part of the content of the module by placing stimuli in the form of pictures or illustrations, printing in bold, italics, underlines or colors.
3. Assignments and exercises are packaged in such a way that they are interesting.
a. Font Shape and Size

   Requirements for the shape and size of the letters on the module are
   a) Using easy-to-read fonts and sizes according to the general characteristics of students
   b) Using a proportional ratio of letters between titles, subtitles and the content of the manuscript.
   c) Avoid using capital letters throughout the text, as it can confuse the reading process and make it difficult.

Space (Blank Space)
Uses unscripted or image space to add contrast to the appearance of the module. Empty spaces can serve to add important notes and provide pause opportunities for students. Use and place the blank spaces proportionally. Placement of empty space can be done in several places such as:

a. The space around chapter and sub-chapter titles.
b. Border (margin), a wide border forcing students’ attention to enter the middle of the page.
c. Spacing between columns, the wider the column, the wider the space between them.
d. Alternate between paragraphs and start with a capital letter.
e. Alternating between chapters or sections.
f. Use shape and font sizes consistently from page to page. Try not to combine multiple prints with too many variations in font shapes and sizes.
g. Use consistent spacing. The distance between the title and the first line, between the title and the main text. Line spacing or unequal spacing is often considered bad, untidy.
h. Use a consistent typing layout, both typing patterns and typing margins/boundaries.

**Consistency / Adherence to Principles.**

All elements contained in the module, both those related to the writing format, organization, lettering and empty space, must be consistent. In the Electrical Engineering Vocational Education Study Program there is a Microprocessor Course. The microprocessor or CPU is the "brain" which is the main controller of all operations in a computer system. The microprocessor takes binary instructions from memory, translates them into a series of actions and executes them. The action can be in the form of data transfer from memory, arithmetic and logic operations, or the generation of control signals (Achmad, B, 2004).

Identical or the same as the function of the human brain is the processor which is often referred to as the brain and the central controller of the computer system, this processor can perform arithmetic operations, think logically, store information and manipulate data as is done by the human brain. To be able to operate a computer system supported by a number of components in it, there is a hardware processor *Integrated Circuit (chip)* which functions to control the entire course of a computer system. Processors, better known as ‘Microprocessors’, currently have extraordinary processing speeds reaching Gigahertz (GHz). The performance of a microprocessor is largely determined by the speed of the process in processing data or information, as a determinant of speed is the clock attached to the microprocessor. In a computer system, a processor requires data to be processed, for this purpose the processor is equipped with a system interface and it is through interface this data or information can be input or output. Input or *input* to the computer system includes: keyboard (*keyboard, mouse, scanner, pen*, sensor system, *touchscreen* and so on, as for the output of computer systems including printers, monitors, LCDs, actuators and so on.

**Figure 1.** Minimal Block Diagram of a Microprocessor System

In a minimal storage processor system (*storage*) is used to store data, the relationship with the processor is two-way because data can be written to or stored, and data can be read back by the processor. Meanwhile, data input can only be read (one way), and data output can only be written in one direction (Sugiono, D, 2013). The microprocessor system is a microelectronic system that uses a microprocessor as its central processing unit. While the microprocessor is an LSI (component *Large Scale Integration*) that performs almost all the functions of a traditional processor (processing function) on a chip, like a processor or what is often referred to as a CPU (*Central Processing Unit*) on today’s generation computers. The basic functions of the CPU or processor, namely:

1. Can identify memory locations where instructions or data are located.
2. Carry out the process of taking instructions or data.
3. Can temporarily store instructions or data until they are executed.
4. Recognizes, understands, and can translate every instruction.
5. Can execute instructions.
6. Can coordinate all processes so that they are carried out in the correct sequence of steps. 
7. Repeats all sequences of processes as long as there are still instructions to be executed.

According to Patmasari, R., Wijayanto, I., Nugraha, R. (2014) Says that an instruction is a directive in the microprocessor process, so that the processor can run according to the instructions that have been entered. CPU (Central Processing Unit) is the brain or source of the computer that regulates, processes and executes all computer work. The main function of the CPU is to run programs that are stored in main memory. This is done by taking instructions from main memory and executing them one by one according to the command line. In executing an instruction, the CPU must go through two ways, namely reading the instruction (fetch) and executing the instruction (execute). This process of reading and executing is repeated until all instructions in main memory are executed or the computer is turned off. This process is also known as the cycle fetch-execution.

**Literature review**

The following are some relevant research studies that have been carried out by previous researchers, including the following:

Research conducted by (Robbani, H, 2018), with the title Development of a Microcontroller Learning Module Based on Character Education for Class XI Students in the Industrial Automation Engineering Expertise Program in SMK Negeri 2 Depok. This research is R&D (Research and Development). The research procedure was adapted from the ADDIE model (Analysis, Design, Develop, Implementation, Evaluation). Data analysis used quantitative descriptive analysis. Based on the research procedures that have been carried out, the assessment of the feasibility level of the learning module includes aspects of the material, media, and assessment by students. The assessment of the material aspect obtained a value in the "Very Eligible" category with a percentage of 50% and the "Eligible" category with a percentage of 50%. The media assessment obtained a value in the "Very Eligible" category with a percentage of 100%. The assessment of the module by students obtained a value in the "Very Eligible" category with a percentage of 29.6% and a value in the "Eligible" category with a percentage of 70.4%. There are similarities with the thesis that I developed including: a) using the R&D research method in developing the learning module, b) using quantitative descriptive analysis data, c) collecting data or assessing the feasibility of the module using a questionnaire. As for the differences: a) The development model uses ADDIE (Analysis, Design, Develop, Implementation, Evaluation).

Research conducted by Khoirunnisa, N (2020) with the title Design Jobsheet Zilog 80 Microprocessor Using the MPF-1 Microprofessor. This study uses research and development methods (Research and Development) and the ADDIE development model (Analyze, Design, Develop, Implement and Evaluate). Analysis of the data used includes validation of the worksheet by media experts, material experts and questionnaire results from users jobsheet. The research results obtained for the Jobsheet Zilog 80 Microprocessor based on the assessment of media experts get a total percentage of 81.2% and are included in the "Very Eligible" category, then the results of the assessment based on material experts get a total percentage of 87.5% and are included in the Very Decent category. Worthy. There are similarities with the thesis that I developed including: a) using R&D research methods in developing learning modules, b) collecting data or assessing module feasibility tests using questionnaires, c) using quantitative descriptive analysis data. As for the differences: a) The final product resulting from this research is a learning media in the form of a Zilog 80 Microprocessor Jobsheet, b) The development model uses ADDIE (Analysis, Design, Develop, Implementation, Evaluation).

Research conducted by Nurrizkiani, J. (2020) with the title Development of Learning Media Modules on Animalia Material for Class X SMAN 1 Pontianak. This study aims to develop the Animalia Module learning media, which meets the aspects of validity, practicality, positive student responses and the effectiveness of the media. The research method used is the development (R&D) of the model 4-D, including the Define, Design, Develop and Disseminate stages, but the stage was Disseminate not carried out. The research shows that the validity and practicality of the language aspect by 90% (very valid and very practical), the material aspect by 86.33% (very valid and very practical) and the graphic aspect by 90% (very valid and very practical). Based on small-scale trials and large-scale trials, student responses to the learning media module are positive, so that the media can be used in the learning process. The effectiveness of the learning media is obtained based on the scores posttest. The classical completeness of the experimental class is 83% and the classical completeness of the control class is 61%, which shows that the Animalia Module learning media is declared effective. Based on the results obtained, it shows that the learning media module is suitable for students to use.
in animalia biology learning. There are similarities with the thesis that I developed including: a) using R&D research methods in developing learning modules, b) collecting data or assessing module feasibility tests using questionnaires, c) using quantitative descriptive analysis data. As for the differences: a) the 4-D model includes the Define, Design, Develop and Disseminate stages, but the Disseminate stage is not carried out.

Research conducted by Nugroho, SY, Suyitno, Daryanto, Achmad, F., Endah, L., Rohman, M, (2019) with the title Development of Learning Modules for CNC Machining Techniques in Vocational High Schools”, This study aims to produce a teaching module from the CNC Machine Vocational High School, to analyze the validity of the teaching module, to analyze the practicality of the teaching module, to analyze the effectiveness of the teaching module. This study uses the ADDIE development model, including (1) analyzing, (2) designing (3) developing (4) implementing, and (5) evaluating. Product testing has two tests. Internal testing and external testing. Internal testing gets the results of the media and lesson validity scores. The external test obtained results from the practicality scores of teachers and students, and the effectiveness scores of class t from the teaching module. The subjects of this study were students of class XI Mechanical Engineering Department, SMK Negeri 1 Padang. The results of the research and development of the teaching module show that (1) the scores of the validity of the media and lessons are 0.71 and 0.69, then the teaching module is valid, (2) the results of the practicality scores of students and teachers are 87% and 95%, which indicates the module very practical teaching, (3) the result is sig. The 2-tailed score of class effectiveness is 0.003, this indicates that the teaching module is effective, and (4) the teaching module of CNC Machines at SMKN 1 Padang is valid, very practical, and effective. There are similarities with the thesis that I developed including: a) using R&D research methods in developing learning modules, b) collecting data or assessing module feasibility tests using questionnaires, c) using quantitative descriptive analysis data. As for the differences: a) Product testing has two tests. Internal testing and external testing. Internal testing gets the results of the media and lesson validity scores. The external test obtained results from the practicality scores of teachers and students, and the effectiveness scores of class t from the teaching module.

Research conducted by Avrieldi, M., KMS., Suparno, & Refdinal, (2019) with the title "Development of Learning Modules for Alternative Energy Courses in the Electrical Engineering Vocational Education Study Program". The purpose of this development research is to produce a product in the form of a printed learning module package for Alternative Energy Courses that is feasible and effective to use in the learning process. The research method used is research and development (R&D) using the Rowntree development model flow. This research was conducted at the Electrical Engineering Vocational Education Study Program, Faculty of Engineering, Jakarta State University. To validate the module, 2 instruments were used, namely a questionnaire and a test. The validation stages of the Alternative Energy Course module package include: expert review, legibility trial, face to face trial, and field trial. The data analysis technique begins with preliminary research, then module development planning, then validation, evaluation, and module revision. The results of data analysis showed that the learning outcomes of students who studied with module learning resources increased significantly. Therefore, to improve alternative energy learning outcomes, a printed learning module is needed. The learning module developed, based on the validation results from material experts, media experts, supporting lecturers, and field tests to students was declared good and feasible to be implemented for learning. This Alternative Energy learning module can be recommended for use in the course learning process. There are similarities with the thesis that I developed including: a) using R&D research methods in developing learning modules. As for the differences: a) the development model used is Rowntree, b) To validate the module, 2 instruments are used, namely questionnaires and tests. The stages of validation of the Alternative Energy course module package include: expert review, legibility trial, face to face trial, and field trial. The data analysis technique begins with preliminary research, then module development planning, then validation, evaluation, and module revision.

Research conducted by Anggraeni, RD, Elmunisyah, H., Handayani, N. A, (2019) with the title "Development of the Maintenance and Repair Engineering Course Module for Electronic Engineering Students, Department of Electronics and Informatics Engineering Education, Faculty of Engineering UNY". The objectives of this study were to: (1) develop module teaching materials in the Maintenance and Repair Engineering Course at the D3 Electronics Study Program, Faculty of Engineering, Yogyakarta State University, respondents. This research is the development of teaching materials for Maintenance and Repair Engineering courses using the 4D Model method, namely (1) Definition (Define), (2) Design (Design), (3) Development (Develop), and (4) Disseminate (Disseminate) by having 8 themes of learning activities consisting of 4 maintenance (computer, printer, air conditioner and speakers active) and 4 repairs (fan, rice cooker, dispenser and electric iron). The data collection method involved two learning material experts and two learning media experts. The product quality test was carried
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out on 13 students of the 2016 Diploma III Electronic Engineering Study Program, Yogyakarta State University. The data analysis technique for the feasibility of teaching materials uses descriptive qualitative analysis. The results of the development show that the development of teaching materials for the Maintenance and Repair Engineering Course, material validation obtained a feasibility level of 86% Very Eligible, media validation obtained a feasibility level of 84% Very Eligible, while the product quality of students obtained a feasibility level of 81% Eligible. This shows that the Maintenance and Repair Engineering Module is feasible and appropriate as a lesson in Maintenance and Repair Engineering learning. There are similarities with the thesis that I developed including: a) using the R&D research method in developing learning modules, b) collecting data or assessing the feasibility of the module using a questionnaire. As for the differences: a) using qualitative descriptive analysis data, b) 4D Model methods, namely (1) Definition, (2) Design, (3) Development (Develop), (4) Disseminate with has 8 themes of learning activities consisting of 4 maintenance (computer, printer, air conditioner and active speakers) and 4 repairs (fan, rice cooker, dispenser and electric iron).

Methods

The method used in this research is the approach Research & Development. The form of this research method is that it can create a new product and test the effectiveness of this product (Sugiyono, 2020). The purpose of this research is to create a Microprocessor Module learning media to improve students’ understanding of the material. The development of this microprocessor learning media is a research conducted to produce a product in the form of a learning module.

Before conducting Research & Development research, researchers must make development procedures so that mistakes do not occur in conducting this research, after observing the researchers decided to adapt Sugiyono’s development model, namely a development model consisting of ten stages, namely: potential and problems, data collection, product design, design validation, design revision, product testing, product revision, usage testing, product revision, mass production. The following is a picture of the steps of research and development according to Sugiyono.

![Figure 2. Steps of using R&D methods](image)

The development model in this study uses the proprietary development model [13], in this study not all development steps can be applied, this is because the research conducted is still on a limited scale and does not cover the In a broader research, the researcher only takes several stages of development, namely by doing: (1) potential and problems, (2) data collection, (3) product design, (4) design validation, and the last (5) usage trials. The research will be carried out at the Electrical Engineering Vocational Education Study Program at Sultan Ageng Tirtayasa University starting in June 2021. The following are the stages of development that the researchers carried out:

1. Potentials and Problems

The first stage of development research is to collect information related to the potential and problems of the research location. Potential is anything that adds value when used. However, if no one can take advantage of it, that potential can also become a problem. The problem is the deviation between the expected state and the actual state. This means
that the conditions that occur are not in accordance with the expected conditions. If one can use it, the problem can also be turned into a potential. The first data collection was through observation at the Electrical Engineering Vocational Education Study Program, Sultan Ageng Titayasa University. After observing the researchers concluded that there was no module on Microprocessor Courses. With these problems, the researchers wanted to make a learning module for the Microprocessor Course which was used later as a student handbook and lecturer.

2. Data Collection
After observing and finding problems in the field, the next step is to collect data and information about the problem. In collecting data and information, interviews were conducted with several students who had contracted the course. From the interview, it can be explained that there is no learning media module to support the Microprocessor Course, some students also do not understand the materials in this course.

3. Product Design
In this stage what the researcher does is create a design framework for the learning media that will be made. Next, start working on the module design that has been previously designed in designing this module, the researcher uses Corel Draw X7 software. This initial design can be said to be imperfect, so a revision stage will be carried out to perfect the design that the researcher has made.

4. Design Validation
After the design is completed, the next design is validated. In this case, the role of the expert is needed to validate. There are two experts, namely material experts and media experts. The design of learning media products will then be validated by two experts where the experts will later provide values and input on the design of learning media products. In this case, material experts and media experts in conducting validation are also given validation instruments.

5. Usage
Trial The usage trial was conducted at the Electrical Engineering Vocational Education, University of Sultan Ageng Tirtayasa, especially for students who contracted the Microprocessor Course. Improvements are no longer made on this test due to time constraints and the Covid-19 pandemic. Testing is carried out in the form of experiments. Through the trial use, it will be known whether or not the media used to increase students' understanding of this course is feasible.

This data collection technique aims to obtain the data that we will analyze. By searching and finding problems that existed during the research process. Data collection techniques used in this study are observation, interviews, and questionnaires.

The data collection instrument in the Microprocessor Learning Module aims to obtain the results that researchers want to achieve. The instruments used in the development of this module are questionnaire instruments about learning media and instruments about learning materials. To assess and get a good instrument, it must pass several stages, namely instrument validity and instrument reliability. The validity of the test instrument aims to determine whether the instrument is valid or not. An instrument's validity will affect data collection. The validity test in this study will use item validation or item validity and validation from media experts and design experts.

correlation formula Pearson Product Moment, as follows:

\[ r_{xy} = \frac{n \sum X_i Y_i - (\sum X_i)(\sum Y_i)}{\sqrt{[n \sum X_i^2 - (\sum X_i)^2][n \sum Y_i^2 - (\sum Y_i)^2]}} \]

Description:
- \( r_{xy} \) : correlation coefficient between variables x and y
- N : number of items
- Xi : score obtained by the subject in each item
- Yi : total score obtained by subject in all items
- X : total score of items
- Y : total score

The instrument is reliable enough to be used as a data collection tool because the instrument is good. Good instruments will not tend to direct respondents to choose certain answers. Instruments that can be trusted, reliable will produce reliable data as well. Reliable means, can be trusted, so reliable. This test was carried out on student tests to collect student score data and analyzed using the KR 21 formula. The formula is as follows:
Data analysis will be carried out after obtaining data from media experts and material experts. Descriptive analysis technique was carried out using descriptive statistics. Descriptive statistics are statistics used to analyze data by describing or describing the data that has been collected [13]. The data obtained from material, design and student experts were then analyzed using descriptive quantitative analysis of the results of the assessment of the development product and then presented through a scoring that had the following criteria:

### Table 1. Alternative Answer Scoring

<table>
<thead>
<tr>
<th>Category</th>
<th>Skor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>4</td>
</tr>
<tr>
<td>Good</td>
<td>3</td>
</tr>
<tr>
<td>Less</td>
<td>2</td>
</tr>
<tr>
<td>Very Less</td>
<td>1</td>
</tr>
</tbody>
</table>

After getting the calculated value from the score formula above, the next step is to calculate the average score, using the following formula:

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Description:
- $\overline{x}$: Average score of each aspect of product assessment
- $\sum_{i=1}^{n} x_i$: The total score of each aspect of the product assessment
- $n$: the sum of each aspect of the evaluation of the product assessment item

After getting the results of the average score, the next step is to calculate the results of the above calculations into a percentage. Each answer from the respondent is multiplied by the score on the Likert scale which will then be entered into the following formula:

$$\text{Percentage} \% = \frac{\text{Jumlah Skor Total (X)}}{\text{Skor Maksimum (Xi)}} \times 100\%$$

Description:
- Total score (X): The number of scores obtained by the respondents.
- Maximum score (Xi): The highest score from the questionnaire times the number of respondents.

After getting the percentage score, the researcher checked the feasibility percentage according to the following table:
Results

Based on the research that has been carried out, the data obtained include research from material experts, media experts, and trials of use on a small scale. The process stages carried out in this development research have 5 stages, namely potential and problems, data collection, product design, product validation, and usage trials. The following are the results of the research that has been carried out.

1. Potentials and Problems

The first step in conducting this development research is to collect information related to the potential and problems that exist in the research location. After looking for potentials and problems, the researcher made observations at the Electrical Engineering Vocational Education Study Program, Sultan Ageng Tirtayasa University. After observing the researchers concluded that there was no module on Microprocessor Courses. With these problems, the researchers wanted to make a learning module for the Microprocessor Course which was used later as a student handbook and lecturer.

2. Data Collection

For the second stage, data collection was carried out by interviewing several students regarding the need for the learning modules needed by referring to the Semester Learning Plan (RPS), in this interview the results showed that students' awareness to study or find sources of material independently was still lacking. So the need for learning media in the form of Microprocessor Course Learning Modules that can help a little learning activities.

3. Product Design

This learning module is the result of the development of an existing module. The writing of this module is based on the principle of developing a teaching material model by identifying needs, collecting initial data and based on the Microprocessor Course Semester Learning Plan. The teaching materials that will be made are learning modules for 4th semester students with the title Development of Microprocessor Learning Modules for the Microprocessor course of the Electrical Engineering Vocational Education Study Program, Sultan Ageng Tirtayasa University. This learning module is designed using easy-to-understand language so that students can understand the content of the material. The completeness of the content in this learning module refers to the Semester Learning Plan for the Microprocessor Course.

This module consists of 3 main parts, namely: the first part, the second part, and the third part. The first part contains the cover, introduction, table of contents, list of pictures, learning mechanism, glossary, chapter I (Introduction). The second part contains Chapter II (Learning Materials) in which there are 5 learning materials, namely Material 1. (History of

Table 2. Percentage of Feasibility Results Likert Scale (Sugiyono, 2020)

<table>
<thead>
<tr>
<th>Percentage Feasibility</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% - 20%</td>
<td>Not Eligible</td>
</tr>
<tr>
<td>20.1% - 40%</td>
<td>Less Eligible</td>
</tr>
<tr>
<td>40.1% - 60%</td>
<td>Fairly Eligible</td>
</tr>
<tr>
<td>60.1% - 80%</td>
<td>Eligible</td>
</tr>
<tr>
<td>80.1% - 100%</td>
<td>Very Eligible</td>
</tr>
</tbody>
</table>
Microprocessors), 2. (Microprocessor and Memory Systems), 3. (Intel 8088 Microprocessor), 4. (Zilog Z80 Microprocessor), 5. (Instructions On Zilog Z80). Furthermore, in the third part contains Chapter III (End Semester Assessment) and Bibliography.

4. Design Validation

The main purpose of this design validation is to get approval from several experts including media experts and material experts, before the product is finally used or used in learning activities. The assessment carried out by the material expert covers aspects of the characteristics of the module and the assessment by the media expert covers aspects of the digestibility of the module, the use of language, appearance and organization. Before validating, the researcher consulted with the supervisor by providing an initial draft of the module. If the initial draft is approved by the supervisor, then the module is then given to material experts and media experts for input and validation. After getting valid module results and having been assessed by material and media experts, the module is ready to be used in a trial use.

5. Usage

Trial The usage trial was carried out by looking for the results of the product feasibility test that was made, due to time constraints and the Covid-19 pandemic, the data collection for the feasibility test was carried out using a questionnaire instrument that was distributed using Google forms. The product feasibility test was carried out by asking respondents from some 25 students of the 4th semester Electrical Engineering Vocational Education study program at Sultan Ageng Tirtayasa University.

The assessment of the quality of the module in terms of media and material was carried out by Mr. Bagus Dwi Cahyono, SST, M.Pd. By using a media expert questionnaire instrument there are 30 questions which are divided into 3 kinds of assessment aspects, namely Aspects for module size, module cover design, and module content design. For the results obtained in the media expert questionnaire, which is 90% which is categorized as very feasible criteria and for the material expert questionnaire there are 34 questions with 8 aspects, namely aspects of the suitability of the material with Competency Standards and Basic Competencies, accuracy of material, up-to-date support for learning materials, up-to-date materials, presentation technique, presentation support, learning presentation, presentation completeness with a total assessment result of 89% which is categorized as very feasible criteria.

The development of this module uses Sugiyono’s steps with 10 stages of development, namely: (1) Potential and Problems, (2) Data Collection, (3) Product Design, (4) Design Validation, (5) Usage Trial, (6) Product Revision, (7) Product Trial, (8) Design Revision, (9) Product Revision, and (10) Mass Production. Due to time constraints, the researcher only used 5 stages, namely: potential and problems, data collection, product design, product validation, usage trials. In the development of this module, there are 3 main stages, namely the process of making the module, evaluating the module, and testing the feasibility of the module. With the development process, the module is feasible to be used as a learning medium.

The assessment carried out aims to determine the feasibility level of a Microprocessor Course Module learning media which is carried out by going through several stages. In the first stage of assessment by material experts with a score obtained of 89% which is categorized as "Very Eligible". More details can be seen in the table below:

<table>
<thead>
<tr>
<th>Results Percentage</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>89%</td>
<td>Very Eligible</td>
</tr>
</tbody>
</table>

Table 1 above is the result of an assessment from a material expert by assessing several aspects, namely: aspects of the suitability of the material with the Competency Standards and Basic Competencies, the accuracy of the material, the up-to-date support for learning materials, the up-to-date material, presentation techniques, presentation support, learning presentation, completeness of presentation. The second stage carried out was an assessment by media experts with a score obtained of 90% which was categorized as "Very Eligible". More details can be seen in the table below:
Table 2. Media Expert Validation Assessment

<table>
<thead>
<tr>
<th>Results</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>Very appropriate</td>
</tr>
</tbody>
</table>

Table 2 above is the result of an assessment from media experts by assessing several aspects of the assessment, namely aspects for module size, module cover design, and module content design.

In obtaining student responses as media users, the researcher distributed a questionnaire via google forms which aimed to measure student responses to this microprocessor course module. From the questionnaires that the researchers have distributed, the results obtained from the respondents of the 4th semester Electrical Engineering Vocational Education Study Program students at Sultan Ageng Tirtayasa University totaling 25 people. The following are the results of the questionnaire, the initial results of respondents using software SPSS 21.

Table 9. Respondent Review Results

<table>
<thead>
<tr>
<th></th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
<th>S11</th>
<th>S12</th>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Conclusion

Based on the results of research and discussions that have been carried out, it can be concluded that:

The process of developing learning modules for the microprocessor course refers to the flow of development R&D by Sugiyono, by applying 5 stages from what should be 10 stages, namely: (1) Potential and Problems, (2) Data Collection, (3) Product Design, (4) Product Validation, and (5) Usage Trial. The results obtained from media expert validators and material expert validators have obtained very decent results. For the results of the assessment from the media expert validator, the percentage of results is 90% where the results have been included in the "very feasible" category. Meanwhile, the results of the material expert validator get a percentage of 89% which indicates that the content of the material in the Microprocessor Course Learning Module can be categorized as "Very Eligible".
References


