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Development of Digital Electronics Practicum Modules on Logic Gates

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Abstrak

Praktikum elektronika digital merupakan salah satu mata kuliah yang dipelajari pada Program Studi Pendidikan Fisika Universitas Jambi. Berdasarkan angket kebutuhan awal, diperoleh bahwa 88% mahasiswa menyatakan materi gerbang logika, termasuk materi yang sulit dipelajari. Tujuan dari penelitian ini, untuk mengembangkan modul praktikum pada materi gerbang logika. Penelitian ini termasuk penelitian pengembangan yang menggunakan model pengembangan ADDIE dan dilakukan sampai pada tahap evaluation. Subjek penelitian ini yaitu 35 mahasiswa Pendidikan Fisika FKIP Universitas Jambi angkatan 2017. Instrumen yang digunakan yaitu angket validasi media dan materi serta angket persepsi mahasiswa. Tahap Analyze untuk memperoleh data yaitu tidak terdapatnya tinjauan materi pada penuntun praktikum yang digunakana sebelumnya dan prosedur kerja yang sulit dipahami. Selanjutnya tahap Desain, desain modul cetak dibuat menggunakan program microsoft office word 2010. Tahap Develop, pengembangan modul elektronika digital berbasis direct instruction pada materi gerbang logika. Hasil validasi terhadap penyajian praktikum sebesar 87% dengan kategori sangat baik dan hasil validasi materi 62% dengan kategori baik. Sedangkan untuk hasil persepsi mahasiswa terhadap produk yang dikembangkan adalah 89% dengan kategori sangat baik. Keunggulan dari produk yang dikembangkan adalah prosedur percobaan disusun secara sistematis sesuai dengan sintak direct Instruction. Berdasarkan hasil tersebut dapat disimpulkan bahwa modul praktikum elektronika digital pada materi gerbang logika layak digunakan sebagai salah satu media pembelajaran yang dapat digunakan dalam pelaksanaan pembelajaran mata kuliah praktikum elektronika digital.

Kata Kunci: *Modul, Praktikum, Elektronika Digital, Gerbang Logika*

Abstract

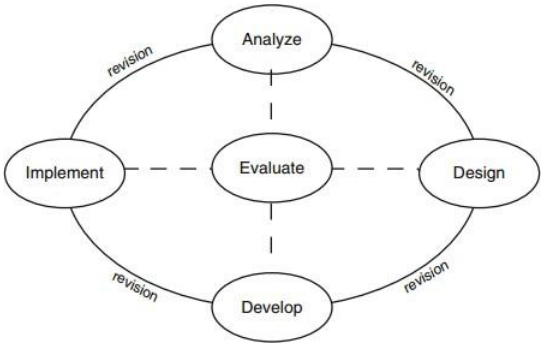
Digital electronics practicum is one of the subjects studied in the Physics Education Study Program at the University of Jambi. Based on the initial needs questionnaire, it was found that 88% of students stated the logic gate material, including material that was difficult to learn. The purpose of this research is to develop a practicum module on logic gates material. This research is development research that uses the ADDIE development model and is carried out up to the evaluation stage. The subjects of this study were 35 students of Physics Education FKIP Jambi University class of 2017. The instruments used were media and material validation questionnaires as well as student perception questionnaires. The Analyze phase was used to obtain data, namely that there was no review of the material in the practicum guide previously used and work procedures that were difficult to understand. Next is the Design stage, the printed module design is made using the Microsoft Office Word 2010 program. The Develop stage, the development of direct instruction-based digital electronics modules on logic gates material. The results of the validation of the practicum presentation were 87% in the very good category and the results of the material validation were 62% in the good category. As for the results of student perceptions of the product being developed is 89% with a very good category. The advantage of the product being developed is that the experimental procedures are arranged systematically according to the Direct Instruction syntax. Based on these results it can be concluded that the digital electronics practicum module on logic gate material is suitable for use as a learning medium that can be used in the implementation of learning digital electronics practicum courses.
Keywords: *Modules, Practicum, Digital Electronics, Logic Gates*

Introduction

Modules are a form of teaching materials that are arranged systematically using language that is easy to understand, according to the level of knowledge and age of students so that they can learn on their own (Sheng & Chen, 2022). The practicum module is used as a guide for carrying out practicums, it is expected to help practicum students carry out assignments independently (Fitri Nur et al., 2020).

Digital electronics is one of the subjects studied by physics education students (Izza & Azhar, 2022). Logic gates are a sub-material that is studied in digital electronics courses (Manus & Mamahit, 2017). The logic gate practicum at the Physics Education University of Jambi is a practical implementation of digital electronics courses, practicums are carried out by students independently guided. Logic gates are the basis for forming digital electronic systems that function to convert one or several inputs into a logical output signal. Logic gates operate based on the binary number system, namely numbers that only have 2 code symbols, namely 0 and 1, using the theory of boolean algebra.

Field findings in the sixth semester of the Physics Education Study Program at the University of Jambi amounted to 21 students out of 24 respondents who still had learning difficulties, especially in logic gates.



Furthermore, during the observation of the FKIP UNJA Physics Education laboratory, it was found that the digital electronics practicum guide used did not have a material review, where this material review is very useful in providing an initial understanding before students carry out practicums. The ideal condition expected is a good and clear review of the material in the digital electronics practicum module so that the practitioner can carry out the practicum properly.

The results of the interviews also found deficiencies in the digital electronics practicum module, namely the experimental procedures in the module were difficult to understand. Minahaya said, "*The digital electronics practicum guide does not contain all the procedures to be carried out*". Minahaya's statement was also justified by Bella where "*The work procedure is difficult to understand because of the procedures like this and when it is practiced like that, there are many things that are lacking*". Based on observational data, interviews, and findings in the field in the sixth semester of the Physics Education Study Program, Jambi University, students are still experiencing difficulties in understanding the concept of logic gates, this is what prompted the author to conduct research with the title "Development of Digital Electronics Practicum Modules on Logic Gate Materials."

Method

The data used are qualitative and quantitative. Qualitative data were obtained from responses, suggestions from media experts and material experts, and quantitative data were obtained from the results of the validation team's questionnaire analysis, namely media experts and material experts in the form of assessment aspects and student perception tests. This study uses the development method with the ADDIE development model.

Figure 1. ADDIE circuit

The implementation of the research began with the analysis stage, namely making initial observations to collect data related to the problems faced by class 2015 students of the Physics Education Study

Program, Universitas Jambi. Based on the results of the needs questionnaire, it was found that as many as 88% of students still experienced difficulties in learning digital electronics.

After the analysis phase is carried out, the next step is to carry out the design phase. At this stage, the researcher attempts to compile a digital electronics practicum guide based on the information that has been obtained from the various previous stages. Furthermore, the digital electronics practicum guide was validated in advance by experts, namely material experts and media experts. The next stage is the implementation stage, this stage is not carried out by researchers because the purpose of research conducted by researchers is to develop practicum guides that are suitable for use by students. The last is the evaluation stage. There are three levels in the evaluation stage, namely, level one perception, level two learning or knowledge, and level three implementation. At this stage the researcher only evaluates at level one, namely, knowing student perceptions of the digital electronics practicum module.

Results and Discussion

Making teaching materials in the form of basic electronics learning modules using the ADDIE development model goes through 5 stages. The development procedure consists of several stages which are described in Table 1. below:

Table 1. Development Implementation Procedures

No	Development Procedure	
1	*Analysis*	Needs analysis
		Work gap
2	*Design*	Preparation of module design (practicum objectives, basic theory, practicum equipment, work procedures, discussion, work tables, and conclusions)
3	*Development*	Module creation
4	*Implementation*	Product trials
5	*Evaluation*	Product revision at the development stage
		Revision product implementation stage

This research and development resulted in a digital electronics practicum module. The final product of this practicum module consists of 3 experiments, namely: Basic logic gates (AND, OR, and NOT, and combination logic gates (X-OR and X-NOR), as well as an evaluation to ensure that students have mastered the previous practicum namely basic logic gates and combination logic gates. In each experiment, there is also practicum equipment, work procedures, work tables, discussion, and conclusions that must be completed by students after conducting experiments on each experiment in the digital electronics practicum module. The results of this research and development are data regarding the specification requirements required in developing a digital electronics practicum module, feasibility data for the module were obtained from questionnaire calculations during validation by material experts and media experts as well as questionnaires to determine student responses.

Presentation Expert Evaluation

After seeing and examining the modules that have been developed, the validator then assesses the practicum module based on a questionnaire with a Likert scale rating. The following is the validation of media experts shown in Table 2:

Table 2. Media Validation Results

	Grain	**Mark**	**Aspects of Assessment/Suggestion**
Serving Technique	1. Logical presentation	8	
	2. Presentation breakdown	9	
	3. References/sources of text, tables, pictures, and attachments	9	

Supporters Material Presentation	4. Accurate numbering and naming tables/figures and attachments	8	
	5. Accuracy of concepts/ principles/ presentation gaps	9	
Completeness Presentation	6. Introduction	8	
	7. Table of Contents	8	
	8. Bibliography	8	
ial	3. The depth of the material	6	
Material Accuracy	4. Accuracy of facts	5	
	5. Accuracy concept/principle/law/theory	5	
	6. Accuracy of procedures/methods	6	
Supporters Material	7. Appropriateness and accuracy illustrations/pictures	7	
	8. Advance *organizer*(generator motivation)	5	
UseSymbols And Terms	9. Correct use term	7	
	10. Correct use symbol	7	
	11. Consistency of use term	7	
	12. Consistency of use symbol/symbol	7	

Material Expert Evaluation

The following is a validation of the practicum module material:

Table 3. Material Validation Results

	Grain	**Mark**	**Aspects of Assessment/Suggestion**
	1. Material equipment	6	
ScopeMater	2. Breadth of material	6	

The following is an instrument for assessing student perceptions of the practicum module developed.

Table 4. Percentage of Display Aspects of the Digital Electronics Practicum Module

No	**Statement**	**Percentage**	**Category**	**Average Percentage**	**Category**
1.	The font and size of the letters used on each page are clear and easy to read	94.29%	Very good	90%	Very good
2.	The arrangement of modules is systematic and neat	88.57%	Very good		
3.	Simple module design and interesting	87.43%	Very good		
4.	The size of the image presented is appropriate (not too big and not too small)	87.43%	Very good	89.3%	VeryGood
5.	The images presented are by the material	92%	Very good		
6.	The colors and shapes of the images presented are clear	88.57 %	Very good		
7.	The practicum module can be used as a learning resource for practicum implementation instructions	93.71%	Very good		
8.	The order of presentation of the material in the module is clear.	87.43%	Very good		
9.	This module can emphasize on direct experience	86.86%	Very good		

10.	The information presented in the module is easy to understand	88.57%	Very good	88.5%	VeryGood
11.	The module encourages me to carry out investigations through experimental activities	86.29%	Very good		
12.	The module trains me to present the experimental results that I do	88.57%	Very good		
13.	This module is suitable for making observations/observations	89.14%	Very good		
14.	I can understand the work procedures in the practicum module well	88.57%	Very good		
15.	The material contained in the module is complete	87.43%	Very good		
16.	The language in the module is simple and easy to understand	89.71%	Very good	87.14%	VeryGood
17.	Sentences used in work procedures are imperative sentences	84.57%	Very good		

Based on Table 4, namely the percentage of display aspects, it can be concluded that the digital electronics practicum module that the author has developed has a very good category for use in practical learning. This can be seen from the percentage of student perceptions of answers which, if averaged, have a percentage of 90%, which is in the very good category.

The distribution of the questionnaire that was carried out to Jambi University physics education students class of 2017 was as many as 35 respondents and based on the perception questionnaire analysis based on the percentage method (Rosmiati & Ruhamah, 2020) as a whole it can be concluded that the digital electronics practicum module that has been developed is good for use. This can be seen from the percentage of the four indicators contained in the questionnaire which have been averaged, the results obtained are 83% in the very good category which indicates that this practicum module is feasible to use.

According to (Ekawati et al., 2021), the purpose of validating performance gaps is to produce a statement of basic objectives to locate implementation gaps or related problems, find causes, and find solutions from these gaps.

Teaching materials are information, tools, and texts needed by teachers or instructors for planning and studying the implementation of learning (Prasetyono & Sigitta Hariyono, 2020). This view is complemented by Pannen that teaching materials are materials or subject matter that are arranged systematically and are used by teachers and students in the learning process (Santosa et al., 2018).

On the Dikmenjur website, the definition is explained in more detail that teaching materials are a set of learning material or substance of learning (teaching material) which is arranged systematically, displaying a complete figure of the competencies that will be mastered by students in learning activities (Treml et al., 2018).

With teaching materials, students may be able to learn competency coherently and systematically so that cumulatively they can master all competencies as a whole and integrated (Nair, 2021).

From the explanation above, it can be concluded that teaching materials, in general, are all materials (whether information, tools, or text) that are systematically arranged to display a full figure of competencies that will be mastered by students and used in the learning process with the aim of planning and reviewing the implementation of learning (Tetep & Dahlena, 2021).

Conclusion

Based on the results of the development research and discussion that has been carried out, it can be concluded that the development of practicum modules in digital electronics courses is carried out using the ADDIE model, namely: Analysis, Design, Development, Implementation, and Evaluation, but at the Implementation stage, it is not carried out. The practicum module developed consists of 3 experiments adapted to the RPS. The advantages of the developed practicum module are systematic and clear practicum procedures and are equipped with diagrams that make it easier for practicum practitioners, as well as attractive module designs. The drawback is that the practicum module developed has not yet been carried out at the implementation stage so learning outcomes using the practicum module cannot be known.

The digital electronics practicum module was evaluated by 2 evaluators and obtained an evaluation result of the material was 62% in the good category, and the results of the presentation evaluation were 87% in the very good category, and the student's perception value was 89% which was in the very good category.

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