

The development of learning material using learning goal orientation approach in digital electronics

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Abstract. Mastery of digital electronics principles is essential for future engineers in the digital era. This article describes the use of simulations in an undergraduate electrical engineering course to promote the adoption of a learning-goal orientation. This study used experimental method. This was done by providing students with a simulation environment which students freely use to experiment with various circuit models. Students were then invited to reflect on how the simulation results compare with results from lab experiments. The module got 82% of positive rating from 28 students and all of them passed in the examination with 81.8 as the average score. Those majority students were motivated by the combination of two learning goals written in the module. Moreover, they also gain the ability to design more complex systems because of their combined experience. Additionally, the module also has been validated and got 83% of reliability. The final product of this research hereafter can be recommended to be used as teaching material.

1. Introduction

Digital technology in today's information age contributes tremendously to the development of the overall human lifestyle. Beginning with the invention of transistors in 1947, human civilization has shifted due to technological developments ranging from vacuum tubes to semiconductor devices [1]. The presence of semiconductor technology then continues to evolve with the introduction of integrated circuit (IC) which enables the processing of digital data automatically by a tiny component.

With the development of digital technology, binary information processing should also be done according to the logic gate principle [2]. The need for encoders and decoders is also vital for converting human acceptable analog signals into digital signals that can be processed by the computer. Data processing will be more easily done digitally than using the more intrusive and inefficient analog signal principle.

Because of the importance of knowledge about the principles of digital electronics, it is one of the compulsory subjects in Electrical Engineering. The need for instructional media that can effectively meet the learning achievements then emerges, especially for this subject [3-5]. In cognitive theory, there are two goal orientations: performance goal and learning goal. Furthermore, students with learning goal orientation likely have a better motivation and achieve better result compared to students with performance goal [6].

Laboratory modules are commonly structured as properties, goals, and a sequence of steps to reach the main purpose [7]. This is a classic direct instruction which known as the best method to attain



procedural knowledge or skills [8]. However, this method is lack of creativity and analytical stimulation for the students because they are only following a single set of instructions. In engineering, students need the ability to solve problems using different approaches. They need to have a constructive mind on any issues an engineer might be encountered. By adding another approach to achieve the learning outcome, students are required to learn more by experimenting on the various way for the same target.

Based on the background that has been mentioned above, this study is intended to develop a laboratory module for Digital Electronics based on learning goal orientation approach. The goal is derived from the subject's learning outcomes then applied in the module design which is designed to have two instructions: simulation practice and laboratory work. By using this approach, the learning process is expected to be effectively directed and students may have a variety of the learning experience.

2. Methodology

The development of digital electronics learning the material with learning goal orientation is organized using Four-D model proposed by Thiagarajan and Semmel [9] which consist of: define, design, develop, and disseminate process which shown in figure 1 below:

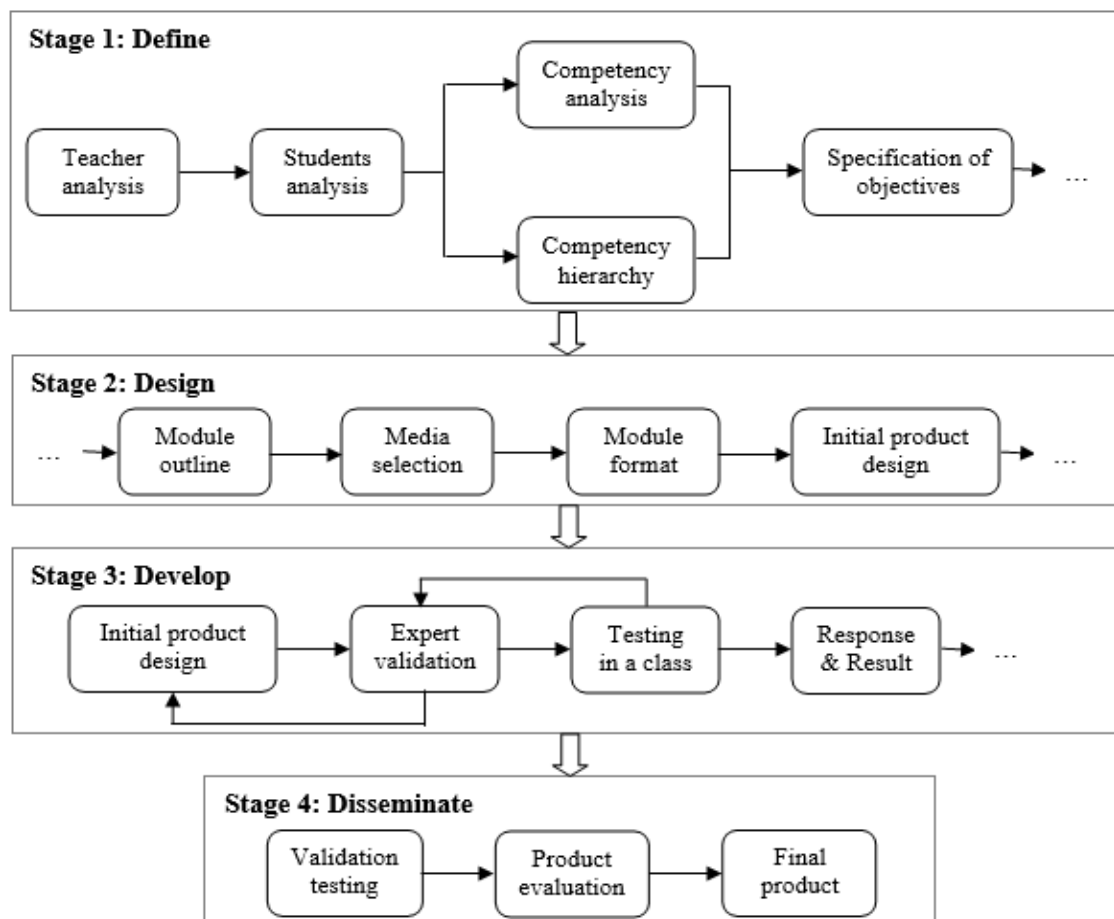


Figure 1. Four-D model for learning material development

The stages are started by defining the problems by analyzing both teacher's and student's current situation, considering the targeted competencies of the subject and its concept, then finally result in a specification of objectives. To specifying the objectives, there's a need for defining instruments. This study is using a group discussion between teachers and students to evaluate the current situation and its potential problems.

Secondly, after determining the specification, a concept of the module can be designed including its format and media selection. The initial design then needs to be evaluated by experts, tested in the developmental stage, and get feedback from those processes.

The third process is the development stages where the material is developed based on the basic needs and also feedbacks from other parties. In this research, the module is developed in a different way where it combined the usual lab work instructions with simulation steps.

The last part is the disseminate stage where the produced module is tested, validated, and evaluated until it can be launched as the final product. Along with the development of the final learning material, students' response and their learning outcome also been monitored.

Furthermore, in conducting the research, it is necessary to have an instrument related to the evaluation process of the whole research process. A research instrument is a tool or facility used by researchers in collecting data to make the work easier and the results better, in a more accurate, complete, and systematic so that more easily processed [10, 11]. Instruments in this study include validation sheet of teaching module and student response questionnaire. Validation of teaching materials will be done by colleagues in Department of Electrical Engineering Universitas Negeri Surabaya, while the questionnaire will be given to the Diploma-3 Electrical Engineering students as the subject of the research.

3. Results and discussion

This section describes the result of this study and discusses it. There are three main results: the validation result of the learning material, the students' response to the learning material, and also the students' final score on Digital Electronics.

3.1. The expert validation result

This research produces the Digital Electronics Practice module. The module was further validated by four lecturers of Electrical Engineering Department at Universitas Negeri Surabaya. Three lecturers with a master degree in electrical engineering act as subject experts and one lecturer with a master degree in education act as a media expert.

Assessment is given by the validator by checking (✓) on the list of indicators indicated and processed by the researcher's rating. Instrument validation criteria include: (a) Module Structure, (b) Material Writing Organization, and (c) Language. The formula for calculating the rating scale is as table 1:

$$\text{Score} = \frac{\sum \text{respondents' answer}}{\sum \text{respondents' highest score}} \times 100\% \quad (1)$$

Table 1. Assessment criteria

Quantitative Assessment	Qualitative Assessment	Score
20% – 35%	Very Invalid	1
36% – 51%	Invalid	2
52% – 67%	Quite Valid	3
68% – 83%	Valid	4
84% – 100%	Highly Valid	5

Table 2 below presents the module validation result data provided by the validator and has been calculated using the above formula.

Table 2. Result of module validation

No.	Aspect	Score					Σ Validator	Rating
		1	2	3	4	5		
1.	Structure							
	a. Organization for the presentation in general				4	4		80 %
	b. General presentation is attractive			1	3	4		75 %
	c. The consistent linkage between the subject matter				2	2	4	90 %
	Average of structure rating							81.25 %
2.	Organization of Materials							
	a. Material coverage				2	2	4	90 %
	b. Clarity and material order			1	3	4		75 %
	c. Material precision with lesson plan					4	4	100 %
	d. The relationship between the problem and the student's life/cognition context contained in the module			1	3	4		75 %
	Average of materials rating							85.00 %
3.	Language							
	a. Use of good and appropriate language				4	4		80 %
	b. The language is communicative				3	1	4	85 %
	c. The sentences' structures are effective				4	4		80%
	Average language rating							81.67 %

Based on those results, the Digital Electronics Practice module can be categorized valid with the final result rating of 82.64% so it is worthy to be used as a learning instrument in the Department of Electrical Engineering

3.1.1. Validation results of students' response questionnaire

Students' response questionnaire of the Digital Electronics Lab Module is also validated by the validators. Criteria and response validation results are shown in table 3 below:

Table 3. Result of students' response questionnaire validation

No.	Aspect	Score					Σ Validator	Rating
		1	2	3	4	5		
1.	The module presentation							
	a. The module is well presented so it's easy to understand				3	1	4	85%
	b. The module is presented in graphs and tables					4	4	100%
	c. The module has bibliography			2	2	4		70%
	The average of presentation rating							85%
2.	Material							
	a. The material covered in the module is well organized				4	4		80%
	b. Module is easy to understand				4	4		80%

The average of material rating				80%
3	Language			
a.	Use of good and appropriate language	4	4	80%
b.	The language is communicative	3	1 4	85%
c.	The sentences' structures are effective	1	3 4	75%
The average language rating				80%

Based on Table 3, the rating of the student's validation response is 81.67% so that the module is declared eligible to be used to take the student's response in the Electrical Engineering Department.

3.1.2. Result of student response questionnaire

After the questionnaire of the validated student response, this questionnaire was given to 20 D3 Electrical Engineering students class of 2015. The questionnaire results were used to find out the student's response regarding the content of Digital Electronics lab module. Table 4 below shows the questionnaires that were distributed to students. The criteria for assessment of student responses refer to table 4 concerning the validated questionnaire.

Table 4. Result of students' response questionnaire

No	Highly Agree	Agree	Not Sure	Disagree	Very Disagree	Σ Score in each point	Criteria
1.a	8	10	2	-	-	87 %	Very Strong
1.b	2	16	2	-	-	81 %	Strong
1.c	3	15	2	-	-	82 %	Strong
2.a	4	14	2	-	-	83 %	Strong
2.b	2	14	4	-	-	80 %	Strong
3.a	2	14	4	-	-	83 %	Strong
3.b.	5	12	3	-	-	83 %	Strong
3.c	3	12	5	-	-	80 %	Strong

The result of table 4 can also be described in figure 2 below:

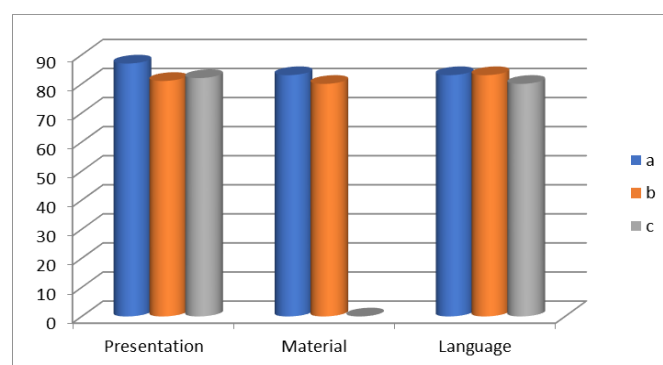


Figure 2. Diagram of students' response questionnaire

Based on the result of a questionnaire of student response, the result that the total score of student response using the following formula:

$$\Sigma \text{total response score} = (\text{overall score}) / 8$$

$$\Sigma \text{total response score} = 659/8$$

$$\Sigma \text{total response score} = 82.37\%$$

Thus, in Digital Electronics Practice learning, the use of this module gives excellent results with a score of 82.37%.

4. Summary

Based on the formulation of the problem and the results of the data obtained in the study and has been poured on the discussion, it can be concluded that:

- Based on the module validation results, the Digital Electronics lab module obtained 81.25% score on Structure Module criteria, 85% on the criteria of Writing Material Organization, and 81.67% on the Language criterion. Thus, the overall value is 82.64% and the module can be declared eligible to be used as a learning instrument at the Department of Electrical Engineering, Universitas Negeri Surabaya.
- The response result from 20 D3 Electrical Engineering students stated that in three categories: Presentation of Module, Material, and Language contained in Digital Electronics Practice module get the result of rating equal to 82.37%.

References

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