DEVELOPMENT OF INTERACTIVE E-BOOKS ON DIGITAL CIRCUITS TO IMPROVE TECHNOLOGY AND ENGINEERING LITERACY SKILLS FOR ELECTRICAL ENGINEERING EDUCATION STUDENTS

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Abstract

The purpose of this research is to develop an interactive e-book for digital circuit courses. The development is carried out using 4D which consists of define, design, development and disseminate. To test the validity of the e-book, validation was carried out by media experts and material experts, while the effectiveness test related to technology and engineering literacy skills was carried out using a questionnaire on 20 students. The results of expert validation show that interactive e-books are in the excellent category so that they are feasible to use. The results of the effectiveness test show that interactive e-books are effective for improving technology and engineering literacy for electrical engineering students.

Keywords:development, interactive e-book, technology and engineering literacy

1. INTRODUCTION

Marking as a century of openness or a century of globalization, human life in the 21st century underwent fundamental changes that are different from the previous century (Wijaya, et al, 2016). Guthrie (2010) stated that the atmosphere of life at work, interactions between people at work, interactions between humans and machines at work, interactions of human groups across units/institutions/work organizations, types and characteristics of work develop into increasingly complex conditions, erratics, contradictories, full of differences and changes. This is where universities are challenged to prepare graduates who are ready to face all challenges, issues, and problems that exist in the working world as a result of global change.

The demands of life needs in the global era are increasingly evolving and complex and follow the dialectics of technological civilization. As an impact on life, one must master knowledge and technology to compete with others (Mukhadis, 2013). To deal with these challenges, one of the skills that students must possess is literacy skills. In the 21st-century, literacy is not only limited to the ability to read, hear, write and speak verbally but more than that, literacy is emphasized on literacy skills that are connected in the digital era as it is today. As claimed by NCREL & Metiri Group, (2003) in enGauge 21st-Century Skills, literacy in the digital era includes several components, including (1) Basic Literacy, (2) Science literacy, (3) Technological literacy, (4) Economic literacy, (5) Visual literacy, (6) Information literacy, (7) Multicultural Literacy, and (8) Global awareness. Specifically in Engineering Education, there is a need for technology and engineering literacy skills to face the challenges of the 21st-century. Technology and engineering literacy skills are important skills for an engineer because the engineer is an agent of technology design who can change the world (NAEP, 2018).

Efforts to improve technology and engineering literacy skills are carried out through the development of learning resources that meet the needs of the 21st-century. The challenge of the world of Education in the 21st-century is to encourage students to master 21st-century skills that are important and useful to them to be more responsive to change and develop Junanto & Afriani (2016). The 21st-century technological advances have had an extraordinary impact on the world of Education (Dafrizal, 2017). According to Ansari (2013), students throughout the world today cannot be separated from information technology. One form of technology implementation in Education is an interactive e-book. The interactive e-book is suitable as a learning resource in the 21st-century because the interactive e-book is a flexible digital learning resource to facilitate student learning activities that can be accessed classically or independently. The characteristics of an interactive e-book are expected to be more involved (engaging), inspiring (inspire), interesting (excite), and interactive (interactive) for use in lectures. The use of digital technology is believed to increase the retention and persistence of students in learning and can also provide rich content and more suitable for application in 21st-century learning (Mawarni & Muhtadi, 2017).

One of the compulsory subjects that must be taken in the Electrical Engineering study program is the digital circuit. This subject is one of the important

subjects that students must master to design technology. Considering the importance of this course, the existence of appropriate learning resources is needed so that students can compete and face the challenges of the 21st-century. Based on the explanation above, the authors intended to 1) develope interactive e-book as a source of learning in the 21st-century, 2) do validity testing of interactive e-book products developed, and 3) test the effectiveness of interactive e-book to improve technology and engineering literacy skills.

2. METHOD

The development method used in this study was 4D which consisted of 4 stages, namely define, design, develop, and disseminate (Thiagarajan, et al., 1974). The software used in the development of this interactive e-book was Kvisoft Flipbook MakerPro. Following is the flow of interactive e-book development in the digital subjects circuit.

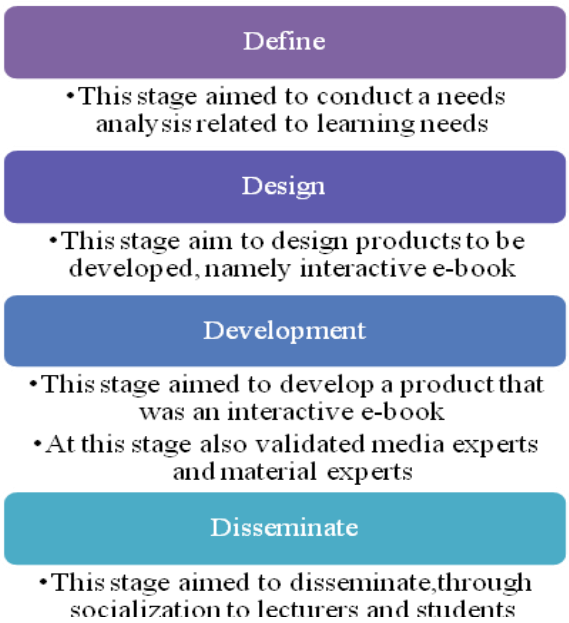


Figure 1. Development Stage with 4D Model

In this study, data collection was carried out using a questionnaire to measuretechnology and engineering literacy skills. Adapted from NAEP (2018) there are three aspects to assess technology and engineering literacy skills, namely 1)Understanding Technological Principles, 2) Developing Solutions and Achieving Goals and 3) Communicating and Collaborating. The questionnaire used used a Likert scale with a value of 1-5.The interpretation of the assessment is very good, good, moderate, bad and very bad. (Riduwan and Sunarto, 2015).The research was conducted by involving 20 students of Electrical Engineering Education who took Digital Electronics courses. The data analysis used to analyze the validation results is descriptive analysis, while the data analysis used to analyze the improvementtechnology and engineering literacy skills is the Gain technique with an experimental design of one group pretest posttest design.

3. FINDINGS AND DISCUSSION

a. Define stage

The define stage is the stage of establishing and defining what is needed to develop learning media that will be used in the Digital Circuits course. This define stage includes five main steps, namely front end analysis, student analysis, task analysis, concept analysis and formulation of learning objectives. (Thiagarajan, et al., 1974).

b. Design Stage

The design stage aims to design interactive e-book learning media for flip-flop, register and counter material. The steps taken at this stage are as follows:

1) Media selection(media selection)

Media selection is the selection of learning media that is relevant to the material. The media was selected to suit the analysis of the concept, characteristics of the target user and source of creation (Thiagarajan et al., 1974). The selection of media is done to optimize the use of teaching materials in the process of developing teaching materials in classroom learning. The selection of the media used is in the form of interactive e-book learning media where the e-book media does not only contain writing and pictures, but there are evaluation questions that the student data is working on and the scores will immediately appear from the results of working on the questions.

2) Selection format(format selection)

The format chosen is the one that meets the criteria of being attractive, easy and helpful in learning and in this research, the format chosen is the .exe format.

3) Initial design(initial draft)

At this stage, the interactive e-book media will be made. The product that will be produced later is an interactive e-book that is run on a computer using a flash player. In designing an interactive e-book media before the media is used, the steps that need to be taken are as follows:

a) Preparing writing material, the writing material in this study is teaching material about flip-flops, registers and counters. Below is a view of the material in the e-book:
b) Production, in this stage the main activity carried out is designing the cover and layout of the interactive e-book which requires certain software in the process.

The following is a design for the use of interactive e-books in the subject of microprocessor engineering.

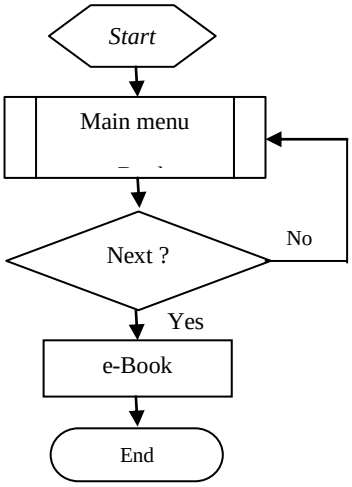


Figure 2. Flowchart of e-Book

c) Development Stage

To get a suitable interactive e-book, after the interactive e-book is completed in the define and design stage, the next stage is the development stage. This development stage aims to produce an interactive e-book that has been validated by media experts and material experts so that it is suitable for use. The following are the results of expert and material expert validation:

Table 1. Validation Results

Aspect	Indicator	Criteria
Theory	a. The suitability of the material with the learning objectives	excellent
	b. Conformity to the needs of the task	excellent
	c. Conformity with students' thinking level	good
Interactive eBook format	a. Systematize presentation	Excellent
	b. Table of contents structure	good
	c. The font used	good
	d. Font size used	good
	e. paragraph order	good
	f. Image display	excellent
	g. Image size compatibility with media	Excellent
	h. The suitability of the background with the material	Excellent
	i. Margin suitability on the material	Excellent
	j. Layout design and colors presented	Excellent
Language	a. Easy to understand language	Excellent
	b. The language used can explain the material presented	Excellent
	c. Language according to the intellectual development of students	good
	d. Language coherence or regularity between chapters, sub-chapters and paragraphs	good
	e. Effective use of subtitles	Excellent
	f. The number of illustrations used is appropriate	Excellent

Based on the validation results above, it can be concluded that the interactive e-book for Digital Circuit courses is very good and feasible to use. The validator also provides the following input:

Table 2. Input Validator

No	Suggestion	Information
1	E-book display should not be made its own way (automatically)	Already repaired
2	Need to add a more detailed table of contents	Already repaired
3	*Fonts*in the preface is equated with the content font	Already repaired
4	Some spelling (typo) fixed again	Already repaired
5	Fix unclear image quality	Already repaired

The results of developing interactive e-books are as follows:

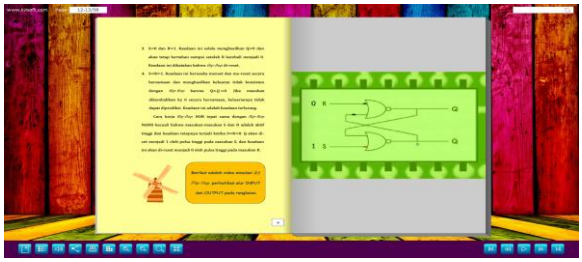


Figure 3. Interactive e-book display

After the interactive e-book is declared suitable for use, then further testing its effectiveness is carried out, namely to measure the improvementtechnology and engineering literacy skills by using a prepared questionnaire. The trial design used was a one group pretest posttest design, where there was a pretest before treatment and a posttest after being treated. The one group pretest posttest design refers to Hamzah (2019) with the following model:

O1	X	O2

Information :
X : Treatment
O1 :Pretest
O2 :Posttest

Analysis of improving learning outcomes using N-Gain which can show differences in student learning outcomes before and after being given treatment. The normalized score gain indicates the level of effectiveness of the treatment rather than the score or posttest gain. N-Gain formulated by Hake (1999):

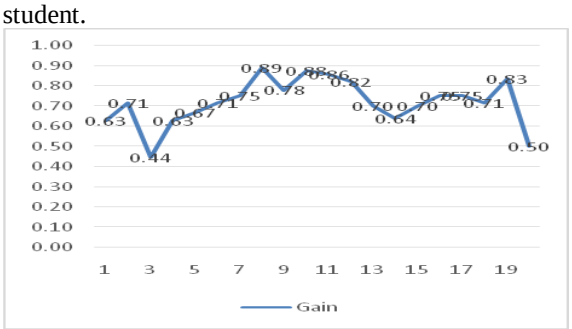
Information :
N-Gain = Gain index
Tpost = Score after treatment
Tpre = Obtained score before treatment
With the scoring criteria can be seen in Table 3

Table 3 N-Gain . scoring criteria

No	N-Gain category gain	Information
1	0.70 > N-Gain	High
2	0.30 N-Gain 0.70	Currently
3	N-Gain < 0.30	Low

Adapted from Hake (1999)

The following is the Gain value data for each student.



Based on the data above, it is known that the results of the effectiveness test conducted on 20

students showed that there was an increase in technology and engineering literacy skills with an average N-Gain of 0.72 and was included in the high category. This shows that the interactive e-book developed is effective in improving technology and engineering literacy skills.

c. Disseminate Stage

Based on the results of the validation and effectiveness testing of the interactive e-book, then the distribution is carried out. Dissemination is done by conducting outreach to lecturers and students.

4. CONCLUSIONS

Based on the results of the development, it can be concluded that: 1) interactive e-books developed empirically are proven to be suitable as a learning resource in the Digital Circuits course, 2) interactive e-books are effective for improving technology and engineering literacy skills. The results of this study can be used as input and as an alternative source of learning for lecturers in Electrical Engineering Education.

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