E-MODULE DEVELOPMENT FOR THE SUBJECT OF MEASURING INSTRUMENTS AND MEASUREMENT IN ELECTRONICS ENGINEERING EDUCATION

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ABSTRACT

This study aims to develop an e-module as a medium of learning for the practice course of Measuring Instruments and Measurement in the Department of Electronics Engineering Education of Yogyakarta State University and to determine the feasibility of the e-module. This study employed a method of research and development. The development process was conducted through four phases by using the model of Lee and Owens which consisted of analysis phase, design phase, developing and implementation phase, as well as evaluation phase.The evaluation was conducted in several stages. Firstly, an alpha test for product validation was conducted by the experts on material and media. After that, a beta test was conducted by testing the product in small group users. The subjects of this study were the students of Electronics Engineering. The instruments used to collect the data were a validation sheet and questionnaires. The results of qualitative data were then modified into quantitative data with a range of 1 to 5, then they were converted with a rating scale to determine the feasibility of the medium. The results showed that based on the alpha test, the medium was in a very high quality. Meanwhile, in the beta test of the instructional aspect, in terms of material and evaluation and the multimedia aspect the e-module was respectively considered feasible and quite feasible. The four indicators namely text, image, animation and video were all generally considered feasible. In terms of usage aspect, the e-module was considered feasible where its two indicators, namely instructions and navigation, were generally regarded as very feasible by all respondents.

Keywords: e-module, flipbook, innovative learning

INTRODUCTION

The short term vision of Faculty of Engineering of Yogyakarta State University is to produce professional educational Bachelor and Diploma graduates in the technology and vocational fields based on piety, self-reliance, and intellectuality in accordance with the demands of science and technology development in the global era. Therefore, improving the quality of learning process becomes a necessity and an obligation of each department including the Department of Electronics Engineering Education. One of the efforts to improve the quality is by optimizing the component of learning resources abequipment in the learning process, both in theory and practice. The practice course of Measuring Instruments and Measurement is one of the compulsory subjects taken by students majoring in Bachelor degree of Electronics Engineering Education and Diploma degree of Electronics Engineering.

The fact in the field showed that instructional media used in the practical subject of Measuring Instruments and Measurement were still conventional. It makes the students difficult to learn the material, especially when they are still in the early semesters and they are not accustomed to doing laboratory activities, such as those who are not graduated from vocational high schools who were not familiar with a wide variety of electronic equipments. Therefore, innovative learning media that facilitate students in learning are required. One of them is an e-module with flipbook method. Besides, Suarsana (2013: 2) stated that in modern education, lecturers need to integrate Information and Communication Technology (ICT) in learning process. ICT should not only become object that must be learned but it should be integrated in the learning process.

The integration of ICT in daily life has given many changes including in the education field (Herry, 2013). Nurchali in Suarsana (2013: 2) exemplify by using computer in learning process may give learning experiences, improve motivation, also develop the student's ability in ICT. Using e-module is one way of integrating ICT in the learning process. By developing the e-module, it is expected that students can learn the material easily, effectively, and efficiently.

The model employed in developing the learning model was the development model of Lee and Owens. It consists of four stages namely (a) assessment/analysis phase, (b) design phase, (c) development and implementation phase and d) evaluation phase (Lee and Owens, 2004). Developing instructional media in the form of flipbook e-module by employing Lee and Owens model is a creative and innovative idea to motivate the students, enhance their understanding as well as improve the learning outcome.

A medium is regarded as a learning medium when it provides information for learning purposes. Brigs in Rusman (2009: 151) stated that instructional medium is the physical means of conveying instructional content. In addition, Rusman (2012: 160) stated that learning medium is a technology that convey messages for learning purposes. Thus, it can be concluded that media are instruments to simplify the delivery process of content and information of the materials.

To achieve successful teaching and learning process, the roles of teaching methods and aids are very significant. They usually mentioned as learning media, will determine the success of the learning process. In this study, the developed learning medium is a flipbook e-module. E-module can be defined as a digitalized module created in an interactive way. It can also be regarded as a medium for independent learning because it is equipped with self-study guides. Unlike the usual modules, this digitalized e-module does not only contain word and pdf materials but it also presents videos and animations to enable users learn actively.

According to Directorate General for Quality Improvement of Teachers and Education Personnel (PMPTK, 2008: 3 - 5), a module is considered as good and attractive if it meets the following characteristics: Firstly, Self Instructional; through the modules, users or learners are Gable to study by themselves and do not depend on others' help. To fulfill the self-instructional character, the module should; (a) contain clearly defined objectives, (b) present learning materials in small/specific units to make it easier to learn thoroughly, (c) provide examples and illustrations to support the clarity of the learning materials, (d) provide exercise/ questions, tasks which allow users to respond and measure their level of mastery, (e) be contextual, which means the materials or tasks presented are associated with the atmosphere or the environment of the users, (f) use simple but communicative language, (g) present a summary of the learning materials, (h) provide assessment instruments/ assessment, which allows the users to do self assessment, (i) there is an instrument that can be used to measure or evaluate the level of mastery of the material, (j) provide feedbacks on the assessment, so users know the level of mastery of the material, and (k) provide information about the sources of enrichment or references that support the learning material.

Secondly, self contained which means all the learning materials of one competency or sub competency unit are available in the module as a whole. The aim of this concept is to give learners the opportunity to learn the materials completely because they have been packed into one unified whole. If the materials of one unit need to be divided, it should be conducted carefully based on competencies that should be mastered; (3) Stand Alone, which means the modules developed do not depend on any other media or should not be used together with other instructional media; (4) Adaptive; the module should be very adaptive to cope with the

advance of science and technology. A module is considered adaptive if it can adjust to the development of science and technology and is flexible (up to date). In addition, the content should be able to be used up to a certain period; (5) User Friendly which means each presented instruction and information is helpful and friendly to the users, including the users' convenience in responding and accessing the content. Using simple language which is easy to understand and employing common terms. Therefore, to achieve such a high-quality e-module, it should be developed by fulfilling those characteristics. The interactive and interesting e-module will help learners understand the materials.

The developed e-module was equipped with flipbook. Basically, flipbook is a form of simple animations generated by opening the pages quickly. However, along with the development of information technology, this flipbook idea was adopted and used in the manufacture of digital books which enable them to be opened and inverted like a regular book. Flipbook is similar to an e-book. However, when e-book is a digital book that has monotonous look of texts and images, flipbook is equipped with animations, videos and quizzes that make it more attractive and interactive.

Measuring Instruments and Measurement is a practical subject that concerns about instrumentation and measurement. It is one of the basic competencies to be mastered by the students of the Electronics Engineering Education. Therefore, understanding and mastery of the practical materials are very important for them since the knowledge and the skills will be applied in other courses. The instruments studied in this course include multimeter, amperemeter, voltmeter, oscillo scope and AFG. The students also learn about calibration of electrical basic measuring instruments and changing the measurement function and limit.

Based on the objectives above, it was crucial to develop an interactive learning medium to improve the students' achievement. Therefore, an e-module with flipbook as an instructional medium on the practical subject of Measuring Instrument and Measurement was developed.

METHODS

This study is categorized as research and development with four phases of development process referring to the model of Lee and Owens. The phases conducted in developing the learning module is presented in Figure 1.

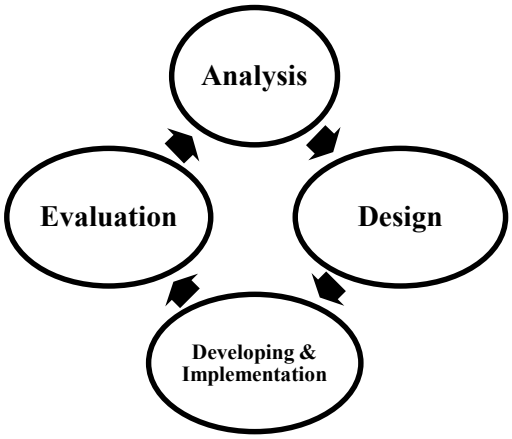

Figure 1. The Development Model
(Source: Lee and Owens, 2004)

The media developed in this study was a flipbook application program with the following specifications shown in Table 1.

Table 1. Product Specifications and Requirements

Component	Information
Navigation	Animation operational standard/video display (play, stop, pause, rewind, back)
File Type	Html (mozila firefox, google chrome), executable.
Display	Dual page or function one page with zoom in
Animation	Swf
Video	Mpeg, flv
Audio	Standart audio (mp3 , wav)
Picture	Jpeg , pdf
Other Features	Find document, go next page, single file exe and portable

Alfa and beta testing were conducted in this study to ensure that the e-module is able to answer the formulated problems. The Alpha test aimed to test the feasibility of the product was done by the experts of media and materials. The input from the experts was used as the basis of revision and improvement before the product was tested on the limited subjects. The experts appointed in the alpha test consisted of an expert on instructional media and an expert on Measuring Instrument and Measurement practice course. Meanwhile, the beta test was conducted on students who were divided into three categories: potential users, average users, and slow learner users. The grouping was based on their scores and GPA. The students assessed the e-module and the results would be the basis of the next revision and improvement. This study used two kinds of questionnaires to collect the data: (a) a questionnaire administered in the alpha test; and (b) a questionnaire administered in the beta test. The detailed explanation about both questionnaires is presented in Table 2, Table 3 and Table 4.

Table 2. The Content Outline of the Alpha Test Instrument (Material Aspect)

Aspect	Indicator	Point of Statement
Content Feasibility	Compliance with the learning purpose	1, 2, 3
	Accuracy of the materials	4, 5, 6, 7, 8, 9
	Supporting learning materials	10, 11, 12, 13, 14, 15
	Latest materials	16, 17, 18
Presentation Feasibility	Technique of presentation	19, 20
	Presentation support	21, 22,23, 24, 25, 26
	Instructional presentation	27
	Presentation completeness	28, 29, 30
Language	Simple and direct	31, 32, 33
	Comunicative	34, 35
	Interactive	36, 37
	Fit for students' level of development	38, 39
	Ordered and coherent	40, 41
	Using terminology, symbols, or icons	42,43

Table 3. The Content Outline of the Alpha Test Instrument (Aspect of Media)

Aspect	Indicator	Point
Display	Easy-to-read text	1
	Font selection and size	2
	Color proportion	3
	Layout proportion	4
	Background Selection	5
	Images which fit to the materials	6
Content Coherence	Text colors which match to the materials	7
	Suitability of the animations and the materials	8
	The order of material presentation	10
	Instructions	11,12
Visual Comunication	Comunicative visual aspect	12,13
	Simple and attractive look	14,15,16

Table 4. Content Outline for Beta Test Instrument

Aspect	Indicator	Point
Instructional	Material	1,2,3
	Evaluation	4,5,6
Multimedia	Text	7,8,9,10
	Image	11,12,13
	Animation	14,15
	Video	16,17,18
Usage	Guidance	19,20
	Navigation	21,22,23

The data were analysed with quantitative descriptive to determine the feasibility of the medium related to its function. The questionnaire provided five alternative options for the respondents to give feedbacks. The scores were classified into five categories. They were very high, high, low, and very low with the scores of 5, 4, 3, 2, and 1 respectively. The scores were then converted into values in the scale of 5 by referring to Table 5 quoted from Sukardjo (2005: 55) as follows:

Table 5. The Value Conversion in the Scale of 5

Interval Scores	Grade	Category
X >IM + 1,8 ISD	A	Very high
IM + 0,6 ISD < X ≤ IM + 1,8 ISD	B	High
IM – 0,6 ISD < X ≤ IM+ 0,6 ISD	C	Moderate
IM – 1,8 ISD <X ≤ IM – 0,6 ISD	D	Low
X ≤ IM – 1,8 ISD	E	Very low

Where:
X = actual score (empirical)
IM = the ideal mean, calculated by using the following formula:
IM = ½ {ideal maximum score + ideal minimum score}
ISD = ideal standard deviation, was determined by the formula:
ISD = 1/6 {ideal maximum score - ideal minimum score}

The scale above shows that the ideal maximum score is 5 and the ideal minimum score is 1, so the calculation of IM and ISD is as follows:

$$IM = ½ (5 + 1) = 3 \quad \text{(i)}$$

$$ISD = 1/6 (5-1) = 0.67 \quad \text{(ii)}$$

Under these provisions, the result of scale 5 calculation can be seen in Table 6 below:

Table 6. Qualitative to Quantitative Data Conversion (Scale 5)

Scale	Criteria	Score	
		Calculation	Result
5	Very high	X > 3 + (1,8 x 0,67)	X > 4,2
4	High	3 + (0,6x0,67) < X ≤ 3 + (1,8x0,67)	3,4 < X ≤ 4,2
3	Moderate	3 – (0,6x0,67) < X ≤ 3 + (0,6x0,67)	2,6 < X ≤ 3,4
2	Low	3 – (1,8x0,67) < X ≤ 3 – (0,6x0,67)	1,8 < X ≤ 2,6
1	Very low	X ≤ 3 – (1,8x0,67)	X ≤ 1,8

In order to obtain the average score of the product assessment, the formula was:

$$X_i = \frac{\sum x}{\sum a \times \sum n} \quad \text{(iii)}$$

Where Xi, ∑x, ∑a, and n are average score, total score, total of aspects observed, and total of respondents respectively.

RESULTS AND DISCUSSION

E-module development for the course of Measuring Instruments and Measurement in the Department of Electronics Engineering Education was designed in accordance with the basic competencies to be achieved in the practice course. The e-module was developed to help the students understand the instrumentation and measurement including multimeter, amperemeter, voltmeter, oscilloscope, AFG, calibration of electrical basic measuring instruments, and changing the measurement function and limit. The steps in doing the practical works as well as the feedback in learning a variety of instruments and measurements are explained in the e-module so that the objectives can be achieved and mistakes can be avoided. The e-module is equipped with images, videos, and animated simulations which support the respective competencies to be mastered. It was designed based on the practice course syllabus of Measuring Instruments and Measurement which consists of 12 competencies.

The e-module was developed using several softwares, namely Adobe Flash and Flipbook, then the product was validated by experts to test its feasibility in terms of media as well as material aspects. There were 4 experts as the respondents in this alpha test. The suggestions from the experts were then used as input for revising and improving the product before it was tested in limited subjects. The alpha test was also conducted in order to identify and minimize the weaknesses. The instrument of alpha test was needed to guarantee that the performance of the e-module being developed was valid. The results of the alpha test showed that the medium fulfilled 85% of quality aspect and 87% of media aspect. Thus, the feasibility level of the e-module could be categorized as very high.

After the product was considered feasible and passed the alpha test, the medium was then implemented for small group subjects or the users to be (beta test). The beta test was also improved the product before it is used by the real users. The beta test was conducted by students as the product users. In this case, the small group consisted of 42 selected students of Electronics Engineering Education. They conducted a practice course by using the e-module of Measuring Instrument and Measurement and then gave an assessment of the medium through a questionnaire.

The assesment reveals the following results: in terms of instructional aspect, 11.9% of the respondents stated that the e-module was very feasible; 47.62% of them considered it to be feasible; 23.81% of them stated that it was quite feasible; 7.14% of them classified it as less feasible; and 9.52% of them stated that it was not feasible. Specifically, in terms of materials, as shown in Figure 2, 7,14% of the respondents said that the e-module was very feasible; 47.62% of them considered it feasible; 15.29% of them regarded it quite feasible; 30.95% of them classified it less feasible; and no one claimed the e-module to be not feasible. Meanwhile, based on the evaluation indicator, 21.43% of the respondents said that the e-module was very feasible; 40.48% of them considered it feasible; 15.29% of them stated that it was quite feasible; 23.81% of them classified it less feasible; and no one claimed it to be not feasible. It can be concluded that based on the instructional aspect, in terms of material and evaluation, the e-module of Measuring Instruments and Measurement was categorized into feasible.

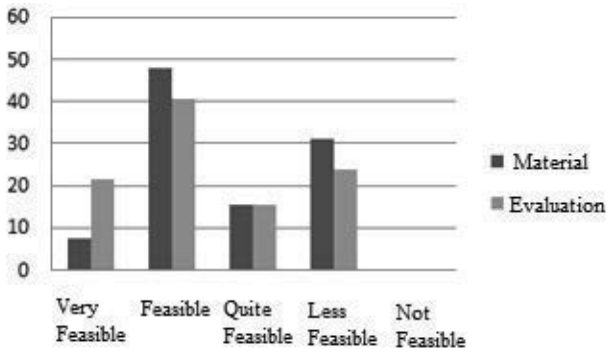

Figure 2. Beta Test Results on Two Indicators of Instructional Aspect

In terms of multimedia aspect, 14.29% of the respondents said that the e-module was very feasible; 26.19% of them considered it feasible; 30.95% of them stated that it was quite feasible; 11.9% of them classified it to be less feasible; and 16.67% of them categorized it not feasible.

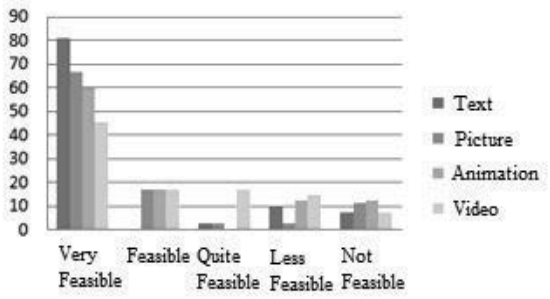

Figure 3. Beta Test Results on Four Indicators of Multimedia Aspect

As shown in Figure 3 in terms of text indicator, 80.95% of the respondents said that the e-module was very feasible; no one considered it feasible; 2.38% of them stated that it was quite feasible; 9.52% of them classified it less feasible; and 7.14% categorized it not feasible. In terms of picture indicator, 66.67% of the respondents said that the e-module was very feasible; 16.67% of them considered it feasible; 2.38% of them stated that it was quite feasible; 2.38% of them classified it less feasible; and 11% regarded it not feasible.

In terms of animation, 59.52% of the respondents said that the e-module was very feasible; 16.67% of them considered it feasible; no one claimed it to be quite feasible; and 11.9% of them classified it less feasible and the same number of respondents stated that it was not feasible. Based on the video indicator, 45.24% of the respondents said that the e-module was very feasible; the same number of respondents, 16.67% of them, claimed it to be feasible and less feasible; 14.29% of them classified it less feasible; and 7.14% of them categorized it not feasible. It can be concluded that, generally, in terms of multimedia aspect with its four indicators namely text, images, animation and video, the respondents claimed that the e-module of Measuring Instruments and Measurement was feasible.

The numbers of respondents who considered the product very feasible, feasible, quite feasible, less feasible and not feasible were 9.52%, 38.1%, 28.57%, 11.9% and 14.29% respectively. As shown in Figure 4, in terms of instruction, 80.95% of the respondents said that the e-module was very feasible; no one considered it feasible and less feasible; 4.76% of them stated that it was quite feasible; and 14.29% of them classified it not feasible. Meanwhile, in terms of navigation, 90.45% of the respondents said that the e-module was very feasible; the same number of respondents, 2.38% of them, claimed it to be feasible, quite feasibe, and less feasible; and 7.14% of them categorized it not feasible. Thus, it can be concluded that in general, in terms of usage, the e-module of Measuring Instruments and Measurement was considered feasible where the indicators, navigation and instructions, were claimed very feasible by all respondents.

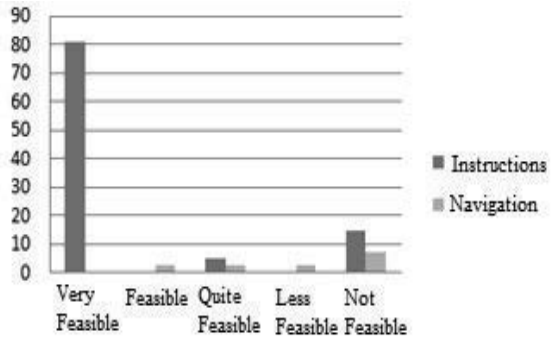

Figure 4. Beta Test Results on Both Aspects of the Use of Indicators

Table7. Results of Expert Judgment

Name	Expert 1			
Expertise				
Aspect of the test	Material			
Material Aspects	Total Score	Maximum Score	Percentage	Information
	186	210	88.57	Very good
Content feasibility	78	90	86.7	Very good
Presentation feasibility	57	60	96	Very good
Language feasibility	51	60	85	Very good
Name	Expert 2			
Expertise				
Aspect of the test	Material			
Material Aspects	Total Score	Maximum Score	Percentage	Information
	171	210	81.42	Very good
Content feasibility	71	90	78.9	Very good
Presentation feasibility	51	60	85	Very good
Language feasibility	49	60	81.7	Very good
Name	Expert 1			
Expertise				
Aspect of the test	Media			
Media Aspects	Total Score	Maximum Score	Percentage	Information
	70	80	87.5	Very good
Display	21	25	84	Very good
Content coherence	22	25	88	Very good
Visual communication	27	30	90	Very good
Name	Expert 2			
Expertise				
Aspect of the test	Media			
Media Aspects	Total Score	Maximum Score	Percentage	Information
	69	80	86.25	Very good
Display	21	25	84	Very good
Content coherence	21	25	84	Very good
Visual communication	27	30	90	Very good

CONCLUSION

In developing the e-module of Measuring Instruments and Measurement in the Department of Electronics Engineering Education, the content has been adjusted to the basic competencies to be achieved in the practice course. It was designed to help the students learn and understand instrumentation and measurement that include multimeter, amperemeter, voltmeter, oscilloscope, AFG, calibration of electrical basic measuring instruments, as well as changing the measurement function and limit. The e-module is also equipped with images, videos, and animated simulations which support the respective competencies to be mastered in this course. It was designed based on the practice course syllabus of Measuring Instruments and Measurement which include 12 competencies. It was developed by employing some soft wares, such as Adobe Flash and Flipbook. As an instructional medium, the feasibility level of the e-module was categorized into very good by the experts on materials and media. The quality of materials and media gained the score of 85 and 87 respectively.

In the beta test of the instructional aspect, in terms of materials and evaluation and the multimedia aspect, the e-module was respectively considered feasible and quite feasible. The four indicators namely text, image, animation and video were all generally considered feasible. In terms of usage aspect, the e-module was considered feasible where its two indicators, namely instructions and navigation, were generally regarded as very feasible by all respondents.

REFERENCES

Ditjen PMPTK. 2008. *Penulisan Modul. Direktorat Tenaga Kependidikan*. Jakarta: Ditjen PMPTK

Herry Fitriyadi. 2013. Integrasi Teknologi Informasi Komunikasi dalam Pendidikan: Potensi Manfaat, MasyarakatBerbasis Pengetahuan, Pendidikan Nilai, Strategi Implementasi dan Pengembang-an Profesional. *Jurnal Pendidikan Teknologi dan Kejuruan Fakultas Teknik UNY*. 21, 3. 269-284

Lee, W. and Owens, D. L. 2004. *Multimedia Based Instructional Design: Computer Based Training Web Based Training Distance Broadcast Training, Performance Based Solutions 2nd Ed*. San Fransisco: Pfeiffer

Rusman. 2009. *Manajemen Kurikulum Seri Manajemen Sekolah Bermutu*. Jakarta: PT Raja Grafindo Persada

Rusman. 2012. Belajar dan Pembelajaran Berbasis Komputer: Mengembangkan Profesionalisme Guru Abad 21.Bandung: Penerbit Alfabeta

Putu Sudira. 2011. *Kurikulum dan Pembelajaran Pendidikan dan Pelatihan Vokasi Menyongsong Skill Masa Depan. Makalah Pengembangan Kurikulum*. Bali: Politeknik Negeri Bali

Sadiman, A. S. 2009. Media Pendidikan: *Pengertian, Pengembangan dan Pemanfaatannya*. Jakarta: PT Raja Grafindo Persada.

Suarsana, Mahayukti. 2013. Pengembangan E-Modul Berorientasi Pemecahan Masalah untuk Meningkatkan Keterampilan Berpikir Kritis Mahasiswa. *Jurnal Pendidikan Indonesia,* 2, 2. 264.

Sukardjo. 2005. *Desain Pembelajaran: Evaluasi Pembelajaran.* Handout Graduate Program of YSU