



Development of Interactive E-Book on Basic Electronics Courses

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ABSTRACT

Basic Electronics is an introductory course that provides an initial understanding of electronics to Electrical Engineering Education students. In today's learning, it is necessary to make several innovations in the learning process so students can easily understand the information or material conveyed in knowledge. One of the innovations that can be done is to develop an interactive e-book for introductory electronics courses. The purpose of this research is to produce an interactive e-book that is feasible, accessible, and comprehensible. The development of this interactive e-book refers to the 4D Models development model which has four stages, namely definition, design, development, and dissemination. The data used were qualitative and quantitative. The instrument used in this research was a questionnaire. The research data are expert-validated, limited, and expanded trial data which aim to see the feasibility and convenience of the developed research product. Based on the validation results of two experts, this e-book is in the applicable category. The level of practicality of using interactive e-books was obtained from the results of trials which consisted of two stages, namely limited trials and expanded trials. From the results of this trial, it was found that the level of practicality of this interactive e-book was very practical and feasible to use.

Keywords: *Interactive e-book, Flipbook maker, Basic Electronics*

1. INTRODUCTION

Basic Electronics is one of the required courses in the Electrical Engineering Education study program at Universitas Negeri Medan. This course consists of 2 credits which are theoretical courses that discuss and introduce characteristics, working principles, analysis, and calculations on electronic components. This course provides an initial understanding of electrical engineering education students regarding electronics. This course is also the initial foundation for students in understanding electronic circuits. Based on the results of observations and interviews conducted by the author in the Basic Electronics course in the odd semester 2022/2023, many students still do not understand and know about the characteristics, working principles, analysis, and calculations of electronic circuits studied in this course. The results of the interview conducted with 37 students regarding the material showed that 56 % of students were unable to understand the material that had been explained.

On the other hand, the results of observations conducted in the Introductory Electronics Course show that the media and teaching materials used are still very minimal. This can be seen from the use of lecture sources or teaching materials which still use

textbooks and most students copy those original books causing the appearance of those source books not very supportive to be used as material and learning resources in lectures. Based on the results of observations found that the learning media used were still conventional media such as PowerPoint and whiteboards. In the learning process, media is a means of communication [1], [2] and has a very important role in achieving learning goals [3], [4]. Learning media is a tool used in learning to convey learning material, which consists of books, tape recorders, videos, pictures, graphics, TV, and computers [5, p. 19]. Teaching materials are all forms of materials used in learning that aim to help educators in learning activities [6, p. 159]. Teaching materials are learning materials that are designed systematically and are used by educators in the learning process [7]. Media and teaching materials are two things that are very important in achieving learning objectives. Using the right media and teaching materials will have a big impact on the success of learning. Therefore, it is necessary to develop and innovate in the learning process in terms of developing creative and innovative teaching materials so that they can increase student interest and understanding in learning.

To boost student interest and comprehension in learning, the learning process must be developed and innovative in terms of creating unique and original teaching materials. This is consistent with research by Suprpto [8] titled Development of an Animation-Based Interactive E-Book and research conducted by Hidayat [9] titled Development of an Interactive Book on Quantum Physics material that states that interactive book is feasible and should be used to increase students' understanding in learning. The use of interesting teaching materials can increase student motivation so that it will influence student learning outcomes [10]. This is an essential resource for researchers to develop an e-book in basic electronic courses, that is interesting, creative, innovative, and also easy for students to understand.

Innovative e-book development can be produced through the use of Information and Communication Technology (ICT) developments. Along with the development of ICT, the world of education also needs to make changes and developments in the learning process [11], [12]. Technology and information can facilitate the delivery of information to students. One of the solutions to overcome the problem of learning basic electronics courses that have been described above can be overcome by using ICT in learning. Utilization of ICT can be applied by innovating in the development of teaching materials.

The development of teaching materials by taking advantage of ICT developments needs to be done in the learning process so that the information or material conveyed in learning can be easily understood by students. Innovation can be done by developing teaching materials that can train students' thinking skills and can involve students in learning so that the process of delivering information to students is not monotonous and can attract students' attention to learning. Innovations made in learning by utilizing ICT in the development process can be in the form of interactive e-book teaching materials in basic electronics courses.

E-books, also known as digital books, are electronic versions of printed books that can be read on computers, laptops, cell phones, and tablets. E-books also have the meaning of a learning environment that has applications that contain a multimedia database of instructional resources that stores multimedia presentations about the topics in a book [13]. According to [14], the usage of e-books in learning allows students to investigate and widen their comprehension of the content and different ways of thinking. This research aims to develop teaching materials in the form of e-books that can improve students' critical thinking skills in broadening their

understanding of the material. The e-book developed here is an interactive e-book, which can include pupils in its use. An interactive e-book can assist students in understanding more about the subject offered since there is direct involvement and interaction of students in learning [15], [16]. The development of an interactive e-book for basic electronics courses was developed and designed with the help of a flipbook maker application which makes it possible to include all types of learning media easily.

2. LITERATURE REVIEW

2.1. Instructional Media

Media is the plural form of intermediary or medium, that has meant as a means of communication. The media refers to everything that communicates information from information sources to people who receive it [17, p. 6]. Thus the media becomes an intermediary between sources and recipients of information. Media is a means and source of communication [18, p. 9]. Ansyar [19, p. 5] says "In the process of communication between communicators and communicants, media is a tool or method that acts as a channel or intermediary". According to Huda et al [20], media is also called "props that help the process of demonstrating something". Thus, from all definitions of media, it can be said that the media is a liaison between the sources of information and the recipient of information. Information obtained will be understood if the recipient and the source are in the same area of experience and knowledge. Messages in a media can be understood by the recipient if the recipient of the message also understands the language conveyed.

Rusman [21] explained that media is a tool in the learning process that is used in all forms of learning activities to achieve learning objectives. The media in question can be media in the form of print and non-print. In the sense put forward by Rusman, it is limited that the media used for learning purposes is in the form of physical facilities. However, Smaldino does not limit physical and non-physical facilities, but rather all intermediary things that convey information from sources to recipients. According to this statement, it can be concluded that the form of media in learning is not limited to physical form only, but also to non-physical form.

Learning media are all forms of learning tools that can be used in a learning process that aims to enhance effectiveness and efficiency in achieving a learning goal [22, p. 4]. So all forms of learning media that can convey messages or become intermediaries in the learning process can be said to be learning media.

Learning media can be in the form of tools, methods, and techniques that function to increase the effectiveness of communication and interaction between lecturers and students. The use of visual aids alone may still lead to verbalism, thus lecturers might employ a variety of strategies to communicate with students both visually and auditorily. A student's learning experience is the purpose of the media in the educational process. It can be concluded that media in the learning process is a communication tool to convey all information in learning so that students can gain a learning experience from the process of conveying this information. Media in learning can be classified into several parts, such as audio media, visual media, audiovisual media, various media (blackboards and display boards), three-dimensional media, dramatization technique media, community learning resources, programmed learning, and computers).

2.2. Lecture materials

All types of resources are utilized as teaching materials to help lecturers and instructors carry out teaching and learning activities in the classroom. The National Center for Competency-Based Training and Vocational Education Research Ltd claims that the content in question may be either written or oral. All information, tools, and text that are methodically arranged and show a comprehensive picture of the abilities that students will acquire are considered teaching materials. These materials are utilized in the learning process to help plan and research how learning is implemented. The following are examples of instructional resources that can be utilized in the classroom: textbooks, handouts, interactive materials, audio materials, models or mockups, and so on [23, p. 17]. Instructional materials have a purpose in education and impact the learning process. The quality of learning, as well as the quality of learning results, can be impacted by teaching materials. As a result, instructional materials serve a purpose in the learning process, are highly strategic, and influence the accomplishment of learning objectives. Thus, all learning materials that are systematically ordered, contain all the capabilities that students will acquire during a learning experience, and have the ability to affect the caliber of learning outcomes are considered teaching materials.

2.3. Interactive E-book

Electronic book versions are often known as digital books or e-books. While books are typically collections of papers with text and/or photographs,

digital books also include digital material with text, images, and/or video. In the process of making it, e-books still have to meet the requirements for making modules/textbooks, namely according to the provisions of the National Education Standards Agency (BSNP). These requirements include three criteria, namely the eligibility criteria for content, language, and presentation. The advantages and benefits of writing or developing an e-book include small physical size, so it can be stored on hard disks, CDs, or flash drives, easy to carry, not weathered, easy to process, can be read by people who cannot read, easy to reproduce, easy to distribute, interactive, publication speed and supports greening [24]. In conclusion, an e-book is an electronic version of a book that contains information that in the manufacturing process must meet all the same requirements as making a regular printed book.

Nowadays, e-books are also experiencing developments in form and design. This is none other than due to the rapid development of ICT. One of the current developments in e-books is interactive e-books. This interactive e-book can combine several forms of learning media such as text, audio, video, or graphics, where the operation can occur in two directions and is interactive with the user. Interactive e-books are digital books where users can interact and communicate reciprocally [25]. Interactive teaching materials are teaching materials that combine several learning media (audio, video, text, or graphics) that are interactive to control command so that there is a two-way relationship between the teaching material and its use [23]. Thus, the main characteristic that differentiates interactive e-books from previous versions of e-books is that in operating them users can interact reciprocally or interactively.

2.4. Basic Electronics Courses

Basic Electronics courses are one of the courses that must be completed by students majoring in Electrical Engineering. The learning achievement in the basic electronics course is that students can apply basic electronics knowledge that is relevant to the engineering field to obtain in-depth and comprehensive engineering studies by showing an attitude of responsibility independently, with quality and measurability. The sub-study of learning outcomes for this course is that students can analyze components, characteristics of component types, component functions, and condition of electronic components.

The abilities that students who take basic electronics courses must have consist of several aspects, namely cognitive, affective, and psychomotor. Student cognitive behavior is behavior that is the result

of the thinking process, for example, students are expected to be able to know, understand, apply, synthesize, evaluate, create, or create subject matter. Student psychomotor behavior is behavior that is produced as a result of body movements, for example imitating and manipulating. Therefore, it is hoped that students can apply the lecture materials in a real and correct way in terms of their physical abilities. Affective behavior is behavior that occurs when a person makes choices or decisions in interacting with the environment in the form of feelings or attitudes, for example, response, appreciation, assessment, and organization. Thus, through learning basic mathematics, students can gain knowledge and skills in analyzing the characteristics, types, functions, working principles, and application of electronic components in circuits.

3. RESEARCH METHODS

3.1 Types of Research

This research is classified as R&D or development research. The 4D development paradigm was applied in this study. The four main phases of it are defined, designed, developed, and disseminated [26]. The 4D model was chosen for this study because it provides a systematic method that corresponds to the challenges underlying this investigation.

3.2 Research Sites

This research was conducted at the Faculty of Engineering, Department of Electrical Engineering Education, Universitas Negeri Medan.

3.3 Research Procedure

The development steps in this research were carried out referring to the 4D Models development model, as follows.

3.3.1 Define

At this stage, the researcher tries to identify and define the fundamental learning challenges so that training materials can be developed. This analysis will provide a high-level summary of facts, expectations, and alternative solutions to basic problems, making it easier to determine or pick training materials to produce.

This step is a requirements analysis, in which an examination of the learning conditions that exist before development is performed. The goal of this step is to find solutions and appropriate tactics as a foundation for producing the anticipated learning medium. There are two stages of action at this point, namely problem identification and curriculum analysis.

3.3.2 Design

This phase is the first phase of product design to be developed. The products developed are adapted to the material and learning outcomes of basic electronics courses. This stage begins with formulating learning objectives, which are adjusted to the achievements of basic electronics courses, collecting references, compiling the framework of the product being developed, designing systematics and structures for writing e-books, preparing various programs or applications used in designing interactive e-books as well as the design of validation instruments and legibility tests of the products being developed.

3.3.3 Development

This phase involves creating research products that are both practical and simple to use by students. Validity testing including restricted and expanded product trials was conducted at this point on media and material specialists. The purpose of validation is to assess the viability of the final product. Lectures in the Electrical Engineering Education department served as the material experts and media experts for the expert validation process to determine how accessible the final interactive e-book was, both restricted and expanded trials were carried out.

Validation of learning materials occurs to find out if the content and material used in the final product are appropriate. Three perspectives are taken into consideration when analyzing the validation results from subject matter experts: learning, content, and evaluation.

3.3.4 Disseminate

This stage is carried out to disseminate research results both to users through outreach, and to the general public through seminars and publication in scientific journals.

3.4 Data Collection Techniques and Data Analysis

The methods used in this study to acquire data were observation and questionnaires. Observations were made to analyze development needs as well as to analyze and obtain data on problems that occur in learning which serve as the basis for conducting this development research. Questionnaires were distributed to lecturers and students in basic electronics courses to assess the viability and usefulness of the products developed based on student responses.

Descriptive data analysis, which describes the viability and user-friendliness of the product under development, was the method employed in this study. Utilizing a Likert Scale where 1 is the lowest possible number and 4 is the highest. The practicality test

instrument is distributed to 22 respondents. The data collected was obtained from a questionnaire distributed to respondents and will then be processed to obtain a percentage of the question points submitted to respondents. The formula for calculating the percentage of data obtained from a questionnaire can be used:

$$\text{Percentage} = \frac{\text{Total score of each item}}{\text{ideal score}} \times 100\% \quad (1)$$

The test results are categorized into several value ranges as follows:

Table 1. Validity criteria for interactive e-books

Percentage (%)	Category
0 – 20	Invalid
21 - 40	Less Valid
41- 60	Quite Valid
61- 80	Valid
81 - 100	Very Valid

4. RESULTS AND DISCUSSION

The discussion of research results is explained in the following stages:

4.1 Define

At this stage, the following results were obtained:

4.1.1 Problem identification

The results of problem identification obtained at this stage are: (1) the media and teaching materials used in learning are still conventional and limited media, (2) in terms of students' understanding of the material, as many as 56% of the total number of students taking basic electronics courses did not understand the material provided. This is in line with the problem in Puspitasari's research [10], where the problem identified from the results of the questionnaire answers distributed was the lack of optimal use of media in learning. The results of the questionnaire showed that 62.9% of students stated that the use of media in learning was incomplete, thus causing a lack of development of students' knowledge and competencies.

4.1.2 Curriculum analysis

At this stage, the results obtained were that the curriculum achievements that were used as the basis for the development of e-books were learning outcomes 1 to 7 which consisted of understanding, analytical skills, and application of electronic components in the circuit. This step was also carried

out by Suprpto [8], where in his research an analysis of competencies was carried out in accordance to develop an interactive e-book, namely on arithmetic series material in class X Light Vehicle Engineering

4.2 Design

The initial stage of product development begins with creating an interactive e-book draft with Microsoft Word and creating the initial structure of the e-book using the Canva Application. The use of the Canva application in designing e-books aims to improve the overall look of the e-book display design and easier to edit. This is also reinforced by the results of research by Detia [27] which states that the use of Canva in designing learning media is very supportive in creating an attractive appearance and is suitable for various themes. After the initial draft has been designed using the Canva application, it will then be imported into the Flipbook Maker application. In this research, the program Flip PDF Professional is used to create flipbooks. The Flip PDF Professional software is utilized because of its user-friendly capabilities for converting e-books into interactive ones. The Flip PDF Professional software provides features to include various kinds of media such as sound, video, images, and interactive quizzes that can be designed through applications or embedded through other quiz maker applications. The output of the Flip PDF Professional application consists of several formats such as .html, exe, .app, and, .fbr which will allow students access to these interactive e-books from their many devices [28]. Therefore, the use of various applications in creating interactive e-books is due to producing interactive e-books that are interesting, easy to use, and can also be accessed by several types of tools.

The developed interactive e-book is organized into seven chapters, which begin with an introduction to the multi-sim application that can support analysis in electronic circuits, an introduction to the basic laws of electronic circuits, and a discussion of electronic components. Each chapter consists of 4 sub-chapters consisting of learning outcomes, and basic theory which is complemented by learning videos, exercises, and evaluations in the form of interactive quizzes. Thus, the e-book produced is a teaching material that is equipped with videos and interactive evaluations. The interactive e-book design forms are designed as demonstrated in Figure 1.

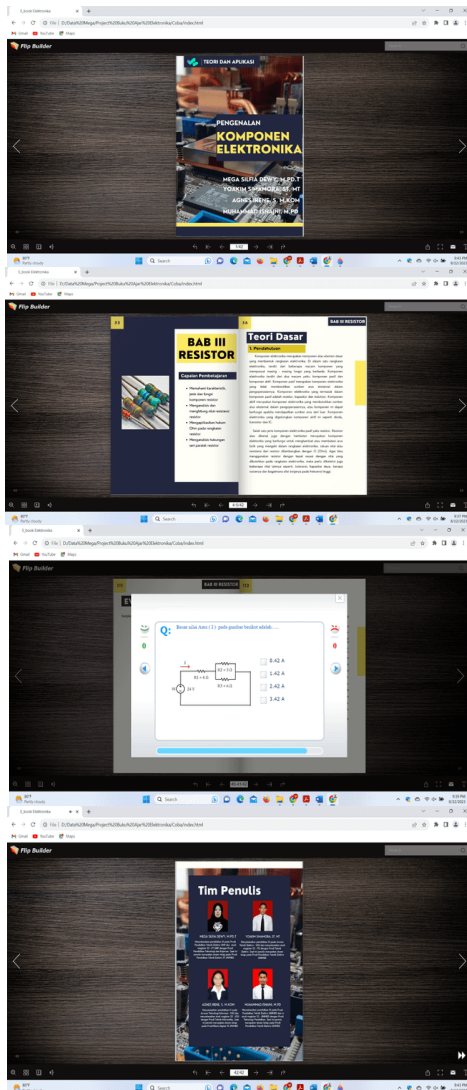


Figure 1. Interactive e-book product design

4.3 Development

A score of 90% was attained for the evaluation element, 91.6% for the content or content component, and 89.25% for the learning aspect in the validation results from material specialists. The material validation assessment's three components have an average score of 90.28%, placing it in the very valid category. From the results of material validation, it was found that the material in the interactive e-book was designed to be suitable and suitable for use in learning. This is in line with Suprpto's research [8], where the results of material validation show that the material is valid and suitable for use in learning. Figure 2 displays the findings from the material expert validation data.

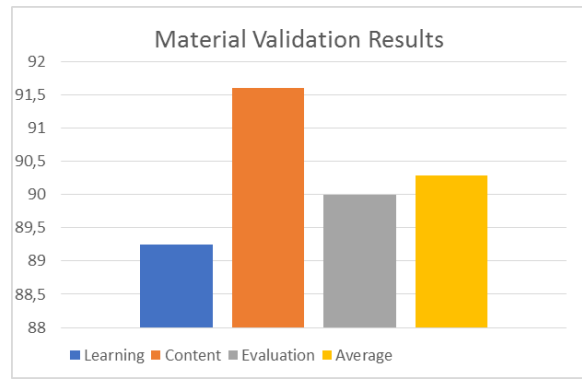


Figure 2. The result of material expert validation

The assessment score for the validation results by media experts was 89.5% for the display elements, 91.67% for the programming elements, and 92.5% for the multimedia principal elements. The average score of the three aspects of the media validation assessment is 91.22%, this belongs into the category of very valid. Thus, from a media aspect, the resulting interactive e-book is suitable for use in learning. The research conducted by Febrianti [29] also found that from the media aspect, the e-book produced was suitable for use. Figure 3 illustrates the validation data results by media experts.

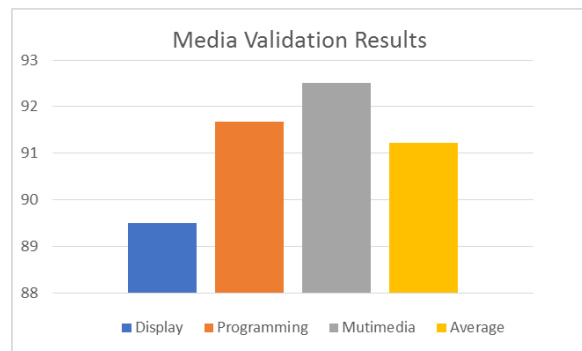


Figure 3. Results of validation by media experts

Based on the conclusions reached of experts' material and media validation, an average validation score of 90.75% was obtained which was in the very valid category. The validation's conclusions demonstrate that the level of the material and the quality of the media are in the very valid category, which means that the interactive e-book produced is feasible to use. This is reinforced by Lieung's research findings [30], which show that the interactive e-book generated is highly appropriate for educational applications.

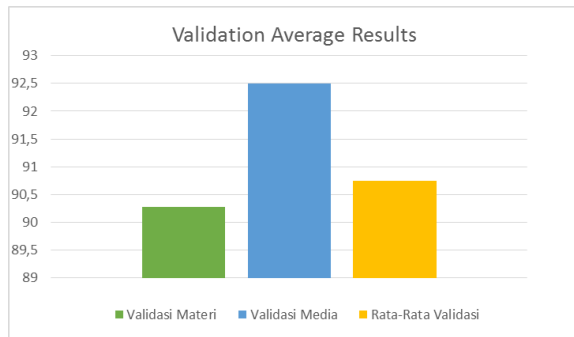


Figure 4. Validation average results

The next stage is a limited trial to find out student responses to the practicality of the e-book being developed. The trial results were limited in the display aspect showing the average percentage value was 73.33%, the programming ease aspect was 67.5% and for the aspect of learning, the mean proportion was 70.5%. Of the three aspects of assessing student responses in limited trials, an average of 70.4% was obtained. At this stage, it can be concluded that the practicality of interactive e-books is suitable for use, however, several improvements are still needed for further use from the results of limited trials, it was found that there were some drawbacks of the interactive electronic books produced in terms of ease of use. The results of this limited trial, several revisions were made based on input and responses from students and continued with an expanded trial with a total of 22 students.

The results of the expanded trial showed that in the display aspect was obtained average score of 87.5%, for the ease of programming aspect the average value was 92.5%, and in the learning aspect, the average value was obtained by 90.5%. The final result of the average rating score was 90.16%. It means that the interactive electronic book (e-book) produced is feasible and easy to use. This is consistent with the study by Suprpto [8], which found that the interactive e-book generated was highly useful for teaching and learning based on student answers.

4.4 Dissemination

At this phase, the activities carried out are by disseminating the results of research products to students who are taking the Basic Electronics course. In addition, dissemination of research results is also carried out through scientific discussion forums and scientific journals.

5. CONCLUSION

The interactive e-book developed in the Basic Electronics course meets the valid and practical

requirements so it is proper for use in the learning process. In the material expert validation test, the average material expert test of the three validation aspects was 91.22%. The media validation test showed an average score of 91.22%, coming into the category of very valid. The results of the validation aspect, an average score of 90.75% was obtained which was coming into the category of very valid. The final results of this validation show that the quality of the material and the quality of the interactive e-book media developed are in the very valid category, which means that the interactive e-book produced is feasible to use. The results of the limited trial showed that the average student response to the three aspects was 70.4%, which was in the easy-to-use category. The results of the expanded trial revealed that the average student assessment of the three aspects was 90.16%. This score is in the very practical category. The practical test results of this interactive e-book show that the resulting e-book is feasible and easy to use.

ACKNOWLEDGMENTS

The researcher expresses gratitude to Universitas Negeri Medan for supporting this research through the Research and Community Service Institute of Universitas Negeri Medan (LPPM), which utilized the PNPB budget for the 2023 Fiscal with contract number: 0158/UN33.8/PPKMPD2023.

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