Development of Augmented Reality Based Occupational Health and Safety Guidebook in Electricity Basic Laboratory

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Abstract:
Basic knowledge of electricity is needed in various work competencies in the field of electricity. As a student of the Electrical Engineering Department, basic electricity is something that must be understood. The basic understanding of electricity is not enough just theory, it takes hands-on practice in a laboratory with infrastructure, processes, and laboratory management adapted to the world of work. In order to optimize this, a guidebook is needed. The research aims are: (1) in the form of an augmented reality-based guidebook product. (2) Knowing the performance of augmented reality-based manuals. (3) The priority of augmented reality-based guidebooks is viewed from the material and media aspects. (4) Knowing student responses to augmented reality-based guidelines. The research uses the research and development (R&D) method of the ADDIE model according to Lee & Owens (2004), which has stages: Analysis, Design, Development, Implementation, and Evaluation. The results of the research are: (1) A manual that is equipped with augmented reality technology, namely the AR-Daslis application to scan marker images. (2) The performance of the AR-Daslis application through the black box test gets a percentage of 100% which indicates the function can run well. (3) Based on the assessment based on the guidelines based on augmented reality, the material received 87% material in the "Very Eligible" category, and 88% based on the media aspect with the "Very Eligible" category. (4) Student responses showed a percentage of 89% in the "Very Good" category.

Keywords: Manual, ADDIE, Basic Electricity, Augmented Reality

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1. Introduction

Basic knowledge of electricity is needed in various work competencies in the electrical field. As a student majoring in electrical engineering education, basic electricity is something that must be understood. Basic mastery of electricity is not enough just with theory, it takes practice or simulation directly in the laboratory. Habituation of good work attitudes, structuring the practice environment, as well as important tasks to be adapted to the world of work (Hiim, 2017). Therefore, it is important to instill the right work attitude, provide adequate supporting facilities, good laboratory management, and learning relevant to the world of work in order to produce reliable graduates who are ready. The cultivation of good work attitudes can be implemented by delivering knowledge of occupational health and safety (OHS) in learning activities. OHS is very important to be implemented in workplaces such as laboratories, to realize comfortable, healthy, efficient work behavior, and reduce the risk of accidents. A manual is needed to provide uniformity in the delivery of learning, laboratory management, and development of supporting infrastructure, in order to obtain optimal results, and to use resources more effectively.

Another thing to note in the manual is to pay attention to technological developments. Currently, massive technological developments have affected all fields life, including education. All levels of education begin to lead to global developments,

science, art, technology, and culture. The technology that is currently developing is the smartphone. The rapid use of smartphone development makes educational practitioners have to respond properly so that it can be useful for learning and not have a negative impact, but what is happening today in the world of smartphone education has not been used optimally.

One of the technologies currently developing is augmented reality. This technology can not only be used through a computer, but also using a smartphone. According to Carmigniani (2011), augmented reality is a real-time display directly or indirectly from the physical real world environment that has been added to information obtained from a virtual computer. Using this technology, objects that were previously flat can be transformed into as if they were real. The use of augmented reality in the world of education is easier to understand, one example is the image in the basic electrical laboratory manual.

Based on the results of observations and interviews in the Electrical Basics Laboratory, Department of Electrical Engineering Education, Faculty of Engineering, Yogyakarta State University (JPTE FT UNY), the management of the work environment, relevant equipment, and the learning process still need to be improved in order to keep up with the developments of this increasingly modern world of work. There is already a manual in the laboratory, but it does not show real work environment management in the Electrical Basics Laboratory of JPTE FT UNY. In addition, equipment and learning need to be improved in accordance with current technological developments. Based on the description of the problem, it is necessary to develop a OHS manual in the Electrical Basics Laboratory of JPTE FT UNY as a reference, uniformity, optimizing the quality of human resources, learning and managing facilities to be more optimal.

2. Brief Theoritical Framework

2.1 Learning

Learning is facilitated when students engage in problem-centered instructional design where skills are taught in the context of real-world problems (Packle, 2014). According to Chen (2021), learning is an activity that occurs through interactions between students and teachers as well as between other students, in translating the curriculum into practice and delivered in real terms. Learning is a reciprocal activity between educators, students, and books that are used as guidelines in learning, and take place in an environment, be it virtual or real. Learning can be interpreted as an activity to provide guidance, regulate, and organize the environment around students so as to encourage and foster interest in learning.

Learning is carried out by educators and students who are supported by guidelines, media, or modules. Learning is essentially a regulation, this is because students' understanding of the material presented is different from one another. As a teacher, you must be able to organize or have the right strategy to overcome the differences in the capture power of each student.

2.2 Augmented Reality

According to Birt (2017), augmented reality (AR) is a system composed mostly of the physical world with several digital components. AR aims to equate virtual information with real contexts for the benefit of users (Fite, 2012). This technology can combine two- or three-dimensional virtual objects and then project them in real time. AR can add all the information so that it can be displayed in real time or visualize an object. Objects that were previously flat in the form of two dimensions can be turned into real objects using this technology. Objects served by AR help users to generate new views and allow them to interact with the real world.

The AR framework has characteristics consisting of a combination of the real and virtual worlds that are able to interact consistently and have several 3D virtual elements. Zhou (2008) characterized augmented reality into three types, namely: (a) intuitive and continuous, (b) a blend of virtual and realworld items, (c) registered in three dimensions (virtual object impressions attached to the real world). The characteristics of the augmented reality framework are intelligently combining computer-generated data with the real world and adapting virtual objects to actual environmental conditions.

Currently, AR applications have been applied to various fields including manufacturing, health, robotics, advertisement, including learning in the world of education, and so on (Fite, 2012). According to Cheng (2017), learning to use augmented reality shows stronger motivation than

traditional inquiry-based. This is in line with the opinion of Bacca (2019), which states that one of the advantages of using augmented reality technology is increasing motivation. AR is also able to facilitate the delivery of learning to students. According to Bower (2014), AR is able to facilitate the learning process by way of visualization so that it can reduce the excessive cognitive load that is conveyed to students. This development research is equipped with augmented reality technology to increase motivation and facilitate the student learning process through manuals.

2.3 Occupational Safety and Health

According to Jilcha (2017) occupational safety and health (OHS) is a holistic approach towards the overall well-being of employees in the workplace. OHS is a field related to safety, health, welfare, work environment, and supporting equipment. OHS is a very necessary condition in the work area as an effort to protect workers from work accidents (ISO 45001). OHS is a system, planning, and prevention efforts needed to ensure workers are protected from work accidents (Annan, 2014). Based on the description above, it can be concluded that OHS is all thoughts and efforts to prevent accidents and occupational diseases, so that workers can work safely, comfortably, safely, and the environment and work equipment are maintained.

OSH training and culture have a high correlation (Arezes, 2011). According to Battaglia (2015), training and involvement of workers in OSH management is important to implement to achieve optimal results. OHS must be implemented for all workers, including students who are carrying out practical activities in the laboratory. Students must have OHS skills like in industry in order to implement them when they enter the world of work.

A group or organization must provide safety and health protection to its workers (Moyce, 2018). According to Tawiah (2016), an organization that prioritizes OHS will increase a sense of security, comfort for workers so that loyalty, commitment, and work results are more optimal. Darabont (2017) mentions that OHS is one of the most important parts that must be considered in organizational management. OHS is important to be applied to the world of work in order to create healthy workers, avoid danger, and can increase work productivity. Accidents and occupational diseases greatly affect productivity, company reputation, competitiveness, and individual and family livelihoods (Jilcha, 2017). The application of OHS must always be prioritized, especially during the 4.0 revolution period with technological advances which also have an impact on increasing danger threats (Zanko, 2011).

The application of OHS has resulted in the suppression of accidents and occupational diseases (Zanko, 2011). OHS trains workers to recognize hazards and carry out work properly. Unsafe conditions in the work area are a common cause of health problems and work accidents. This unsafe situation can be overcome by implementing OHS in the work area. Therefore, it is necessary to manage the work area by paying attention to the health and comfort of workers.

OHS problems generally come from items that pose a risk of harm in the workspace. This unsafe situation can be suppressed by optimal control efforts. The problem of structuring the work area must pay attention to the comfort and safety of workers in order to reduce the occurrence of losses both physically and materially. All elements of workspace users must eliminate habits and room layout designs that pose a risk of harm to users.

2.4 Laboratory

The laboratory is a place to practice direct observation and proof of the theory being studied in order to increase understanding and imprint in memory (Stacey, 2019). The laboratory is a place for the implementation of learning practical evidence from the theory that has been studied or research, and is equipped with relevant supporting infrastructure.

Adequate facilities and infrastructure are needed in the learning process, including in the laboratory. Management of supporting facilities and infrastructure in laboratories, especially in the world of education, needs to be continuously improved in order to keep up with developments in the world of work. Adequate laboratory support in the learning process will produce a professional workforce. Therefore, relevant laboratory facilities and infrastructure, as well as good management are needed in the learning process.

A guide is needed in the implementation of learning activities in the laboratory to keep up with competencies and technological developments that are relevant to the world of work as well as optimal

quality assurance. The guidelines in the laboratory aim to provide uniformity or standardization in developing facilities and infrastructure, as well as learning delivery methods.

3. Methodology

3.1 Research Method

The method used in this research is research and development (R&D). This study aims to develop and test the "AR-Daslis" manual and application. The development of an augmented reality-based manual adapting the stages of ADDIE model development refers to the research of Lee & Owens. The stages of the development model are analysis, design, development, and evaluation.

3.2 Time and Place of Research

This research was conducted in September 2021 at the Electrical Basic Laboratory of the Department of Electrical Engineering Education, Faculty of Engineering, Yogyakarta State University.

3.3 Participants

Participants of this development research were addressed to: 1) two material expert lecturers from JPTE FT UNY, 2) two media expert lecturers from JPTE FT UNY, 3) students who are or have taken learning activities in the Electrical Basics laboratory of JPTE FT UNY. Determination of students as respondents was taken randomly.

3.4 Procedure

The procedure for developing the “AR-Daslis” manual and application follows the following steps:

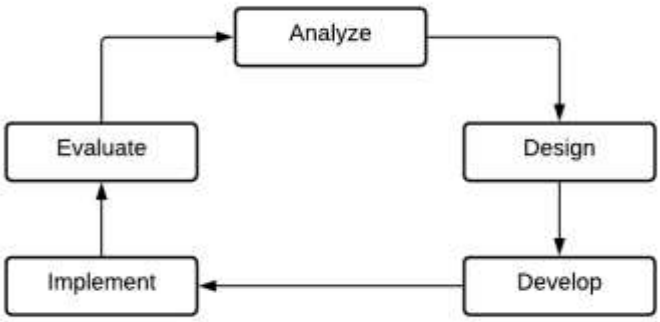


Figure 1. ADDIE Development Model

3.4.1 Analysis

In the analysis phase, the researcher formulates problems in the field to determine the exact needs. The analysis was carried out through interviews and direct observation in the Electrical Basic Laboratory of Yogyakarta State University. The analysis carried out on interviews, and observations are:

- Analyze laboratory needs. This stage is an analysis of all laboratory needs to be used as manual material in the form of practical tools, lab sheets, learning support facilities, application development needs, design ideas, laboratory health and safety analysis, and so on.
- Information gathering stage. At this stage, the researcher collects information from the supervisor and person in charge of the Electrical Basics Laboratory of JPTE FTUNY. The collection of information is used as material for the preparation of the guidebook.

3.4.2 Design

This stage is the design of the "AR-Daslis" manual and application. The design is tailored to the needs of students who carry out learning in the Electrical Basic Laboratory of Yogyakarta State University. The activities carried out at the design stage are determining the design of the manual and adding innovative aspects, preparing the draft and framework of the manual, making flowcharts and application story boards that will facilitate the development process.

3.4.3 Development

The development stage is the realization of the design that has been made previously until the product is ready to be applied to students. The stages of development carried out are making a manual, making an AR-Daslis application, black box testing, and feasibility testing by experts. The feasibility test carried out in this study was by material and media experts. The results of the assessment by the two experts were then revised before being implemented to students.

3. 4.4 Implementation

This stage occurs testing, carried out to determine student responses. The implementation at this stage is directly directed to the user of the manual, namely students who are or have studied in the Electrical Basics Laboratory of JPTE FT UNY. Next, the students gave feedback regarding the AR-Daslis manual and application.

3.4.5 Evaluation

This stage is an analysis of various inputs from respondents, then these inputs are used as evaluation materials in augmented reality-based guidebooks.

3.5 Data Collection

This study used interview, observation, and questionnaire method to collect data. Data collection was carried out to obtain information on performance, feasibility of material and media aspects from experts, and determine student responses to the developed product. The instrument has been through an expert judgment test so that it produces a valid instrument and can be implemented as a research measuring tool. The assessment of the instrument uses a Likert scale with four answer options, namely 4 (Strongly Agree), 3 (Agree), 2 (Disagree), 1 (Strongly Disagree). The data analysis technique applied in this research is descriptive analysis to determine the feasibility of the manual. The data analysis technique was carried out after obtaining data from material and media experts, as well as students.

3.6 Data Analysis Techniques

The data analysis technique implemented in this study is quantitative descriptive data analysis which aims to determine the level of feasibility of the manual. Descriptive analysis is able to stand independently as a product of research, such as when recognizing previously unknown patterns or phenomena (Loeb, 2017). Data analysis was carried out after obtaining data from material experts, media, and students. The following is a table of eligibility percentages:

Table 2. Eligibility Percentage Category

Criteria Score	Criteria Score
0 - 25%	Very Unworthy
>20 - 50%	Less Worthy
>50 - 75%	Worthy
>75 - 100%	Very Worthy

4. Results And Discussion

4.1 Process Description

The analysis phase includes analysis of laboratory needs and information gathering. Based on the results of observations and interviews with lecturers of the Electrical Basics JPTE FT UNY laboratory, the following problems were found: a) the laboratory management system is not optimal, b) processes and learning support facilities need to be improved, 3) the existence of smartphones has not been used optimally for learning. Therefore, it is necessary to develop a guidebook based on augmented reality as a reference, uniformity in improving the quality of human resources, learning, and managing facilities. Another purpose of this development is to increase interest and motivation to learn, as an effort to facilitate understanding of the material presented in the manual. The information gathering stage was carried out during observations and interviews with the lecturer in charge and course supervisor at the Electrical Basics Laboratory of JPTE FT UNY. Information gathering includes addition and improvement of materials, implementation of laboratory management according to standards to be further included in manuals, proposals for supporting learning infrastructure, as well as reference sources consisting of books and journals.

Activities carried out at the design stage are: a) Determination of the design of the manual and the addition of innovative aspects. The design of the manual begins with the selection of an image of the self-protection tool on the cover, this is to better reflect the contents contained, namely K3. The material in the manual is presented in the form of writing, posters, infographics, and mind mapping to make it interesting to learn. The manual is made on A4 size paper. This manual is equipped with augmented reality technology in order to increase the attractiveness and increase student learning

motivation. In addition, the augmented reality technology in this manual can be used on android smartphones. This is intended to maximize the use of Android smartphones in learning activities. b) Drafting of manuals. This stage includes the preparation and organization of each material that will be included in the manual. The steps taken in compiling the manual are determining the title, and setting goals. This manual is entitled "Handbook of K3 Basic Electrical Laboratory, Department of Electrical Engineering Education, Faculty of Engineering, Yogyakarta State University. Determination of the title of the manual based on the results of discussions with the lecturer at the Electrical Basic Laboratory of JPTE FT UNY. Goal setting is used as a basis for compiling the material and content of the manual. The purpose of the guidebook is to provide references, uniformity in the delivery of learning, laboratory management, development of supporting infrastructure in order to obtain optimal results, and use of resources more effectively. c) Preparation of the basic framework of the manual. The development of the manual is based on the framework that has been prepared. d) Application flowchart design. The design of the application flowchart aims to simplify the process of developing the AR-Daslis application. The flowchart design contains the workflow of the AR-Daslis application. e) Storyboard design. The story board contains the display design of the developed application. The purpose of making story boards is to simplify the process of developing the AR-Daslis application. The layout or appearance of the AR-Daslis application is made landscape so that objects will be clearly visible on the scanner camera, because there are objects that have a wide cross-section.

The development phase of the augmented reality-based handbook includes: a) development of the guidebook. The first stage of developing the manual is to collect various kinds of references to be used as material for compiling the material. The references used are sourced from archive files, books, journals, articles, internet, government regulations, and so on. The second stage of the development of the manual is the preparation of the content section. The manual does not only contain theory, but there is also management or real action on the Electrical Basics Laboratory of JPTE FT UNY. Direct management in the laboratory is carried out to provide real references, so that users are easier to understand and apply to learning activities. Researchers do documentation of laboratory conditions before and after management to be used as a comparison or differentiator. Laboratory management carried out by researchers includes 5R/5, disaster mitigation, ergonomic checkpoints, and data collection of furniture and practical equipment contained in the Electrical Basic Laboratory of JPTE FT UNY. Examples of laboratory management activities are replacing floor markings that are less than ideal, tidying work desks, replacing outdated posters, improving storage, and so on. The results of the management documentation that have been implemented are then included in the manual. The inclusion of management documentation is added with information so that readers can better understand. b) Making AR-Daslis application. Making the AR-Daslis application using several software, namely: 1) Unity 3D Version 2019 which is used to process data such as application interfaces, and three-dimensional image objects, 2) Vuforia SDK is used as a means of scanning three-dimensional objects that have been created, 3) Android SDK which is used as development software for the android platform, 4) Microsoft Visual Studio 2019 which is used as software for writing program codes, and 5) Blender as software for designing three-dimensional objects. c) Black Box Test. The black box test is carried out to determine the performance of the AR-Daslis application, whether it can operate as designed. There are six respondents who carry out black box testing of this application. d) Material and Media Expert Validation Test. The meter expert validation test aims to determine the feasibility level of the augmented reality-based guidebook material developed. Validation by media experts aims to determine the level of media feasibility of the developed augmented reality-based guidebook.

The implementation phase is a test of augmented reality-based manuals for students who are or have studied in the Electrical Basics Laboratory, Department of Electrical Engineering Education, Faculty of Engineering, Yogyakarta State University. Respondents in this test amounted to 50 people. The implementation of the test aims to determine student responses to augmented reality-based guidebooks. After testing the manual, students filled out respondent questionnaires. The results of the questionnaire assessment are then

used as a reference in making further improvements.

The evaluation stage is the student's assessment and response. After collecting student assessments and responses, there are several inputs including: typing errors need to be corrected, application size to be made with a smaller size, addition of learning videos, and application display development. It is necessary to do research and development on augmented reality-based manuals so that the product continues to grow.

4.2 Product Description

Gambar 1. Produk Akhir

The final product of this research is the OHS Manual for Electrical Basic Laboratory, Department of Electrical Engineering Education, Faculty of Engineering, Yogyakarta State University and an augmented reality application named "AR-Daslis". The material in the manual is presented in the form of writing, posters, infographics, and mind mapping. This manual is made on A4 paper size. This application has a file size of 184.4 MB and can be installed on an android smartphone.

The developed manual contains a cover, consisting of XI chapters of material, bibliography and glossary. The material of XI chapter is about the introduction, introduction to the laboratory, laboratory management, occupational health and safety in the laboratory, ergonomic checkpoints, personal protective equipment, 5R/5S, disasters, list of furniture and practical equipment, standard operating procedures, and practice report formats. The outline of the content of the manual is described in Table 3 below:

Table 3. Content Framework of the Manual

No	Book Section	Description
1.	Chapter I	Contains an introduction consisting of background, instructions for using the manual, and a summary of the material.
2.	Chapter II	Contains introductory laboratory materials. This chapter explains starting from the definition, basic requirements, supporting needs, and the main laboratory standards. In addition, this chapter also presents the layout of the Basic Electrical Laboratory of JPTE FT UNY in particular, and a summary of the material.
3.	Chapter III	Contains laboratory management materials. This chapter describes: a) operational management, b) continuous improvement management, c) JIT (just in time) approach, d) total productive maintenance (TPM), e) computer-based laboratory system development, f) facility maintenance management, g) management of the arrangement of laboratory facilities and infrastructure, g) material summary.
4.	Chapter IV	Loading material on occupational safety and health in the laboratory. This chapter describes: a) occupational safety and health, b) triggers of work accidents, c) control of

		sources of hazards in the work environment, d) prevention of accidents, e) application of occupational safety and health, f) human error, g) occupational safety behavior , h) business related to work safety, i) means of promotion of occupational safety and health, i) summary of material
5.	Chapter V	Contains material for ergonomic checkpoints that can be applied to the Electrical Basics Laboratory of JPTE FT UNY. This chapter describes: material storage and handling, hand tools, machine safety, workstation design, lighting, premises, hazardous substances and agents, welfare facilities, work organization, and summary of material
6.	Chapter VI	Include personal protective equipment. This chapter describes: a) the definition of personal protective equipment, b) the criteria for personal protective equipment, c) the function and types of personal protective equipment, c) the functions and types of personal protective equipment, d) a summary of the material.
7.	Chapter VII	Chapter VII contains 5R/5S material. This chapter explains concisely, neatly, cleanly, caringly, diligently, and summarizes the material.
8.	Chapter VIII	Loading disaster material. This chapter explains about: a) understanding of disaster mitigation, b) design of disaster mitigation, c) various types of disaster mitigation based on the type, d) summary of material.
9.	Chapter IX	Contains a list of furniture and practice equipment. This chapter explains about: a) a list of furniture and equipment for basic electrical laboratory practice, b) a list of practical materials in the laboratory room cupboard, c) a list of proposed practical furniture and equipment in an electrical basic laboratory, d) a summary of the material.
10.	Chapter X	Contains standard operating procedures. This chapter explains: a) regulations for the use of laboratories in the electrical engineering education department, b) procedures for applying for the use of laboratories, c) procedures for borrowing laboratory equipment/goods/facilities and infrastructure, d) rules for lectures practicum, e) health protocols for covid-19, f) material summary.
11.	Chapter XI	Filled with basic electrical practice report format. This chapter is equipped with an attachment to the lab sheet for the basic electrical practicum course.
12.	References	Contains reference sources in the preparation of manual material. Reference sources consist of printed books, government regulations, research journals, and articles.
13.	Glossary	A glossary is a collection of explanations of unfamiliar or difficult-to-understand terms. The function of the glossary is to make it easier for readers to understand the terms in the material presented.

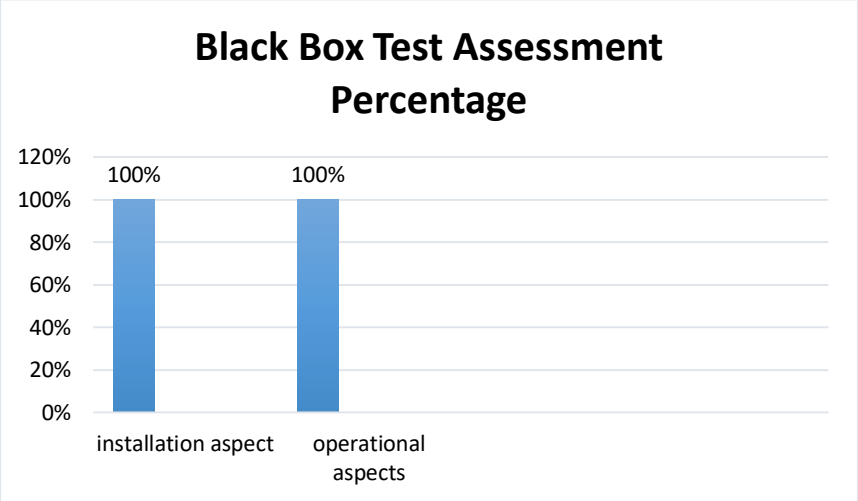
4.3 Statistical Data Analysis

The black box test is carried out to determine the performance of the AR-Daslis application, whether it can operate as designed. The black box tests carried out are installation and operation. There are six respondents who carry out black box testing of this application. The black box test carried out shows that all functions of the AR-Daslis application can work well. The questionnaire used in the black box test consisted of 27 statements with two aspects, namely the installation and operation of the AR-Daslis application. The installation aspect consists of two points, while the operation consists of 25 items. Through the maximum score, an average score of 27 was obtained. The results of the black box test by respondents can be seen in Table 4 below:

Table 4. Black Box Test Assessment Results

Respondent	Aspect		Total
	Installation	Operation	
Respondent 1	2	25	27
Respondent 2	2	25	27
Respondent 3	2	25	27
Respondent 4	2	25	27
Respondent 5	2	25	27
Respondent 6	2	25	27

Based on Table 4, it can be seen that the black box test results from six respondents showed optimal results. The following graph 3 shows the average black box test results on the AR-Daslis application.



Gambar 2. Black Box Test Assessment Percentage Diagram

As shown in the picture 3, the black box test uses two aspects of assessment, namely installation and operation. Aspects of installation and operation each get a percentage of 100%. These two aspects show that the performance of the AR-Daslis application can be categorized as "Very Feasible". This is because the AR-Daslis application can be operated according to qualifications at the development stage.

The development stage also carried out a feasibility test of materials and media by experts. Validation by material experts aims to determine the level of feasibility of the developed augmented reality-based guidebook material. Material validation was carried out by two material expert lecturers from the Department of Electrical Engineering, namely Mr. Eko Prianto, S. Pd. T., M. Eng., and Mrs. Faranita Surwi, S.T., M. T. There are six aspects that are assessed, namely self-instructional, self-contained, independent, and user friendly. This questionnaire consists of 17 questions whose assessment applies a Likert scale score of 1-4. The following is a table of validation results by material experts:

Table 5. Assessment by Material Expert

No	Aspect	Max Score	Score		Average	Percentage
			Expert 1	Expert 2		
1.	Self Instructional	16	15	13	14	87%
2.	Self Contained	36	33	29	31	86%
3.	Independent	4	4	3	3,5	87%
4.	User Friendly	12	12	9	10,5	87%
Total		68	64	54	59	
Percentage		100%	94%	79%	87%	

Based on Table 5 above, it can be seen the data on the results of the assessment by material experts one and two. Figure 4 below shows a graph of the average results of the assessment by material experts on the product.

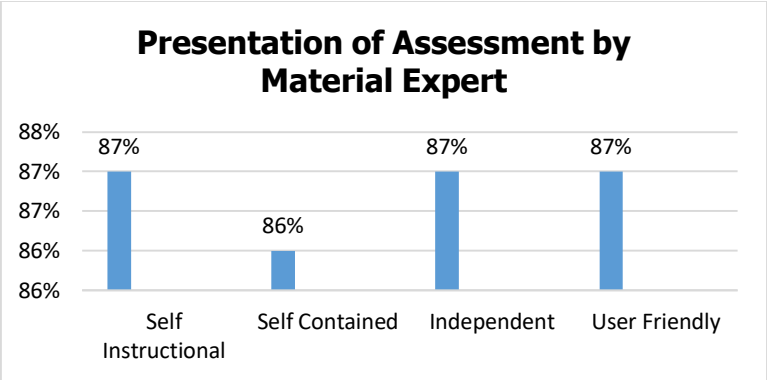


Figure3. Material Expert Assessment Percentage Diagram

Figure 4 shows the assessment by a material expert. The results of the assessment by material experts on the self-instructional aspect got a percentage of 87%, the self contained aspect got a percentage of 86%, the independent aspect got a percentage of 87%, the user friendly aspect got a percentage of 87%, so the total score obtained was 87% with the category "Very Eligible "

Validity by media experts aims to determine the level of media feasibility of the developed augmented reality-based guidebook. This validation was carried out by two media expert lecturers from the Department of Electrical Engineering Education, Faculty of Engineering, Yogyakarta State University, namely Mr.Sigit Yatmono, S.T., M. T., and Mr. Sa'adilah Rosyadi, S.Pd., M. Pd. There are seven aspects assessed, namely format, systematics and layout, attractiveness, typeface selection, space, orderliness, and augmented reality technology. This questionnaire consists of 29 statement items. The following is a table of validation results by media experts:

Table 6. Assessment by Media Experts

No	Aspect	Score Max	Score		Average	Percentage
			Expert 1	Expert 1		
1.	Format	12	12	9	10,5	87%
2.	Sistematika dan Tata Letak	28	25	24	24,5	87%
3.	Daya Tarik	8	6	6	6	75%
4.	Pemilihan Jenis Huruf	16	15	14	14,5	91%
5.	Ruang	16	15	12	13,5	84%
6.	Keteraturan	16	15	13	14	87%

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7.	Teknologi*Augmented Reality*	20	20	19	19,5	97%
Total		116	108	97	102,5	
Percentage		100%	93%	84%	88%	

Based on Table 6 above, it can be seen the data on the results of the assessment by media experts one and two. Figure 5 below shows a graph of the average results of assessments by media experts on products.

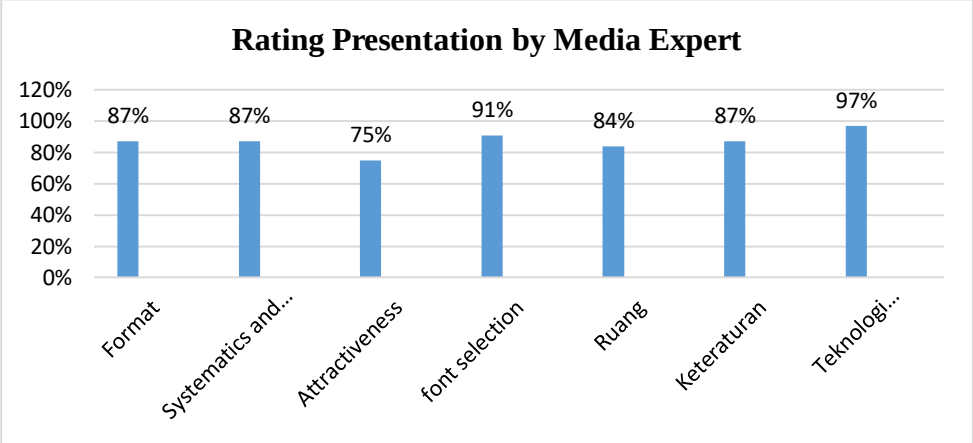

Figure 5. Media Expert Rating Percentage Diagram

Image 5 shows an assessment by a media expert. The results of the assessment by media experts on the format aspect got a percentage of 87%, the systematic and layout aspect got a percentage of 87%, the attractiveness aspect got a 75% percentage, the typeface selection aspect got a 91% percentage, the spatial aspect got a percentage of 84%, the regularity aspect got percentage of 87%, and aspects of augmented reality technology obtained a percentage of 97%. The total number of assessments by media experts is 87% in the "Very Eligible" category.

User assessment is carried out by students who are currently or have studied in the Electrical Basics Laboratory of JPTE FT UNY. The assessment carried out is based on an augmented reality-based guidebook. There are five aspects that are assessed, namely content standards in manuals, presentation standards in manuals, graphic standards in manuals, writing language standards in manuals, and augmented reality applications and technology. The number of statements in this questionnaire is 20 items using a Likert scale of 1-4. The results of the assessment by students can be seen in Table 7 below:

Table 7. Assessment Results by Students

Aspect	Content Standard	Serving Standard	Graphics Standard	Standard Writing Language	AR Applications and Technology	Total
Score Max	40	36	24	24	16	140
Average	35,78	31,82	21,2	21,38	14,68	124,86
Percentage	89%	88%	87%	88%	92%	89%

Based on Table 7, it can be seen the data on the results of the assessment by students. Figure 6 below shows a graph of the average results of the assessment by students on the product.

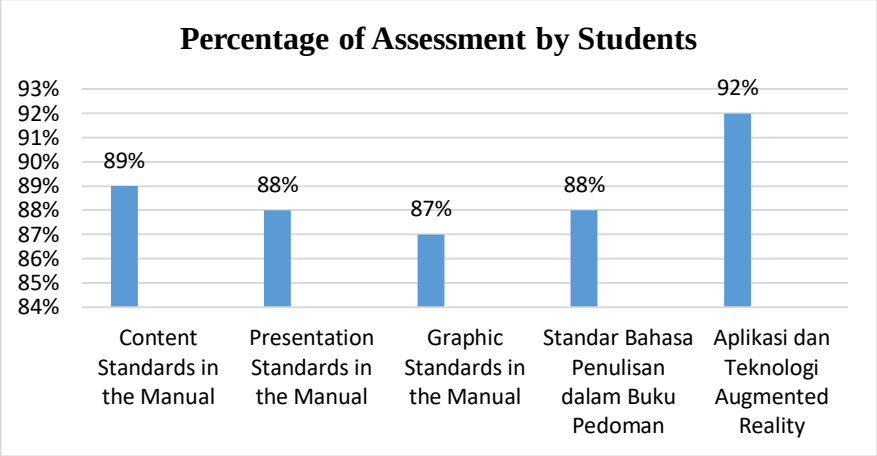

Figure 6. Expert Assessment Presentation Diagram by students

The figure 6 shows the standard aspect of the content in the guidebook gets a percentage of 89%, the standard aspect of the presentation in the guidebook gets a percentage of 88%, the graphic standard aspect in the guidebook gets a percentage of 87%, the standard aspect of the writing language in the guidebook gets a percentage of 88% , as well as aspects of augmented reality applications and technology obtained a percentage of 92%, thus obtaining an overall score of 89% in the "Very Eligible" category.

4.4 Discussion

This manual is expected to be a reference in carrying out learning activities, laboratory management, and more effective use of resources. The results of the assessment by material experts on the self-instructional aspect obtained a percentage of 87% with the "Very Eligible" category because the manual helps students get information about OHS, increase interest in learning, there are various pictures and illustrations that increase understanding. The self contained aspect obtained a percentage of 86% in the "Very Eligible" category because it was in accordance with the needs of students, containing OHS which was adapted to the conditions of the Electrical Basics JPTE FT UNY laboratory. The content of the manual material comes from sources that are accurate, coherent, and clear. The independent aspect obtained a percentage of 87% with the category “Very Eligible because the manual can be used without other print media. The user friendly aspect obtained a percentage of 87% with the "Very Eligible" category because it contains instructions for use, the terms used are easy to understand.

The results of the assessment by media experts obtained a percentage of 87% in the format aspect with the "Very Eligible" category because of the proportional table size, margins, and layout of each paragraph. The systematic and layout aspect received a percentage of 87% in the “Very Eligible” category because the pictures, tables, and illustrations were arranged in a coherent manner. The manual contains background, instructions for use, mindmaps, materials, summaries, glossaries, and bibliography. Mindmaps in the manual are easy to understand, and the gaps between paragraphs and chapters are systematic. The attractiveness aspect gets a percentage of 75% with the "Decent" category. Suggestions and improvements to this aspect are the development of the layout to make it more attractive. The aspect of choosing the typeface received a percentage of 91% with the "Very Eligible" category because the type, size, and color of the letters were easy to read. The font size used is proportional. The aspect of space received a percentage of 84% in the “Very Eligible” category because of the empty spaces on the cover and in the proportional guidebook. The size of the spacing between lines and paragraphs in the manual is proportional. The regularity aspect received a percentage of 87% with the "Very Eligible" category due to the consistent selection of fonts and the layout of text, images, and tables. Aspects of augmented reality technology obtained a percentage of 97% due to the installation and operation or performance of the AR-Daslis application in accordance with the qualifications carried out at the development stage.

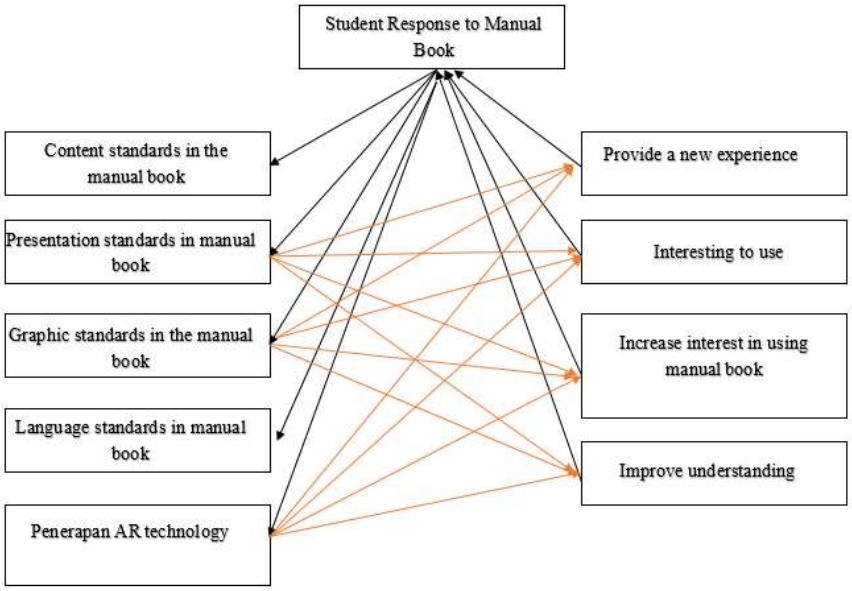

Figure 7. Relationship Analysis of Student Response Outcome

The results of the assessment by students obtained a percentage of 89% with the "Very Good" category in the standard aspect of the content in the manual because it contains materials needed by students when learning in the Electrical Basics Laboratory of JPTE FT UNY such as ergonomic checkpoints, personal protective equipment, disaster mitigation, lists and proposals practical furniture and equipment, standard operating procedures, and basic electrical practice lab sheets. The standard aspect of presentation in the manual obtained a percentage of 88% with the category "Very Good" because the material prepared is clear, easy to understand, and compiled from clear and reliable sources. The standard aspect of the graphics in the manual has a percentage of 87% with the "Very Good" category because the layout of the images and illustrations is neat, comfortable to see, proportional, and makes it easier to understand the material. The standard aspect of the writing language in the manual obtained a percentage of 88% with the "Very Good" category because the writing was clearly legible, spelled, and sentences standardized so that it was easy to understand. Aspects of applications and technology of augmented reality obtained a percentage of 92% with the category "Very Good" because it provides a new learning experience, is interesting to operate, and increases interest in using manuals. The learning process is more interesting with the augmented reality technology in the form of the application "AR-Daslis" in the manual.

5. Conclusions

5.1 Conclusion

Development of Augmented Reality-Based OHS Handbook in the Electrical Basics Laboratory of JPTE FT UNY using the ADDIE model. This development research resulted in the OHS Manual for Electrical Basic Laboratory of JPTE FT UNY which is equipped with augmented reality technology, namely the AR-Daslis (Augmented Reality Basic Electrical) application with .apk format. The subjects of this research are students who are or have carried out learning in the Electrical Basics Laboratory of JPTE FT UNY. The performance of the AR-Daslis application in the black box test obtained a percentage of 100% so that it can be seen that all functions can work well

According to material experts, the level of feasibility of augmented reality-based manuals is 87% in the "Very Eligible" category. The eligibility rate by media experts obtained a percentage of 88% with the "Very Eligible" category. Student responses to augmented reality-based guidebooks obtained a percentage of 89% with the "Very Good" category.

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