Learning Media of Electric Lighting Installation Based on Mobile Augmented Reality

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Abstract. Learning Media of Electric Lighting Installation Based on Mobile Augmented Reality is a technology that can be used as a substitute for conventional learning media to modern virtual learning media. This can be accessed anywhere and anytime by using an Android smartphone. Augmented reality is a technology that helps users to be able to interact directly with virtual components that have been designed to resemble the original. This study applies augmented reality technology to learning aids called learning media at the concentration of household electrical lighting installations. In the operation of learning media, several procedures must be carried out before becoming a product that is ready for use. The results of this study is a media for studying household electric lighting installations assisted by mobile augmented reality.

1. Introduction
Learning media is used as a tool to convey the knowledge of an educator to students in the learning process. Procurement of learning media requires careful planning at the beginning of the semester and the purchase of components and practical tools will issue a large school budget. In a good learning process, the tools in the form of real components and practical tools are very helpful for students to more quickly understand the material presented.

Nowadays one of the most important devices you can use to help with your life is a smartphone. In addition to helping in communication, smartphones are also used for various things and can be accessed anywhere and anytime. Android is an Operating System (OS) that is widely used on smartphone devices. Besides having many applications that can be downloaded for free, the Android OS is chosen by application developers because the facilities are very easy and support their use.

Virtual technology has spread to various lines of life and sections, one of the most widely developed technologies in this era is Augmented Reality and Virtual Reality. The use of virtual technology is widely developed in applications and gaming devices - virtual technology is very familiar to game lovers. One of the famous Augmented Reality Technologies in early 2016 is a game called Pokemon Go - known until June 2019, this game was developed by Niantic. Inc has been able to attract the attention of Android users and has been downloaded by 11,887,394 people on the Google Play Store. Augmented
Reality technology is a technology where a device can display a 3-dimensional visual form that looks like reality by utilizing the camera features on a smartphone device. The use of AR as a learning medium can help streamline budget expenditures for procurement of practical tools and also make it easier to learn the components contained in learning media.

The electric lighting installation is a subject in the competency expertise of Electrical Installation Engineering in Vocational High Schools. In this subject, students learn about introduction of lighting components and types of lighting installations, introduction of components and the types of installation. This is very important for students as a guide so that errors in the installation of lighting can be reduced.

Sudjana, N [1] states that media is one of factors in learning success of students. The activities and processes learned occur, information is transferred from the source to the recipient of information through certain models and media. Learning with models and interesting media will provide convenience for students in achieving learning goals.

Schramm [2] states, in the learning process, it is not enough just to use textbooks or images as learning media so as to make learning less enthusiastic. Teachers must develop their own learning media that are feasible and attract the attention of students, economical, effective and easy in the manufacturing process. The teacher as a facilitator must be able to provide facilities that enable the ease of the learning process.

Persson et al [3] describes mobile technology used in mobile learning. The concept of mobile learning has five characteristics, these are probability, accessibility, personalization, connectivity, and can increase learning motivation. The characteristics described in the statement above are in accordance with the learning media of the lighting installation developed, the media developed are also based on mobile learning.

Triatmaja et al. [4] stated that with the use of smartphones with Android OS in the current era which has become a necessity for every person to communicate without knowing space and time, not least in the world of education, smartphones are a necessity for students to communicate so that media development learning by using a smartphone as its basis will be able to improve learning effectiveness.

Dengzhe Ma et al. [5] describes that AR is the main technology for virtual engineering. AR is the basis for functional virtual prototyping, which allows developers to analyze functional forms and behavior of future products in an immersive and interactive virtual environment. The application of Augmented Reality technology greatly improves communication in product design and production development because this technology helps to identify and avoid design errors in the early stages of the development process and also saves time and money.

Jaya [6] describes the important functions of laboratories and practice tools in technical education because they provide practical knowledge for students. Conventional laboratories are available but limited to a large number of students. Behind its practical functions, laboratories suffer losses, the main disadvantages of laboratories in general are expensive equipment and instruments. The solution to the problem mentioned above is to use a virtual laboratory to help students develop their practical skills.

Odeh et al. [7] explained the advantages of virtual media, which are easy to use, the concept of theory becomes easier to understand, flexible scheduling, the theory of knowledge can be satisfied, a safe environment, advancement of new skills, driven by group cooperation, a comfortable place, more time to experiment.

Jaya [8] explains, there are advantages of Augmented Reality as a solution in practical activities which include: virtual environments can save budgets rather than physical environments, virtual environments are safer than physical environments, interactions through virtual environments provide certain experiences that are not obtained in the physical environment, the practice in the virtual environment can be more developed than the physical environment, the concept of learning takes the form of direct experience, the virtual environment gives a real impression such as the physical environment. Virtual media can increase student motivation in terms of task values and self efficacy [9].
Ogungbenro et al. [10] explained some of the advantages of using emulators on digital techniques, namely native appearance; the nuances and behavior of digital objects remain; initial capital on the production of emulators is greater, but other expenses will be more efficient; reduce laboratory use time; many emulators that have been well developed and licensed; emulators can be used on various device systems; the physical needs of the emulator can be reduced so that it can reduce the cost and time of practice; most emulators have large data memory and can provide many simulated electronic components [11].

Agus Suryanto et al. [12] explained about mobile technology which was developed using augmented reality technology by raising conventional learning problems in lathe learning. the teacher only explained a lathe in front of the class so that not all students understood the characteristics of the lathe so that from these problems a learning media was developed by introducing lathes with augmented reality technology with research and development (R & D) research procedures.

Mohd Erfy Ismail et al. [13] explained in the development of learning media Las Technology assisted by Augmented Reality (AR) in Vocational High Schools needed to create a learning atmosphere that was able to attract students' interest in learning, able to improve student visualization and reduce the cognitive burden experienced by students. In addition, teaching and learning is more interesting because the teacher's teaching style uses theory and practice simultaneously. In addition, the use of AR in education can improve the visualization of students in an abstract manner, which helps them when conducting experience tests and building a safe teaching and learning environment.

2. Learning Media Design

2.1. The Concept of Learning Media

This learning media will use Augmented Reality technology. The interface and learning features in it are made to resemble the actual form of components and work systems. There are three main menus in this learning media, namely Petunjuk, Materi and Profile. A video simulation in the Petunjuk Penggunaan menu explains how to use learning media, so that learning media can be understood and can be used by new users. The Materi menu is the core menu of this learning media. This menu will ask for connection of the camera features on the smartphone. The workings of the Materi menu are like someone who is using a camera, when a smartphone is directed at an object in the form of a marker, certain objects will appear on the smartphone screen. These objects are related to material competencies in the subject of electric lighting installation. The last menu is Profile that displays profiles of researcher and research supervisors.
2.2. Media Design Display

Figure 1 shows the display of Learning Media of Electric Lighting Installation Based on Mobile Augmented Reality. In the main menu display, there are three menus, namely Petunjuk, Materi and Profile.

Figure 2 shows user manual menu display of the learning media. There are media usage instructions and animation about instructions for use, with hope that media users understand and can use learning media easily.
Figure 3. Display of Material Education Manu

Figure 3 Display of Material Education Manu, in the material menu contains the discussion material discussed in this study that is about electric lighting installations and components of 1 phase electric lighting installations.

Figure 4. Display of Materi menu 1 "Saklar Tunngal"

Figure 4 shows Materi menu display using augmented reality technology. Materi can be accessed by the user by directing the camera on the smartphone to the marker or directing the marker towards the camera, displays of component and component assembly will appear on the smartphone screen.

Figure 5. Display of Materi Menu 3 “Simulasi Assembly”
Figure 6. Display of Profile Menu

Figure 6 shows Profile menu display that explains the profile of the researcher.

3. Equipment And Learning Media Devices

Learning Media of Electric Lighting Installation Based on Mobile Augmented Reality Learning media for electric lighting installations are developed using the Unity 3D application on laptops and PCs. Learning media uses augmented reality technology that can run on Android OS-based smartphones. The display design of devices and components was generated from SolidWorks application (.fbx file) and the 3D Blender application (.blend file). Learning media interface design was developed using the Adobe Photoshop CS 6 application. In addition, the Marker was also developed using Adobe Photoshop CS 6. Learning media applications can be installed on an android smartphone by running .apk extension file.

Figure 7. Smartphone Android

4. Features on Learning Media

Some of the features in learning media include:

(1) Interactive Touch of electric lighting components - on the materx menu, when the scanning marker is finished, the components that appear on the smartphone screen can be rotated to see all sides of the component. The result is the compatibility of the characteristics of the components that appear on the screen with the original form of the component can be known by the user. Display of learning media when scanning markers can be seen in Figure 10.

(2) Visual Control and Commands - to get the same learning sensation as when playing games, the visual features and commands on the learning media of electric lighting installation is developed
interactively with augmented reality technology. By utilizing touch sensor on the smartphone's LCD screen, the electrical components are designed to be as detailed as possible.

![Figure 8. Visual Control and Command Settings](image)

![Figure 9. Visual Control and Command settings](image)

![Figure 10. The Use of Augmented Reality Display “Scan Marker of Socket Component”](image)

The form of components in Augmented Reality technology can be displayed based on the shape of the marker being developed. Components displayed on this learning media are components used in household lighting installations, namely KWH Meters, Miniature Circuit Breakers (MCB), Cables, Sockets, Single Switches, Double Switches, Three Gang Switches, Lights, Pipes, Fittings, Plug and Pipe. All of these designs are made to resemble the shape of original components and there are also animations of household lighting work system.

In each component displayed, it is also equipped with a video assembly that aims to strengthen the knowledge of students/users' competence regarding the introduction of the characteristics of lighting components.
In piping simulation, there is a working picture, the working picture will be a reference for the lighting installation to be made. In this simulation, position, function and work system of each component are displayed - starting from the PLN electricity entering the KWH Meter until the loads commonly used in simple house buildings.

5. Research Method
The research model used is the research and development study of Augmented Reality (AR) assisted electric lighting installation media at the Vocational Middle School. The Research Development Model used is the *Waterfall* model.

![Diagram of the Waterfall model](image)

**Figure 11.** Research Method “Waterfall”

5.1. Communication
In this study begins with a communication from researchers to the school that will be used as a place of research, in this communication discusses about the weaknesses that exist in the school, especially in the department of electrical power installation techniques in lighting installation subjects to find a problem that will be raised.

5.2. Planning
In the planning stage the researcher tries to make a solution of the problems found in the school. The solution offered is a learning media that will discuss a particular material in a media package with a touch of the new technology.

5.3. Modeling
In making learning media, researchers try to find technology that can attract students' learning interest to use it so that the mastery of the material raised in the media can be conveyed well to the user.
5.4. Construction
Researchers use augmented reality technology as a package that will attract users to use, in the construction phase researchers use several development-based applications for media creation, some of which are visual studio, unity 3D, solid works, 3D blendrs and Keyshot.

Testing of learning media for lighting installation is done independently before the media is handed over to the user.

5.5. Development
The last process carried out by researchers is the development of instructional media aimed at schools where researchers conduct interviews and observations to determine user responses from augmented reality assisted learning media.

6. Research Result
In this research, testing was conducted on three lecturers as a media validator before carrying out further development to be tested in schools. From the three validators stated that the media is feasible and ready to be implemented in schools.

7. Conclusion
The purpose of developing learning media is to introduce alternative technology in the world of education that creates an atmosphere of learning to be interesting and fun for students without ignoring the elements of learning and competencies that must be achieved. Learners can study in all places and times because all they need is an android smartphone and some markers. This learning media also helps Educators to make time more efficient, because in theoretical subjects students are able to see virtually electrical components along with their characteristics and functions as well as lighting installations in households, without having to go to workshops and be busy by unloading and reloading practical tools. It provides knowledge about the basis of lighting installations in the form of introduction of lighting installation components, introduction to the characteristics of lighting installation components, determining the layout of household lighting installation components and adjusting working picture to actual installation form.

8. References
[1] Sudjana, N., & Rivai, A. (2010) Media Pembelajaran. Jakarta:Sinar Baru
[2] Schramm, 1984. Media Besar Media Kecil, Alat dan Teknologi untuk Pengajaran, Seri Pustaka Teknologi Pendidikan No. 5. IKIP Semarang.
[3] Persson, V. & Nouri, J. (2018) A Systematic Review of Second Language Learning with Mobile Technologies. International Journal of Emerging Technologies in Learning. Vol. 13 (2), 53-61.
[4] Triatmaja, A. K. & Khairudin, M. (2018).Study on Skill Improve/ment of -Digital Electronics Using Virtual Laboratorium With Mobile Virtual Reality. Journal of Physics: Conference Series. Vol. 1140, DOI: 10.1088/1742-6596/1140/1/012021
[5] Dengzhe Ma., Jurgen Gaumeier., Xiumin Fan., & Michael Grafe. (2011). Virtual Reality & Augmented Reality In Industry. The 2nd Sino-German Workshop. Shanghai Jiao Tong University
[6] Jaya, H. (2010). Laboratorium Virtual Mata Kuliah Praktikum Elektronika Digital: Jurusan Pendidikan Teknik Elektronika Fakultas Teknik Universitas Negeri Makassar. *Jurnal Elektronika Telekomunikasi & Computer, Vol.4*(2). 699-710.

[7] Odeh, S., Shanab, S. A., & Anabtawi, M. (2015). Augmented Reality Internet Labs versus its Traditional and Virtual Equivalence. *International Journal of Emerging Technologies in Learning, Vol. 10* (Issue 3), 4-9.

[8] Jaya, H. (2010). Laboratorium Virtual Mata Kuliah Praktikum Elektronika Digital: Jurusan Pendidikan Teknik Elektronika Fakultas Teknik Universitas Negeri Makassar. *Jurnal Elektronika Telekomunikasi & Computer, Vol.4*(2). 699-710.

[9] Dyrberg, N. R., Treusch, A. H., & Wiegand, C. (2016). Virtual laboratories in science education: Students Motivation and Experiences in Two Tertiary Biology Courses. *Journal of Biological Education, Vol.51* (4), 358-374.

[10] Ogungbenro, O. U., Chukwudebe, G. A., Opara, F. K., & Ezeh, G. N. (2017). Design and Implementation of Logic Gate Emulator. *3rd International Conference on Electro-Technology for National Development, 7-10 November 2017, Owerri, Nigeria*

[11] Khairudin M., Triatmaja A.K., Istanto W.J., Azman M.N.A., (2018). Mobile Virtual Reality to Develop a Virtual Laboratory for the Subject of Digital Engineering. *International Journal of Interactive Mobile Technologies, Vol 13*, No 04 (2019)

[12] Agus Suryanto., Diah Ayu Kusumawati., & Ibrahim M. H. Sanhoury. (2018). Development Of Augmented Reality Technology Based Learning Media Of Lathe Machines. *Jurnal Pendidikan Teknologi dan Kejuruan, Vol. 24*, No. 1, May 2018, pp. 32-38. ISSN:0854-4735, accredited by KEMENRISTEKDIKTI, Decree No: 51/E/KPT/2018. DOI: 10.21831/jptk.v24i1.18245.

[13] Mohd Erfy Ismail., Mohd Hasril Amiruddin., Pipit Utami., Irwan Mahazir Ismail., Moh. Khairudin., Badraningsih Lastariwati., & Nopadon Maneetien. (2018). The Effect Of An Augmented Reality Teaching Kit On Visualization, Cognitive Load And Teaching Styles. *Jurnal Pendidikan Teknologi dan Kejuruan, Vol. 24*, No. 2, October 2018, 178-184. ISSN:0854-4735, accredited by KEMENRISTEKDIKTI, Decree No: 51/E/KPT/2018. DOI: 10.21831/jptk.v24i2.20031.