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Implementation Of Augmented Reality (Ar) On Android-Based Fiber Optic Learning Media

Imma Riyani[1]

[1]Department of Computer Network Engineering and Telecommunications, SMK Muhammadiyah 2, Banjarmasin, Indonesia
[1]Email: immariyani@gmail.com

Abstract. Fiber optic technology is a critical topic in the Wide Area Network (WAN) curriculum for vocational high schools (SMK), especially for students majoring in computer and network engineering. However, the high cost and limited availability of fiber optic tools hinder effective learning, leading to difficulties in achieving competency indicators. This research aims to develop an Android-based Augmented Reality (AR) learning medium as an alternative to enhance students' understanding of fiber optic tools through interactive 3D visualizations. The study uses the Multimedia Development Life Cycle (MDLC) methodology, which includes phases such as concept, design, material collection, assembly, testing, and distribution. The application integrates 3D models created with Blender, marker-based tracking with Vuforia, and interface development with Unity 3D. The media includes multiple menus, including AR camera scanning, learning support, competency standards, and information about the application, and black box testing results show that all of the media's functionalities work effectively. The AR-based learning media proves to be a viable tool for introducing fiber optic devices and increasing student engagement in WAN topics. Future research is recommended to expand the range of 3D objects, enable online functionality, and evaluate the impact of the media on learning outcomes.

Key Words*: Augmented Reality, Fiber Optics, Learning Media, Multimedia Development Life Cycle.*

A. Introduction

Vocational High Schools (SMK) are formal educational institutions designed to provide students with practical skills related to their chosen specializations. According to the National Education System Law No. 20 of 2003, one of the primary objectives of SMKs is to prepare students with competencies tailored to specific vocational programs. Among the programs offered, Computer and Network Engineering (TKJ) is a popular choice that includes subjects such as Wide Area Network (WAN).

The WAN curriculum emphasizes fiber optic technology and requires students to understand the physical characteristics and functions of fiber optic tools. However, the high cost and limited availability of these tools present significant challenges. Most schools rely solely on lectures and static images, leaving students with insufficient hands-on experience. For example, many SMKs in Banjarmasin, including SMK Muhammadiyah 2, do not provide hands-on practice with fiber optic tools due to budget constraints and the potential risk of damage during use [3] [7].

Augmented Reality (AR) offers a promising solution to these challenges. As a cutting-edge technology, AR enables the integration of virtual content into the real world, creating an interactive and immersive learning experience [5] [2]. Using AR, it becomes possible to visualize and interact with three-dimensional representations of fiber optic tools without the need for physical equipment. Previous studies have shown that AR-based learning media significantly improves student understanding and engagement, making it a valuable resource in vocational education [7][11].

This research aims to develop an Android-based AR learning application to support the teaching of fiber optic tools. The application is designed to enhance students' understanding through interactive visualizations while addressing the limitations of traditional learning methods. It is expected that the AR medium will provide an innovative and effective approach to learning, particularly for fiber optic topics in the WAN curriculum.

B. Literature Review

The integration of technology in education has been a focus of research and development, particularly in enhancing the learning process. The role of technology, especially information technology, has dramatically changed the way educational content is delivered, making learning more accessible, engaging, and effective. [5][12][15]. This section reviews various studies on the application of technology in education, with a special focus on the use of augmented reality (AR) and mobile learning media in teaching complex subjects such as fiber optics. The evolution of educational technology has led to more interactive and dynamic learning experiences.

According to several studies, the use of digital tools such as multimedia, simulations, and AR improves student engagement and learning outcomes [1][5][7]. These tools provide opportunities for students to interact with educational content in ways that traditional methods such as textbooks or lectures cannot achieve. For example,

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AR allows students to visualize abstract concepts or complex objects in three dimensions, fostering a deeper understanding of the material. This can be particularly beneficial in fields such as engineering or science, where visualizing concepts can aid learning and retention [2][5][7].

Augmented Reality (AR) is one of the most innovative technologies currently being used in education. AR overlays digital information, such as 3D models or animations, onto the real world, allowing students to interact with virtual objects as if they were physically present in their environment [2][5]. In the context of vocational education, particularly for subjects such as fiber optics, AR can provide an interactive and immersive way for students to engage with equipment and processes that would otherwise be difficult or expensive to replicate in the classroom [7][11].

Several studies have demonstrated the effectiveness of AR in improving student engagement and learning outcomes. Lahiya et al. (2021) highlighted that AR-based learning media for fiber optics education successfully helped students visualize the components and functions of fiber optics tools, even without physical devices. This type of technology can overcome the challenge of high equipment costs and limited access to hands-on resources, providing students with a virtual hands-on learning experience.

Similarly, Amrulloh & Febriansyah (2021) developed an AR application for teaching fiber optics that demonstrated high levels of user acceptance and pedagogical effectiveness. Their study found that AR could improve student understanding by presenting complex fiber optic concepts in an interactive format [1]. The ability to manipulate 3D objects and explore their components in real time helps students grasp difficult concepts and encourages active learning [1][11].

In addition to AR, mobile learning has become a major trend in modern education. Mobile devices such as smartphones, tablets, and laptops provide students with the flexibility to access learning materials anywhere, anytime [16][15]. The accessibility of educational content through mobile applications makes learning more convenient and personalized, allowing students to learn at their own pace and revisit content as needed. In addition, mobile learning is particularly useful in regions where traditional educational resources may be scarce, as it provides an affordable and flexible alternative [16][15].

Research has shown that mobile learning can improve student engagement and retention. A study by Wati (2016) found that mobile-based learning media increase student motivation by providing interactive content that students can access on their smartphones [16]. This is particularly relevant for vocational education, where the integration of multimedia tools can simulate real-world experiences, such as operating fiber optic equipment or troubleshooting network issues [11][1].

Fiber optics, a critical topic in network engineering, is often a challenge in education due to the high cost of physical equipment and the technical expertise required to use it [3][7]. Many vocational schools, especially those in underfunded areas, struggle to provide the necessary tools for students to engage in hands-on learning. This has led to the exploration of virtual learning environments, where AR has shown promise in bridging the gap between theoretical knowledge and practical experience [7][11].

As suggested by Lahiya et al. (2021) and other researchers, AR can enhance the understanding of fiber optic systems by allowing students to interact with 3D representations of the tools and their components [7][1]. By providing a virtual environment for practice, AR can simulate real-world scenarios and guide students through complex procedures such as installing or troubleshooting fiber optic networks [1][11]. This approach not only addresses the issue of limited access to physical tools, but also allows students to practice and experiment in a safe, controlled environment.

The use of AR and mobile learning media has shown significant potential for improving the quality of education, particularly in vocational training for fields such as fiber optics [1][7][11]. These technologies offer new ways to engage students, visualize complex concepts, and provide interactive experiences that are difficult to replicate with traditional teaching methods. The continued development and integration of AR into educational programs will continue to enhance the learning process and help prepare students for the challenges of the modern technological landscape [5][7][15].

C. Proposed Methodology

This study proposes the development of an Augmented Reality (AR)-based learning media application for teaching fiber optic technology to students in vocational high schools (SMK). The proposed method involves the use of the Multimedia Development Life Cycle (MDLC) model, which consists of several phases: concept, design, material collection, assembly, testing, and distribution. In the following, each phase of the proposed method for creating and evaluating the AR-based learning media is outlined.

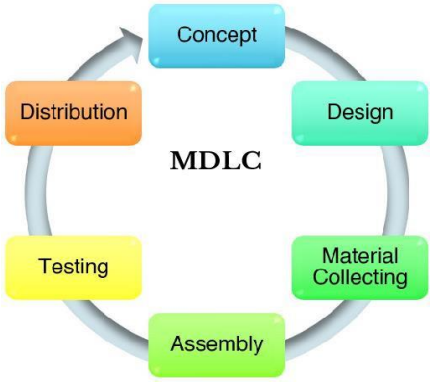

Figure 1. *Multimedia Development Life Cycle* (MDLC).

The description of the MDLC research phases is as follows:

A. Concept

In this phase, the author considers several aspects, including

a. Defining the objective of creating the learning media, which is to visualize the tools in fiber optic networks and present the information in an easily understandable way using augmented reality.
b. This learning media will be used as a supplementary tool in the learning process for the Wide Area Network (WAN) subject, specifically for the fiber optic topic, for both educators and students in grade XI of the Computer and Network Engineering (TKJ) program.
c. The learning media will be in the form of a booklet containing images integrated with Augmented Reality and run on Android devices. Once the data is collected, the next step is to process the existing data by selecting relevant data attributes and eliminating irrelevant data.

B. Desain

In this phase, the author creates detailed specifications for the learning media in the design of the application. This includes:

Navigation Structure Design: The design of the navigation menu creates a hierarchical system for the Augmented Reality-based learning media. The following is the architecture design for the Augmented Reality-based learning media.

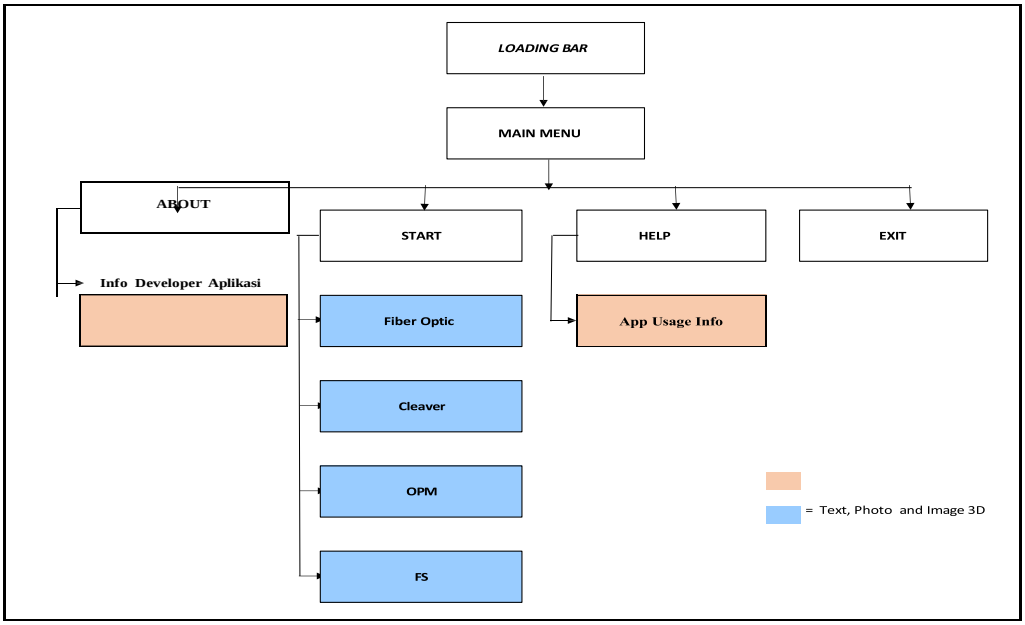

Figure 2. *Navigation Structure Design*

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It can be seen that the main page displayed after the loading bar is the master page (the first main page), and this main page has branching pages called slave pages (supporting pages) such as About, Start, Help and Exit. When one of the supporting pages is selected, the result displayed is called the master page (the second main page), which can be in the form of a 3D object (on the Start page) or in the form of text, photos or images (on the Help and About pages).

C. Flowchart Design

The flowchart design is used to make the program design process easier. Below is the result of the flowchart design.

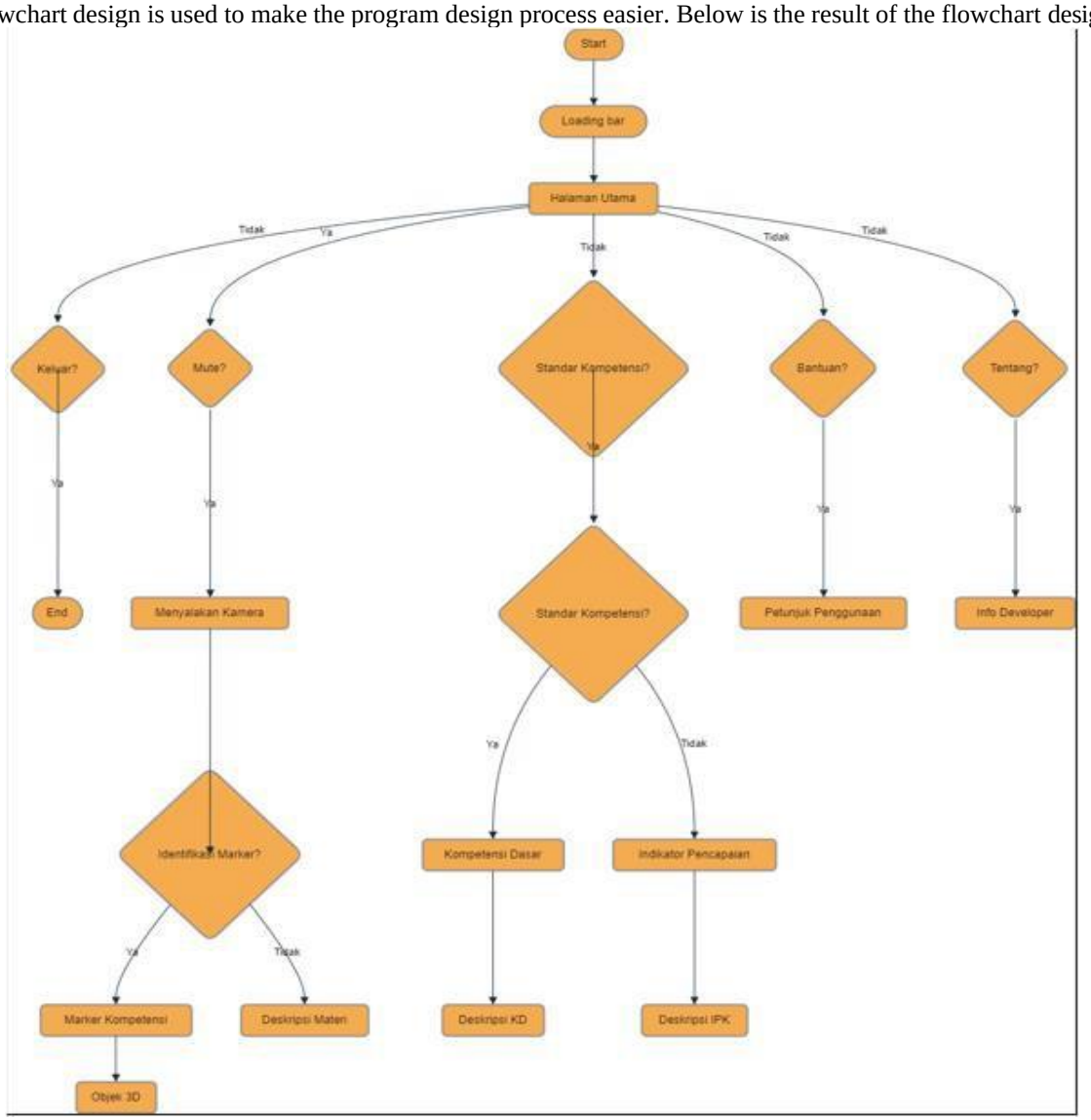

Figure 3. Design Flowchart

D. User Interface Design

The UI design is an illustration of the layout of the instructional media created as the basis for its appearance. Unlike a storyboard, which represents the design of the media, the UI design refers to the layout that will be displayed or viewed by the user.

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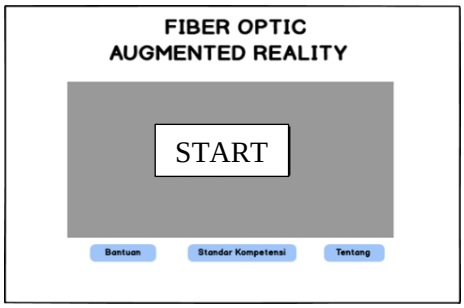

Figure 4. *Loading Bar Design.*

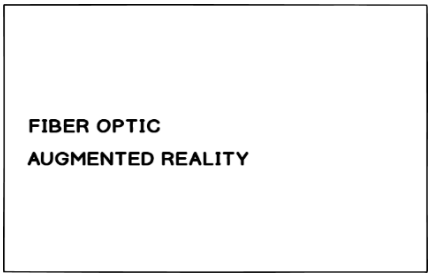

Figure 5. *Main Page Design.*

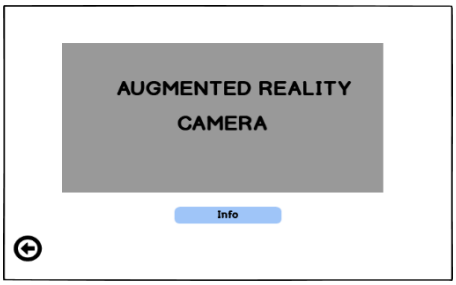

Figure 6. Camera AR Desain

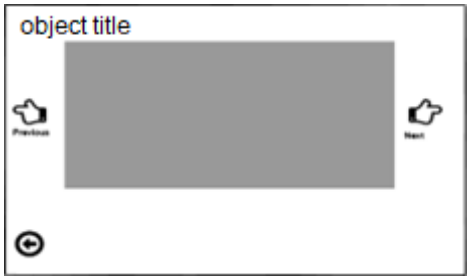

Figure 7. Info Object Design

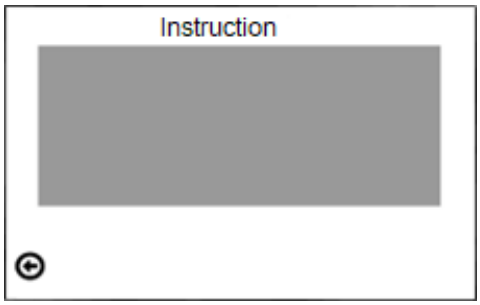

Figure 8. Help Desain

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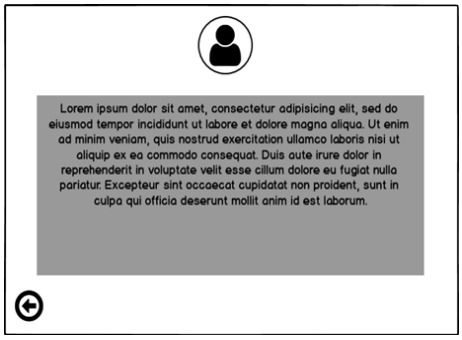

Figure 9. Design about

E. Material Collecting

In this phase, the activities carried out involve collecting the materials needed for the development of the learning media, as determined in the concept phase. This phase can be conducted in parallel with the design phase. However, the material collection and assembly phases can also be performed linearly.

1. **Material**
   The material refers to the subject of Wide Area Network (WAN) Technology, aligned with the scope of the research, specifically on the topic of introducing tools used in fiber optic networks and their functions.
2. **Applications**
   In developing the learning media, the researcher utilizes software that supports the creation of Augmented Reality-based learning media. This includes creating storyboards, objects (assets), and interface designs using Adobe Photoshop, as it is user-friendly for the researcher. For creating 3D objects, the open-source Blender application is used, and for configuring augmented reality, connecting databases to the application, and designing the user interface, Unity 3D is used.
3. **Database**
   Vuforia was chosen as the database because it is the most stable database that operates on Unity 3D. Vuforia offers three types of databases: Device, VuMark, and Cloud. For the developed learning media, the researcher uses the device type because it enables faster image tracking compared to VuMark and Cloud.
4. **Objects**
   Several objects used as assets are obtained from online search engines as well as from internal storage.

F. Assembly (Design and Development)

In this phase, the process of designing, integrating, and developing the application is carried out based on the previous phases. In the application, the marker used is a 2D object designed using Adobe Photoshop. The marker is uploaded to the Vuforia target marker as an image, which is then used as a database and serves as a tracking tool within the application. The marker is utilized to display 3D objects related to fiber optics and their components.

Figure 10. Front View of Marker

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Figure 11. Back View of Marker

G. 3D Object Design

The 3D object design is a critical aspect of the development process, as these objects are displayed through the augmented reality camera and serve as the focus of this research. The researcher designs 3D models of fiber optic tools, and aftercompleting the design, the objects are exported as files with *.blend and *.fbx extensions. These files are then imported into the Unity 3D application for use in the learning media.

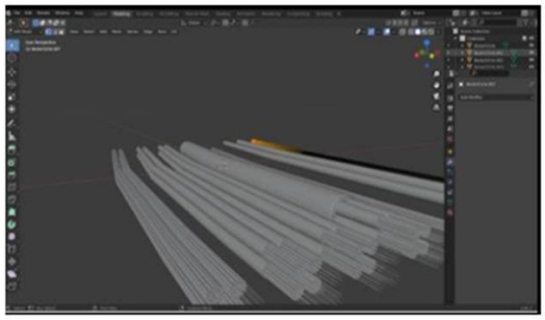

Figure 12. 3D Object Design

H. Testing (Application Testing)

The application testing phase is conducted after the design phase is completed. By running the application, it becomes possible to identify any errors or issues. The testing is performed using black-box testing in the developer's environment in Table 1.

Table 1. Results of Black-Box Testing

Testing Components	Results
Installing the application	Valid
Running the application	Valid
Opening the AR camera	Valid
Displaying 3D objects	Valid
Displaying object information	Valid
Opening the help menu	Valid
Opening the about menu	Valid
Opening the exit menu	Valid

I. Distribution

The distribution phase is the stage where the application has been tested and meets its intended objectives. At this point, the application is ready to be deployed and published for use by educators and students in vocational high schools (SMK).

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4. Experimental Result and Discussion

The final result of the research is an Augmented Reality (AR)-based learning medium that is feasible in terms of both content and functionality, making it suitable as a teaching aid in the learning process.

The steps for using this learning media are as follows:

a. Download and install the AR Camera.apk application on an Android device.
b. After installation, when you open the application, a Unity 3D splash screen will appear, indicating that the media was developed using Unity 3D. A loading bar for the media will then appear.

Figure 13. Unity 3D splashscreen

c. Then the main page will appear which has several menus:

Figure 14. Home Page

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d. Start : for AR Camera, scans markers and displays 3D objects

Figure 15. Start page (AR camera)

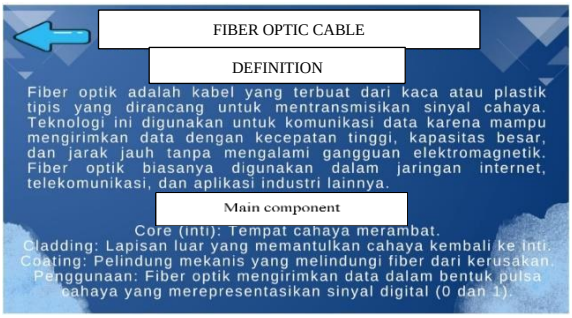

Figure 16. Description Page

e. Help: how to use learning media

Figure 17. Help Page

f. About: contains information about learning media developers

Figure 18. About page

5. Conclusion

Based on the results of the research and discussions presented in the previous chapters, the following conclusions can be drawn:

1. The development of an Augmented Reality (AR)-based learning media for the Wide Area Network (WAN) subject, specifically on the topic of fiber optics, originated from the problem of the limited ability of students to understand fiber optics tools and the unavailability of physical fiber optics equipment. These challenges resulted in the failure to achieve the learning competency indicators (LCIs) during the learning process. Data collection was carried out, including the collection of materials, lesson plans (RPP) and syllabi from the school. Subsequently, the activities carried out included the creation of AR-based learning media using Blender software to develop 3D objects, Vuforia as a database marker, and Unity 3D to integrate all materials into a final product.
2. The functionality of the AR-based learning media on fiber optics was tested using black box testing. The results showed that all the features of the learning media worked and functioned effectively. It can be concluded that the AR-based WAN learning media on fiber optics is suitable for use in the learning process. This learning media can be used as an additional learning resource to support classroom learning activities or independent study.
3. Recommendations for future researchers who wish to develop this AR-based learning media as a teaching tool include
   a. Provide online access to the AR-based fiber optic learning media.
   b. Add more 3D models of fiber optic tools.
   c. Conduct effectiveness tests to evaluate the impact of the AR-based learning media on improving student learning outcomes in fiber optics.

References

[1] Amrulloh, M. F., & Febriansyah, M. (2021). Aplikasi Pengenalan Alat Fiber Optik menggunakan Augmented Reality. *Jurnal SPIRIT*, 41-48.
[2] Craig, A. B. (2013). Understanding Augmented Reality. USA: Morgan Kaufmann.
[3] Fausta, D. E., & Kusuma, R. (2013). Penggunaan Fiber Optik sebagai Salah Satu Modern Materials dalam Bidang Telekomunikasi (Transmisi Data). Indonesian Journal of Applied Physics.
[4] Gall, M. D., Borg, W. R., & Gall, J. P. (1996). Educational Research: An Introduction. Boston: Pearson Education.
[5] Geroimenko, V. (2020). Augmented Reality in Education A New Technology for Teaching and Learning. Leicester: Springer.
[6] Kent, B. R. (2015). *3D Scientific Visualization with Blender.* USA: Morgan & Claypool.
[7] Lahiya, I. W., Suhada, S., & Takdir, R. (2021). Implementasi Augmented Reality pada Pengenalan Alat Fiber Optik. Konferensi Nasional Ilmu Komputer (KONIK), 517-523.
[8] Lyu, M. R. (2012). *Departmen of Computer Science and Engineeringi Digitable Document.* Hongkong: The Chinese University of Hongkong.
[9] Meilani, G. R. (2018). *Membangu Aplikasi Augmented Reality dengan Unity.* Surabaya: CV Garuda Mas Sejahtera.
[10] Safei, M. (2011). *Media Pembelajaran: Pengertian, Pengembangan da Aplikasinya.* Makassar: Alauddin University Press.
[11] Septiyanti, P., Latief, M., Rohandi, M., & Suwandi, I. (2023). Pengembangan Media Pembelajaran Interaktif Berbasis Augmentented Reality Pada Materi Perakitan Komputer Kelas X Tkj Di Smk Negeri 1 Gorontalo. INVERTED: Journal of Information Technology Education, 80-93.
[12] Sudijono, A. (2012). *Pengantar Evaluasi Pendidikan.* Jakarta: PT. Raja Grafindo Persada.
[13] Sudjana, N., & Rivai, A. (2007). *Media Pembelajaran.* Bandung: Sinar baru Algensindo.
[14] Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D.* Bandung: CV. Alfabeta.
[15] Suryadi, A. (2020). *Teknologi dan Media pembelajaran.* Sukabumi: CV Jejak.
[16] Wati, E. R. (2016). Ragam Media Pembelajaran. Yogyakarta: Kata Pena.