Design Application of Augmented Reality-Based Computer Device Assembly Practicum Modules

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Abstract

The adaptation and use of digital technology have presented various opportunities and challenges for actors involved in educational services, i.e., colleges, educators, and students. Augmented reality has recently emerged as one of the digital technologies that have attracted the attention of many academies and practitioners; in addition, AR technology has brought about a change in the way users and machines interact that can teach and direct students to handle the topic of lessons differently and more proactively. This study aims to design and build an android-based Augmented Reality (AR) computer hardware assembly practicum module application as an alternative learning media in the computer hardware device assembly practicum module, which is expected in a learning activity to be more exciting and increase students' skills about computer assembly through AR technology can be one of the solutions to overcome the practicum module which was previously still in the form of a textbook and was not yet technology-based. The research method used is the Multimedia Development Life Cycle (MDLC), which consists of six stages, namely concept, design, material, collection, assembly, testing, and distribution. The results of the practicum module application with Augmented Reality technology can be run on mobile devices with an Android operating system for version 5.1 and above, and this module has a feature that can introduce 3-D objects of hardware devices and simulate the assembly of hardware devices 3D objects 3D IC processor components and mainboards that are driven with the touch of a finger by pairing elements (Drag and Drop)

Keywords *— Augmented Reality, Multimedia Development Life Cycle, Android, Hardware, Design*

1. INTRODUCTION

School education policy in recent years has undergone an increase and development through integrating information technology and computational techniques in the school education system[1]. The evolving Augmented Reality (AR) technology will be quickly and easily accepted. This can be seen in some AR-based applications, a unique technology used in original and artistic applications such as Snapchat, Pokemon Go, Skymap, etc.[2]. Real-world AR technology is added with content results such as text, images, and video with three main characteristics: a combination of real-world and virtual elements, interaction with users in real-time, and registered in 3D space that can provide a new experience for users by allowing them to move and view 3D virtual images from any point just like the original object[3] [4].

Various factors strongly influence fun learning activities, one of which is that the selection of teaching media must be interesting for students to learn, interactive when used, and not reduce the essence of the material presented[5]. AR technology in education results in rich learning experiences, enhances skills and knowledge and enhances collaborative learning[6]. So this has encouraged researchers to integrate this technology into fields such as biology, chemistry, mathematics, medicine, history, engineering, etc.[7]. According to Yuen et al., there are five types of AR applications, including Discovery-Based Learning (DBL) or discovery-based learning, Object Modeling (OM), AR books, Game Based Learning (GBL) or game-based learning, and skills training[3]. AR also allows users to interact: this intense feeling of "presence" increases memorization by looking at natural objects used by AR[8]. In addition, AR has changed how users and machines interact, which can teach and direct students to handle lesson topics differently and more proactively[9].

Augmented reality has recently emerged as a digital technology that has attracted the attention of many academies and practitioners. Augmented reality technology is a technology that has the potential to gain more relevance to many real-world applications, scenarios, problems, and many aspects of our lives that grow beyond expectations and have the potential to deliver significant benefits and bring technological and transformative perspectives to many areas of application such as: as a retail business, travel, and tourism industry, manufacturing, and industry, domains of healthcare, military technology, education systems, gaming ecosystems, entertainment, and more[10][11][12]. The adaptation and use of digital technology have presented various opportunities and challenges for actors involved in educational services, i.e., colleges, educators, and students[13] [14].

Based on the gap phenomenon in this study, the learning effect may differ according to their respective types, which can be used more in some particular disciplines than in others. In this study, it aims to design and build an android-based Augmented Reality (AR) computer hardware assembly practicum module as an alternative learning media in the computer hardware assembly practicum module, which is expected in a learning activity to be more interesting for students of SMK West Jakarta 1 majoring in Multimedia, especially for computer hardware assembly practicum so that it can increase knowledge and skills the students about computer assembly.

According to Anastassova et al., training or practice is one of the favorite domains of AR technology since this technique allows real-virtual dual support of learning activities to the learner by providing him with contextual information[15]. In the world of education, the importance of AR has been brought to the attention of some researchers; according to Fjeld[16], learning activities by utilizing AR make it possible to build knowledge actively and autonomously, according to Cieutat and al. pointing out that in the case of practical work using AR technology can provide an unexpected "semideterminist" aspect regarding which technologies are easy to apply[17].

Several researchers have explored and verified the importance of information and communication technologies in the education system[6]. The results of previous research on training methods with AR technology to obtain better performance and advancement of learning and student involvement in physical education subjects. In addition, the results of

designing augmented reality for school physical education training with augmented reality technology using cloud networks, the Internet of things, and remote users with AR simulation results can explore sportsman performance data and input from sports coaches, the positive impact of the augmented reality environment describes can improve the training and learning ability of the school physical education system[18].

In addition, other studies on the implementation of AR applications for learning activities of the medical staff involved in Interventional radiology (IR) about the usefulness of protective radiation screens and how to use them correctly have been developed. A questionnaire survey conducted using the Instructional Materials Motivation Survey (IMMS) based on the four categories of Attention, Relevance, Confidence, and Satisfaction (ARCS) motivation model to evaluate this AR application as teaching material as a radiation protection effort has resulted in an assessment that AR applications are considered to have high effectiveness by professional concentration subjects[19].

This research is expected to use the AR application as an alternative learning media in the computer hardware assembly practicum module, which is expected in a learning activity to be more interesting for students of SMK West Jakarta 1 majoring in Multimedia, especially for computer hardware assembly practicum which has been using modules in the form of textbooks and not yet technology-based so that it can motivate enthusiasm and interest in learning students to make it easier to understand the knowledge and increase the skills of students about computer assembly through AR technology can be one of the solutions to overcome practicum modules that were not previously technology-based into the application of technology-based practicum modules as practicum simulations by looking at goods as the original, but in a 3-Dimensional virtual form.

2. RESEARCH METHOD

The research used in building the application of the practicum module of computer hardware assembly with Augmented Reality technology is to use the Multimedia Development Life Cycle (MDLC) because this application is included in the multimedia application category, as explained that there are several categories of multimedia applications, including business presentations, training and learning applications, promotions and sales, games, and others [20]. Using multimedia-based learning media applications, it is hoped that users will get a diverse experience from various media to reduce boredom with multiple media and are suitable for independent learning activitie[21].

The Multimedia Development Life Cycle (MDLC) methodology sourced from Luther has undergone the development of a multimedia methodology that consists of six stages, including concept, design, material, collection, assembly, testing, and distribution, as shown in figure 1 below[22].

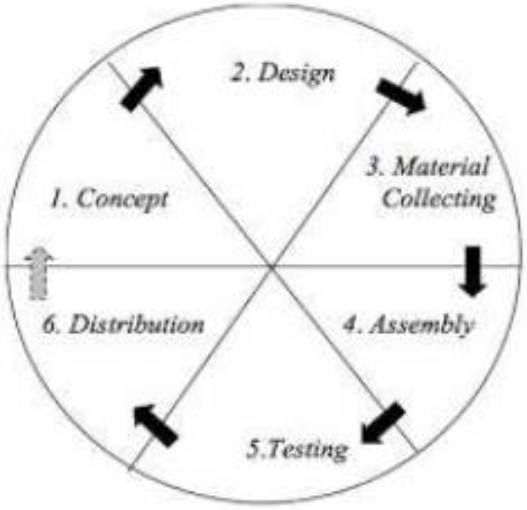


Figure 1. Multimedia Development Life Cycle (MDLC)[22]

The stages of the Multimedia Development Life Cycle are described as follows:

a. Concept, the concept stage is a stage to determine the goals and objectives of application users (audience identification). At this stage of the idea is also carried out, the determination of the type (presentation, interactive, etc.) and the purpose of the application (entertainment, training, learning, etc.).
b. The design or design stage determines the application's specifications related to style, appearance, program architecture, and material/material needs.
c. Collecting material the material collecting stage is the stage where material or materials are ordered as needed. The material collecting stage can be done simultaneously or in parallel to the assembly stage. However, in some cases, the material collecting and assembly stages will be done linearly, not parallel.
d. Assembly, the assembly stage (manufacturing), is the stage of making everything that is an object or multimedia material in the application; at the assembly stage, this is done based on the design stage.
e. Testing at this stage is done after the assembly stage is completed by testing the application or program to evaluate whether there are errors or not. This stage is also known as the alpha test stage, where the test is carried out by the maker or the maker's environment.
f. This stage will be distributed application storage on a storage medium. If the storage media cannot accommodate the application, then compression is carried out against the application.

MDLC is a project development method that is appropriate in the development of multimedia systems with the advantage that the way is the same as the waterfall method so that it can be easily understood and implemented with clear steps and easy to implement because it can also be developed on a small scale[23].

3. RESEARCH RESULTS AND DISCUSSION

A. Concept Stage

Designing a learning module application with Augmented Reality (AR) technology that is more modern, interesting, and useful for teaching materials is an effort by stakeholders in the educational environment to transform from a conventional educational paradigm to education by utilizing technology[24]. The software used to create this application is Unity Version 2018, Adobe Photoshop CS 4, Autodesk Maya 2020, Visual Studio Code, and the Vuforia Developer portal.

Unity is an integrated tool for creating games, building architecture and simulations, Unity is not designed for the design or modeling process, because Unity is not a design tool. In Unity there is a scripting feature provided, it supports three programming languages, namely; JavaScript, C#, and Boo. Flexible and easy to use, rotating, and scaling objects only takes a line of code. Likewise with duplicating, removing, and changing properties. Visual Properties Variables defined by scripts are displayed in the editor, Net-based, meaning to run the program using the Open Source Net platform. This editor was created after thousands of hours which have been spent to make it number one in the top ranking order for game editor Unity is compatible with 64-bit versions and can run on Mac OS x and windows and can produce games for Mac, Windows, Wii, iPhone , iPad and Android. Unity 3D features GUI (Graphic User interface), Audio, Animation, Effects, and Scripting (Programming) as well as the ability to easily control various Objects (GameObjects) in games or applications. Unity3d also supports Scripting (programming) using various programming languages including C#, Java Scrip[25].

Vuforia Developer Portal uses consistent sources that focus on image recognition with many features and capabilities that can help developers to realize their thoughts without any technical limits as seen in Figure 2 below. With support for iOS, Android, and Unity3D, the Vuforia platform supports developers to create applications that can be used on almost all types of smartphones and tablets.

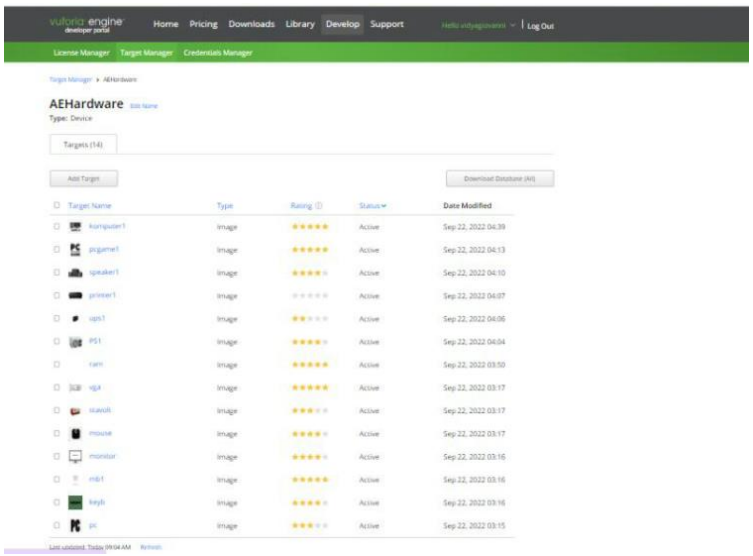


Figure 2. AR Hardware Feature Development

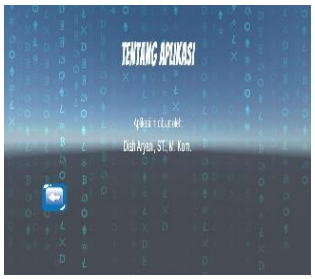
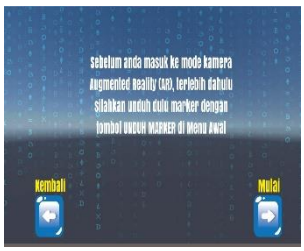
In this Concept stage, the initial step is to determine the usefulness of this application, which is a vocational high school with an interface that is designed to be easy to use and simple; besides that, it must also be made as attractive as possible there is an animation of the buttons it uses, the existing controllers are made to include buttons for training sera material. This AR-based practicum module was created to help the practicum process of the students so that they can improve their learning minutes and make it easier for them to absorb the practicum in the students themselves.

B. Design Stage

The Design Phase includes identifying the scope of the content, determining the use of media and tools needed for editing and sketching interactions in designing the media content. Learning media must pay attention to educational content by combining different media consisting of textual, imaginary, animation and acoustic so that it can be adapted to the needs of students with more interactive learning styles.

At this design stage, it is carried out to make a storyboard material design for the computer hardware assembly practicum module application, and the following is the storyboard design of the practicum module application to be built:

Visual	Sketsa	Audio
In the frame this application has a background layer with a resolution of 1280px x 720px.		Music instrument Splash Screen.
There is a happy meeting sentence in the Opening Screen frame, and a Button Continue to the Application Definition frame.		Opening music instrument and the sound of the Next button

Visual	Sketsa	Audio
In the Application Definition frame, there is a welcome sentence, and an explanation of the application button Continue to the Menu frame.		Opening music instrument and the sound of the Next button
In the Menu frame, there are buttons Instructions, About, Introduction, Assembly, Download Marker, and Exit.		Music instrument Opening and sound button Hint, About button, Introduction Button, Assembly Button, Download Button, Exit Button.
In the Instructions frame, there is a sentence of instructions for using the application and a Back to Menu button.		Music instrument Opening and sound button Instructions
The About frame has an app maker sentence and a Back to Menu button.		Music instrument Opening and sound button About
In the Introduction frame, there is a sentence of instructions for using the augmented reality application introduction to computer component hardware devices, the Back to Menu button, and the Start button.		Opening music instruments and the sound of the Back button and the sound of the Start Button.

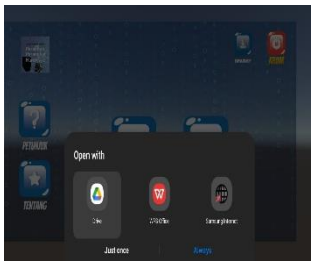
Visual	Sketsa	Audio
On the Assembly frame is a sentence of instructions for the use of augmented reality applications assembling computer component hardware devices, a Back to Menu button, and a Start button.		Opening music instruments and the sound of the Back button and the sound of the Start Button.
The Download Marker frame will be directed to Google Drive to download the marker image for augmented reality.		The sound of buttons.

Figure 3. Storyboard Application practicum module

C. Collecting

At this Collecting stage, the data needed in the design of the computer hardware assembly practicum module application include:

1. Asset
2. Audio

Asset collection is a 3D object model as a replica to support teaching materials used to build computer hardware assembly practicum module applications, starting from supporting images that aim to create interactive animations and backgrounds. The practicum module application is to be made, then the background music for the practicum module application and the sound of buttons when clicked by pointers by providing audio.

D. Assembly

At this stage, the creation of a computer hardware assembly practicum module application starts with asset editing, User Interface (UI) creation, 3D Modeling, and coding. The Three-dimensional (3D) user interface Design Stage is essential to any virtual environment application.

Asset editing, at this stage of editing, the researcher performs several steps, including:

a. Using Adobe Photoshop CS4 application to create menu button icons,
b. Autodesk Maya 2020 to create 3D objects in the form of replicas of hardware devices,
c. To register a marker image to display AR objects, researchers use the Vuforia Developer Portal.

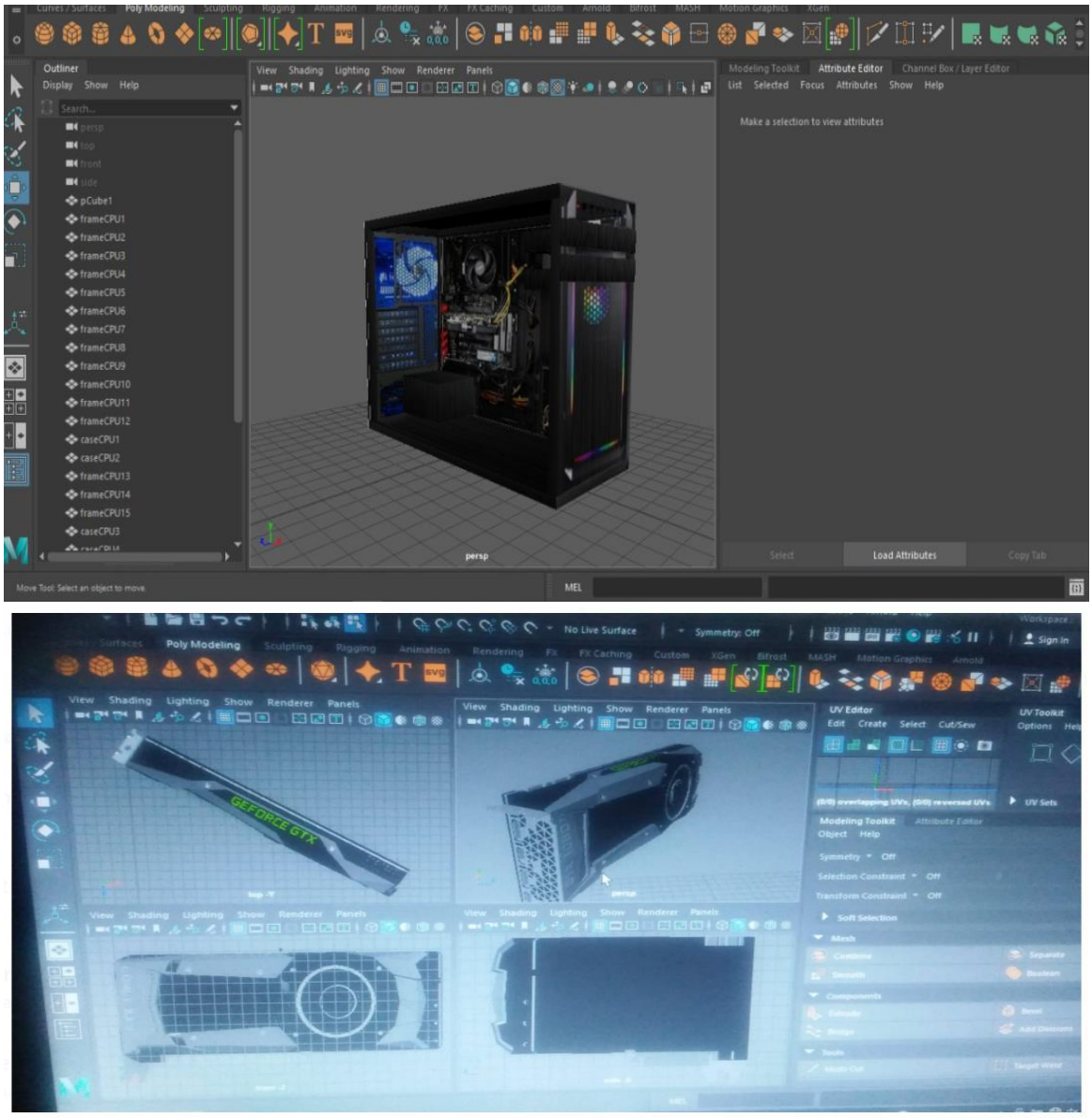


Figure 4. 3D Object Creation

UI creation, at this stage, researchers used the Unity 2018 application to make the UI of the hardware assembly practicum module application by creating a new scene. Next, as a place to put assets and buttons for navigation that will make the canvas.

Coding, this stage aims to make the buttons in the computer hardware assembly practicum module application work, so the researcher needs to add a script to the command buttons. The process of adding a script must create its code and add new components. Next, Unity 2018 will open a visual studio code program on the computer to be coded. This study used the C# programming language to code for the next, back, quit, drag, drop, and play/pause buttons as shown below.

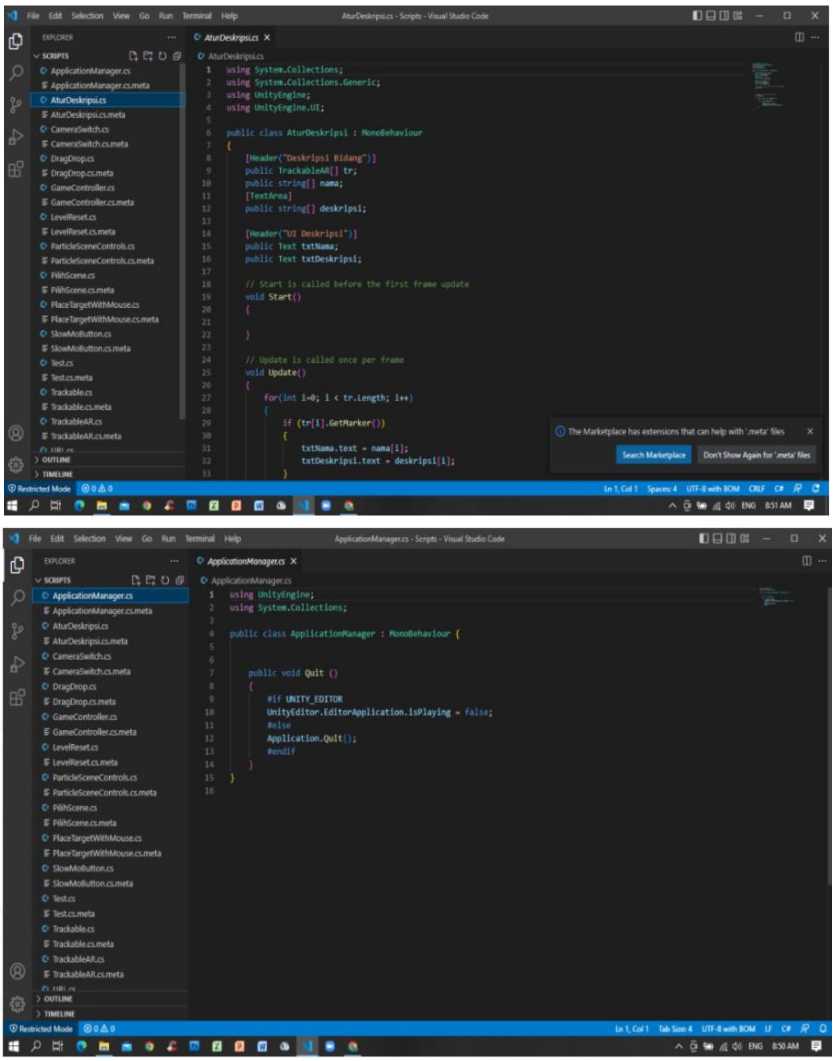
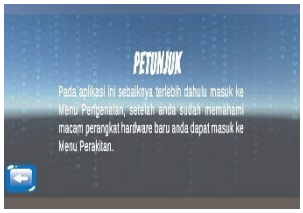


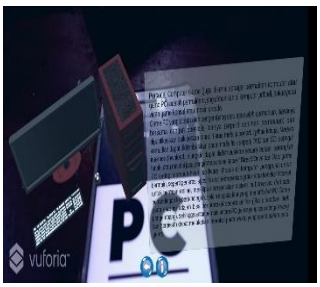
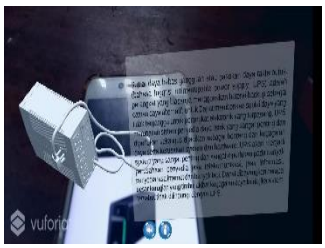
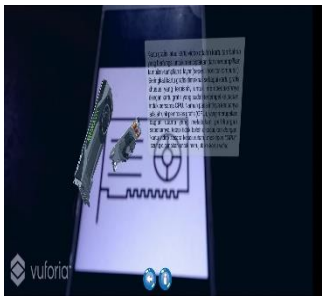
Figure 5. The process of adding a script

E. Testing Stage

At this stage, an application testing of the computer hardware assembly practicum module has been designed to know whether the contents are following the storyboard and whether the application can run according to the platform, and ensure that the buttons that have been made before can function

Table 1. Black Box Testing

Testing Activities	Expected results	Test Results	Conclusion
Hints button	Instructions for the use of the application will appear.		Appropriate

Testing Activities	Expected results	Test Results	Conclusion
Introduction button	There are instructions for using augmented reality applications and an introduction to computer component hardware devices.		Appropriate
Start button on the recognition frame	In the frame of the recognition augmented reality camera, there is a 3D object of the computer hardware component, and to display the description of the 3D object, the Back to Menu button.	    	Appropriate

Testing Activities	Expected results	Test Results	Conclusion
Assembly Button	On the Assembly frame is a sentence of instructions for the use of augmented reality applications assembling computer component hardware devices, a Back to Menu button, and a Start button.		Appropriate
Start button on assembly frame	In the augmented reality camera assembly frame, there is a 3D object of the IC Processor and Mainboard components that are moved with the touch of a finger by pairing the elements (Drag and Drop) and the Back to Menu button, and the Start button.		Appropriate

F. Distribution Stage

One of the most important steps in developing a digital teaching system is the creation of a multimedia-based learning system. Content uploaded to Google Drive and whatsapp groups is converted into material that can be shared by users, both teachers and students. This application can also be directly installed on a smart phone or Android so that users can immediately use it.

4. CONCLUSION

Based on the results of research related to the design and construction of a hardware device assembly practicum module application with Augmented Reality, which aims to design an android-based Augmented Reality (AR) computer hardware assembly practicum module application as an alternative learning media in the computer hardware device assembly practicum module which is expected in a learning activity to be more interesting for students of SMK West Jakarta 1 central Multimedia, especially for practicum assembly of computer hardware devices so that it can increase the knowledge and skills of students about computer assembly, the application of the practicum module with Augmented Reality technology can be run on mobile devices with an Android operating system for version 5.1 and above.

The application of the practicum module for the assembly of Augmented Reality (AR) computer hardware devices is expected to motivate the enthusiasm and interest in learning of students to make it easier to understand knowledge and increase students' skills in computer assembly through AR technology; there is a feature that can introduce 3D objects of hardware

devices and simulation of hardware device assembly objects 3D IC Processor and Mainboard components that are driven by the touch of a finger with the touch of a finger pairing components (Drag and Drop).

5. SUGGESTED

Augmented Reality-based hardware device assembly practicum module application development on Android can then be added features of hardware assembly exercises and can be developed for other learning practicum modules. In addition, in further research, other AR development methods can also be used.

6. REFERENCES

[1] Y. Huang and L. C. Reynoso, "Based on physical self-concept to discuss the effect of environmental education on health-related physical education," Ekoloji, vol. 27, no. 106, pp. 1645–1651, 2018. https://doi.org/10.3390/ijerph17010094

[2] S. Bagade, A. Lidhu, Y. Manral, and J. Vartak, "Augmented Reality Based Visual Dictionary for Elementary Students," in Lecture Notes on Data Engineering and Communications Technologies, Springer, Cham, 2020. https://doi.org/10.1007/978-3-030-34515-059

[3] S. C.-Y. Yuen, G. Yaoyuneyong, and E. Johnson, "Augmented Reality: An Overview and Five Directions for AR in Education," J. Educ. Technol. Dev. Exch., vol. 4, no. 1, 2011.

[4] M. Kesim and Y. Ozarslan, "Augmented Reality in Education: Current Technologies and the Potential for Education," Procedia - Soc. Behav. Sci., vol. 47, no. 222, pp. 297–302, 2012. https://doi.org/10.1016/j.sbspro.2012.06.654

[5] M. Alfiansyah, P. Pradipta, and I. G. P. A. B, "PENGEMBANGAN MEDIA PEMBELAJARAN BERBASIS AUGMENTED REALITY PADA MATA PELAJARAN INSTALASI MOTOR LISTRIK Yulia Fransisca Abstrak," J. Pendidik. Tek. Elektro, vol. 10, no. 3, pp. 327–335, 2021.

[6] H. K. Wu, S. W. Y. Lee, H. Y. Chang, and J. C. Liang, "Current status, opportunities and challenges of augmented reality in education," Comput. Educ., vol. 62, pp. 41–49, 2013. https://doi.org/10.1016/j.compedu.2012.10.024

[7] A. Pantelić and D. Plantak Vukovac, "the Development of Educational Augmented Reality Application: a Practical Approach," ICERI2017 Proc., vol. 1, no. November, pp. 8745–8752, 2017. DOI:10.21125/iceri.2017.2399

[8] J. Cieutat, O. Hugues, and N. Ghouaiel, "Une p ´ edagogie active bas ´ ee sur l ' utilisation de la R ´ ealit ´ e Augment ´ ee Observations et exp ´ erimentations scientifiques et technologiques , Apprentissages technologiques," no. October, 2011.

[9] F. Manuri and A. Sanna, "A Survey on Applications of Augmented Reality," vol. 5, no. 1, pp. 18–27, 2016.

[10] X. Fan, Z. Chai, N. Deng, and X. Dong, "Journal of Retailing and Consumer Services Adoption of augmented reality in online retailing and consumers ' product attitude : A cognitive perspective," vol. 53, no. November 2019, 2020. https://doi.org/10.1016/j.jretconser.2019.101986

[11] Scott G. Dacko, “Enabling smart retail settings via mobile augmented reality shopping apps,” Technol. Forecast. Soc. Chang., no. 124, pp. 243–256, 2017. https://doi.org/10.1016/j.techfore.2016.09.032
[12] M. M. Marques and L. Pombo, “Game-Based Mobile Learning with Augmented Reality: Are Teachers Ready to Adopt It?,” in Project and Design Literacy as Cornerstone of Smart Education, 2019, pp. 207–218. DOI:10.1007/978-981-13-9652-6_19
[13] M. Akçayır and G. Akçay, “Advantages and challenges associated with augmented reality for education : A systematic review of the literature,” Educ. Res. Rev., vol. 20, pp. 1–11, 2017. https://doi.org/10.1016/j.edurev.2016.11.002
[14] J. Radianti, T. A. Majchrzak, J. Fromm, and I. Wohlgenannt, "Computers & Education A systematic review of immersive virtual reality applications for higher education : Design elements, lessons learned, and research agenda," Comput. Educ., vol. 147, no. July 2019, p. 103778, 2020. https://doi.org/10.1016/j.compedu.2019.103778
[15] M. Anastassova, J. M. Burkhardt, G. Mégard, and P. Ehanno, “Ergonomics of augmented reality for learning: A review,” Trav. Hum., vol. 2, no. 70, 2007.
[16] M. Fjeld and B. M. Voegtli, “Augmented Chemistry : An Interactive Educational Workbench,” no. Mmi, pp. 1–2, 2002.
[17] C. JM, H. O, G. N, and B. S, “"Une pédagogie active basée sur l’utilisation de la Réalité Augmentée Observations et expérimentations scientifiques et technologiques, Apprentissages technologiques,” Journées l’Association Française Réalité Virtuelle, Augment. Mix. d’Interaction 3D, Bidart, 2011.
[18] Y. Liu and A. Manickam, “Augmented reality technology based on school physical,” Comput. Electr. Eng., vol. 99, 2022. https://doi.org/10.1016/j.compeleceng.2022.107807
[19] S. Matsuzaki et al., “Development and assessment of an educational application for the proper use of ceiling-suspended radiation shielding screens in angiography rooms using augmented reality technology _ Elsevier Enhanced Reader.pdf,” Eur. J. Radiol., vol. 142, 2021. https://doi.org/10.1016/j.ejrad.2021.109925
[20] Luther, Authoring Interactive Multimedia, AP Profesi. Boston, 1994.
[21] R. I. Borman and E. Idayanti, “Pengembangan game edukasi untuk anak taman kanak-kanak (tk) dengan implementasi model pembelajaran visualitation auditory kinestethic (vak),” vol. 03, pp. 8–16, 2018.
[22] Binanto and Irwan, Multimedia Digital Dasar Teori dan Pengembangannya. Yogyakarta: Andi Offset, 2010.
[23] V. Limken and U. I. Batam, “Designing Learning Media For Bataknese Cuisine Using Multimedia Development Life Cycle (MDLC),” vol. 02, no. 02, pp. 56–63, 2021. http://dx.doi.org/10.37253/joint.v2i2.6072
[24] K. Lee, “Training Augmented Reality in Education and Training,” TechTrends, vol. 56, no. 2, 2012.http://dx.doi.org/10.1007/s11528-012-0559-3
[25] T. Elektro, U. Sam, and J. K. B. Manado, “Rancang Bangun Game 3D Pertahanan Kerajaan Bowontehu,” J. Tek. Inform., vol. 14, no. 4, pp. 455–464, 2019.
[26] D. A. Bowman and J. J. Laviola, “An Introduction to 3-D User,” vol. 10, no. 1, pp. 96–108, 1999. http://dx.doi.org/10.1162/105474601750182342