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Augmented Reality Based Digital Practicum Card Design and Implementation during the COVID-19 Pandemic

ABSTRACT: *This study aims to design a DPC (Digital Practicum Card) application in the practice of learning basic automotive subjects. The application made is a digital practicum tool based on AR (Augmented Reality). The method in application development uses the MDLC (Multimedia Development Life Cycle) model through six stages of the development process, namely: Concept, Design, Material Collection, Assembly, Testing, and Application Distribution. The concept stage begins with the process of analysing the needs of automotive practicum learning, designing interfaces, developing 3D (Three-Dimensional) models with a blender, assembling applications with unity, testing systems, and distributing digital practicum card applications. The DPC application helps students carry out virtual experimental exploration activities on basic automotive materials without being limited by space and time, so that practicum learning becomes easy and can improve the quality of learning. The results of limited application testing for mechanical engineering students show that the package (apk) of the digital practicum card application can be installed on an Android smartphone device, the camera can read markers and generate 3D models of automotive objects normally. In addition to testing from the hardware and software aspects, the DPC application can be used by mechanical engineering students as a practical tool and an average of above 80% states that DPC can be used easily, and as a fun automotive practicum learning tool.*

KEY WORDS: *Augmented Reality; Virtual Laboratory; Digital Practicum Card.*

INTRODUCTION

Vocational education and training have an important and strategic role in preparing human resources, who have industrial skills and competencies, so that they can work and do well. Quality education in

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vocational education can only be done effectively by integrating work into learning through practical activities. Practical activities are very important activities carried out by students and lecturers in the work-based learning process, especially in automotive mechanical engineering courses (Nduna, 2017; Kanwar, 2019; and Rusmulyani, 2021).

However, at this time, practical learning activities cannot be carried out in workshop laboratories, due to the very dangerous COVID-19 (Corona Virus Disease of 2019) attack. These situations and conditions force universities and colleges in the world to implement an online learning system (Khosravi, 2019).[1]

COVID-19 spreads through droplets released by sufferers through the air to people less than one meter away. This virus enters through the respiratory media and attacks the human immune system. The initial symptoms of an infected person's body will be coughing, high fever, and finally difficulty breathing. When the virus has spread and enters the blood vessels, it can cause a heart attack and heart inflammation. The transmission of this virus is very fast depending on the immune system we have, if our immune system is low, it will be easy to get infected quickly. People, who have a strong immune system when infected, will not feel symptoms, but people without symptoms, or OTG (*Orang Tanpa Gejala*), can carry viruses that can harm others (Oram, 2019).

The implementation of learning using e-learning requires methods and strategies that can assist students in absorbing the subject matter. However, for vocational education, especially in the implementation of practicum, special strategies and tools are needed, so that students can still develop knowledge, skills, and gain hands-on experience even though learning is done virtually (Ana, 2020).

The solution to this problem is to design an Android-based virtual laboratory application in the form of a digital practicum card by involving AR (Augmented Reality) technology that supports electronically assisted online learning. The design of the application can encourage student motivation in exploring scientific activities through online observations and prevent crowds without reducing the essence of the learning material (Dede *et al.,* 2018).

According to S. Cawood & M. Fiala (2007), as cited also in M. Mustika *et al.* (2015), AR is a natural way to explore 3D objects and data. AR is a concept that combines virtual reality with the real environment, so that two-dimensional (2D) or three-dimensional (3D) virtual objects look as if they are real and blend with the real world. In AR technology, users can

[1]See also, for example, the articles that are available at: https://en.unesco.org/covid19/educationresponse [accessed in Bandung, West Java, Indonesia: November 3, 2020].

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see the real world around them by adding virtual objects generated by the computer (Cawood & Fiala, 2007; and Mustika *et al.,* 2015).

The application of virtual technology into practical learning and training is dominated by virtual technology, because it can increase learning achievement and motivation. Thus, the integration of AR technology into virtual laboratories can support the introduction of new concepts as part of learning about science and technology; and introduce more general engineering knowledge, through more constructive education and training activities and collaboration on more complex engineering topics, such as learning automotive courses (Potkonjak, 2016; Akçayır, 2017; and Alptekin, 2018).

The combination of AR technology with educational content creates new types of automated applications and acts to increase the effectiveness and attractiveness of teaching and learning for students in real-life scenarios. AR is a new medium, combining aspects of multimedia technology with the surrounding environment. These media offer unique capabilities, combining the physical and virtual worlds, with the user's implicit and continuous control over viewing angles and interactivity (Utarbutar, 2017; and Ana, 2020).

AR must have three characteristics: it combines the real and virtual worlds; has real-time interaction with the user; and is registered in 3D space. AR allows users to interact actively through digital simulations and aims to complement reality without actually immersing the user in a synthetic environment (Wang, 2018).

The concept of digital simulation, that is integrated with AR technology, can change the conventional learning principle that is centered on the instructor to be centered on the learner. Students become more active, creative, and critical in understanding various learning materials, so as to create inherent knowledge and skills based on findings and experiences so that students can do lifelong learning (Andresen, 2002).

This study aims to design an AR-based digital practicum card application in automotive mechanical engineering practicum learning in vocational higher education that is integrated with e-learning. The application made is a practicum tool in the form of a digital card as a medium used to make observations on online learning by integrating virtual technology into practical learning; how the application works by directing the Android smart phone camera at each marker containing automotive material in the form of 3D objects. This application can assist teachers in explaining automotive material and assigning practical activities tasks virtually using an Android smart phone device.

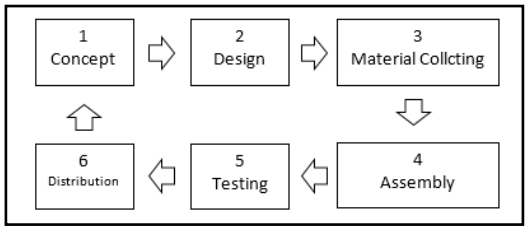

Figure 1:
Development Method Cycle

DEVELOPMENT METHOD

The method used is MDLC (Multimedia Development Life Cycle), which is sourced from A.C. Luther (1994) and has been modified by A. Sutopo (2003). This method has been widely used in building learning applications, such as game-based learning (Luther, 1994; Sutopo, 2003; and Gros, 2007).

The multimedia development method consists of six stages, namely: concept, design, material collection, assembly, testing, and distribution. These six stages do not have to be sequential in practice, these stages can switch positions. However, the concept stage is the first step that must be done. Here is the procedure for developing a digital practicum card application as shown in figure 1.

Figure 1 is the approach used is the method of developing a digital practicum card application for automotive mechanical engineering courses in a 3-D (3-Dimensional) virtual laboratory. The following stages of application development are: (1) *Concept*, this stage is determining the purpose and who the program user is, or identification audience, type of application, purpose of application, and general specifications; (2) *Design*, it is to make detailed specifications regarding the application architecture, style, appearance, and the need for learning materials for making applications; (3) *Material Collecting*, it is the stage of collecting materials in accordance with the needs being worked on, and these materials include, among others, clip art images, photos, animations, videos, audios, and others that can be obtained free of charge or by ordering to other parties according to the design; (4) *Assembly*, this stage is making all multimedia objects or materials; (5) *Testing*, after the application is made, it is time to test the capabilities and performance of the application, whether it is as expected, and here, it is recompiled whether all connections, buttons, and other facilities can function properly; and (6) *Distribution*, this stage is application to be processed and distributed in the form of an apk extension and stored in a cloud storage media on the google play store.

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Table 1:
Description of the DPC Application Design Concept

Concept	Description
Title	Digital Practicum Card Application
Material	Basic Automotive Knowledge
Learning Objective	Create and implement cloud-based AR (Augmented Reality) applications on automotive learning materials. This application is expected to increase knowledge and skill competence, and independently be able to perform comparative, critical analysis, and make a summary of learning outcomes and improve the delivery of a more interactive learning process
User	Mechanical Engineering Student
Audio	Automotive knowledge material narration
Video	Automotive knowledge material narration
Picture	Automotive Objects 3-D (3-Dimensional) Model
Resource	From lecturers, industry, and other open sources

FINDINGS AND DISCUSSION

This research produces a virtual laboratory application for automotive mechanical engineering courses. A virtual laboratory made in the form of a number of cards containing markers for automotive mechanical engineering courses. The practicum card is used by directing the camera at the marker object contained in the card through the android smart phone camera. The marker object image contains material in the form of a 3-D (3-Dimensional) animated video that will appear on the smart phone screen and machine drawing objects and 3-D object components for practice.

Concept. The concept stage is the stage to determine the purpose and who the program users are or user identification. In addition, it determines the type of application (presentation, interactive, etc.) and the purpose of the application (entertainment, training, learning, etc.). The details of the concept in this study are in table 1.

Design. This stage is consisted of three designs, namely: (1) *Application Flowchart Design*; (2) *Application Digital Practicum Card Design*; and (3) *App Mockup Design*. The explanation is following here:

Firstly, *Application Flowchart Design*. Flowchart design is the stage of making specifications regarding the program architecture, style, appearance, and material requirements or materials for the program. At this stage, make an application design and storyboard design. The design of the DPC (Digital Practicum Card) application flowchart uses an online application that can be accessed on the draw.io web page and is available

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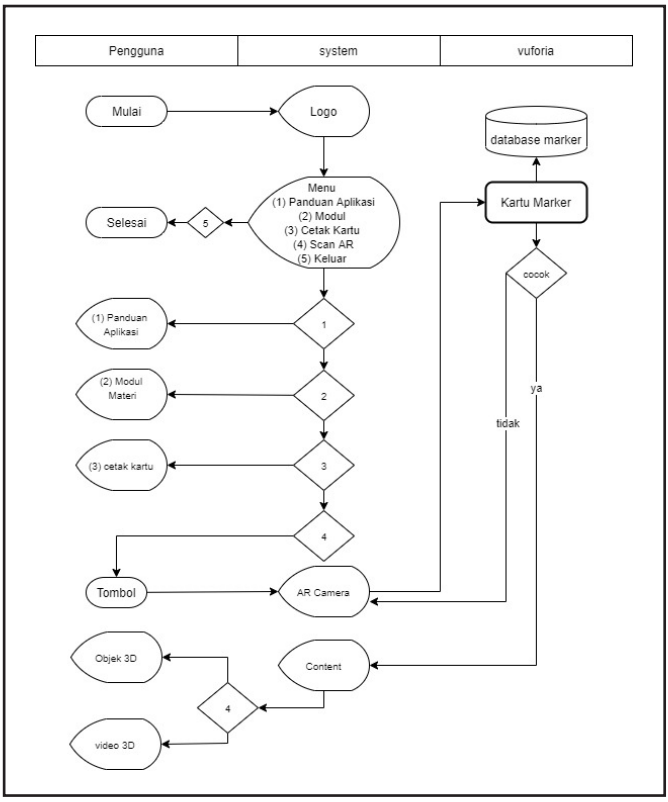

Figure 2:
Application Flowchart Design

online (Giordano, 2015; and Pot, 2018). In detail, the flowchart that has been made, is presented in figure 2.

Secondly, *Application Digital Practicum Card Design.* The DPCs (Digital Practicum Cards) are made using an image processing application, namely Adobe Photoshop. The DPC (Digital Practicum Card) is made based on concepts that are adapted to automotive learning materials. The DPC size is as big as a business card, which is 9 cm long and 5.5 cm wide. The cards made are designed according to the layout and color sketch by paying attention to color aesthetics, then saved in the form of *.jpg extension according to the order of the cards.

After the card design is made, which contains a number of automotive mechanical engineering course materials, then it is entered into the vuforia database. The card made functions as a marker and the image quality is tested, if the saved image gets a three-star rating or more then the card is worthy of being used as an AR (Augmented Reality) application marker.

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Figure 3:
Practicum Card Design

Some of the assessments on the digital practicum card are shown in figure 3.

The practicum card, as shown in figure 3, is an example of a practicum card design. The first card, called engine card 001, functions as a marker that displays a brief introduction to the material. The card can be read through the camera on the Android smartphone device. Based on the results of the marker quality test on the vuforia database storage application, all cards get a five-star value, meaning that the markers made have good image quality.

Thirdly, *App Mockup Design.* The application sketch layout (mockup) design is used to create a process flow for the digital practicum card application display, starting from the logo display, menu, and application usage. The application outline is used to provide an overview of the application that is designed to fit the established concept. The mockup is based on the system architecture that has been created as shown in the application flowchart design. The display design in the form of a mockup is made, so that the application development process using unity or the assembly stage can be made according to a predetermined concept.

The tool used to create a mockup display is a design application that can be accessed online on the www.draw.io web page. The material for practicum learning activities is prepared based on automotive mechanical engineering courses with reference to industry standards, namely the SKKNI (*Standar Kualitas Kerja Nasional Industri* or Industry National Work Qualification Standard). The following are the results of the mockup design for the DPC (Digital Practicum Card) application display that was made,[2] as shown in figure 4 and figure 5.

Material Collection. Material collecting is the stage where the collection

[2]See, for further information, www.draw.io [accessed in Bandung, West Java, Indonesia: November 10, 2020].

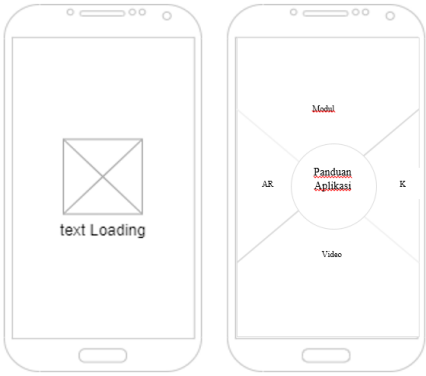

Figure 4:
Mockup Design for Splash Screen Display and Menu Display

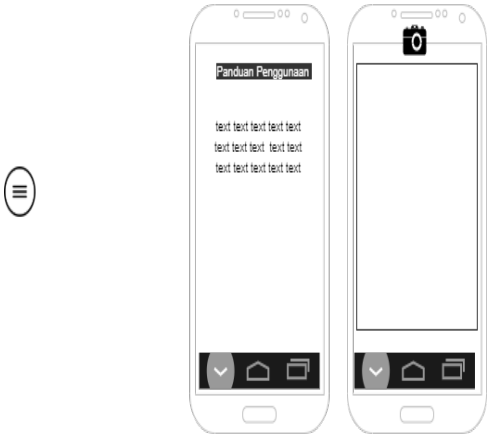

Figure 5:
Mockup Design of the Module View Application and the AR Camera View

of materials according to needs is carried out. This stage is done in parallel with the assembly stage. The materials needed in making this application are as follows: Hardware needed in the form of two units of laptop, scanner, sound recorder, printer. The required software are: Windows 7 64 bit, Unity 3D (3-Dimensional), Adobe Premiere, and Blender.

The material collected in the development of a digital practicum card application is based on industrial competency qualification standards in the form of an introduction to the basic concepts of automotive engineering; basic engine components; how the gasoline diesel engine works; comparison of manual and automatic clutches; power transfer modes; and others.

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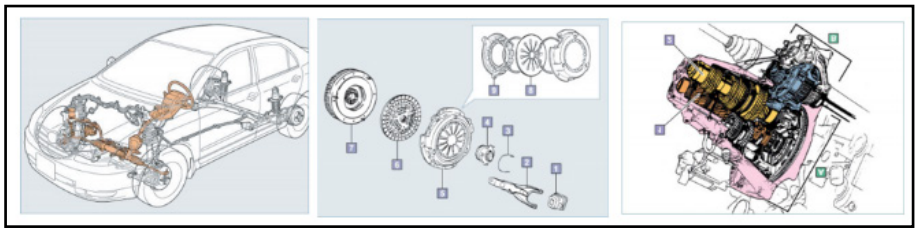

Figure 6:
Material Requirements for 3D Model Applications

Figure 7:
Material Requirements for Animated Video Applications

Photos and pictures are also required to be used as a reference or reference. One example of photos and images used in making a digital practicum card application is shown in figure 6.

In addition to images of materials or assets needed in the development of the DPC (Digital Practicum Card) application, videos are collected from various sources, namely the learn-engineering Youtube channel and other relevant sources. Sources of video material that have been collected are then selected based on the needs and concepts of automotive learning, including video material: (1) Comparison of electric car work systems; (2) Manual Transmission; (3) How manual transmission works; (4) How the clutch works; and (5) Introduction to the ABS, or Antilock Breaking System, brake system (Barry, 2015; Mobasseri & Mobasseri, 2017; and Pot, 2018). In detail, it can be seen in figure 7.

Assembly. The assembly stage is the stage where all multimedia objects or materials are created. Application development is based on the design stage. The assembly stage is the stage of making all the objects

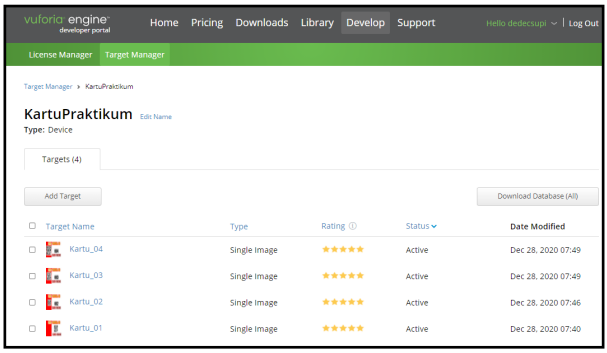

Figure 8:
DPC Marker Database Storage

or multimedia materials created. This assembly stage includes uploading DPC (Digital Practicum Card) markers to the cloud database storage media on *Vuforia*, but first you have to login with a *Vuforia* account. Next, create a database and upload the DPC marker image that was previously made at the card design stage. See figure 8.

After the marker database storage stage, the next stage of making the application is the process of combining all the content that has been created in the previous stage into the DPC (Digital Practicum Card) application. Flowcharts and storyboards of the application user interface that have been made at the design stage become a reference in making applications; application creation is done using Unity 3-D (3-Dimensional) software with the main data storage source used is *Vuforia*, like educational game (Pamoedji, Maryuni & Sanjaya, 2017; Liu, Sohn & Park, 2018; and Rahayu, 2018).

The making of the scene consists of six scenes, namely: (1) Splash Screen; (2) Menus; (3) Guide; (4) Modules; (5) Print Cards; and (6) AR-Camera. The assembly process of application development using unity 3D can be seen in figures 9 and 10.

The development of AR (Augmented Reality) digital practicum cards in virtual laboratories uses several applications, namely assembling applications using unity 3-D (3-Dimensional), designing flow diagrams and application sketches using design applications that are accessed online. The card design uses the Adobe Photoshop application for the design process and is assembled through the Unity 3-D application.

Testing. In this section, we will evaluate the performance of our proposed application, so that the application created can be effectively used in practical learning that is integrated with the e-learning system.

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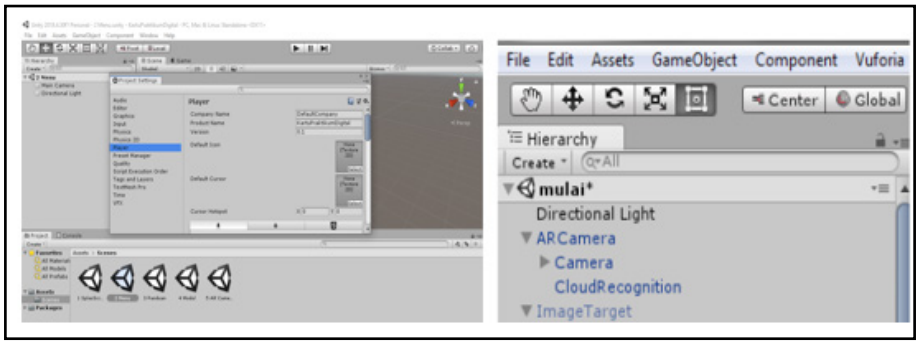

Figure 9:
DPC Application Assembly Process

Figure 10:
DPC Application Display

We ask the automotive course teachers to share applications that have been packaged in the form of DPC.apk. Applications are shared via the Telegram application to students, and a guide to using the application is provided. After the application is installed on a smartphone device, students are directed to use the application and study the material. This test was conducted to find out how effective, easy, and motivated users are when using the DPC (Digital Practicum Card) application to observe virtually through a number of printed marker cards. The user is given the DPCAr.apk application and asks to install it then students are asked to provide feedback on the application used (Rajeswari, 2017; and Griffith, Carruthers & Bliemel eds., 2018).

After that, they were directed to fill out a questionnaire through the google form, after carrying out learning activities through the DPC

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Table 2:
List of Application Test Statements

No	Statement
1.	The digital practicum card application is easy to install on android devices.
2.	The menu design on the application is easy to understand.
3.	Digital cards can be scanned and display material in video form.
4.	3D simulation displayed according to automotive material.
5.	I am very satisfied learning to observe using this virtual 3D object models.
6.	I believe that this tool is able to build transform understanding interactively.
7.	I can repeat the material and learn to observe virtually with this app again.
8.	Fast and accurate marker recognition.

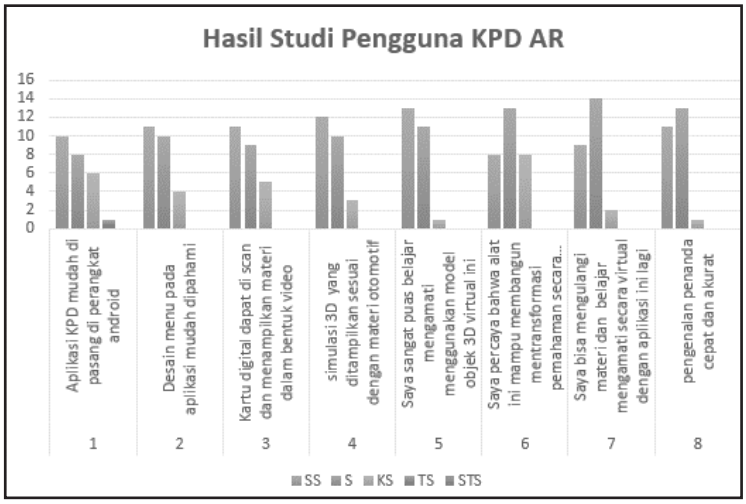

Figure 11:
The Results of Testing the Digital Practicum Card Application

application. Learners are asked to rate statements, namely about learning experiences and their use, on a 7-point scale. The more they agree with the statement, the higher they rate it. The statements are listed in table 2.

Figure 11 explains that question 1 asks users to rate the DPC (Digital Practicum Card) installation that is made to be installed by 72% and gives an appropriate rating and 38% less precise. Statement 2 asked users to rate the design aspects and stated that 84% were easy to understand and 16% answered that they were not appropriate. Statement 3 requested an acceleration of the marker scan speed and stated that 80% stated that the device used could easily read the card with the camera, and 20% stated that it was not suitable. The fourth statement shows that the 3D (3-Dimensional) simulation displayed is in accordance with the automotive material, 88%

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say it is appropriate, and 12% say it is not. Statement 4 of 3D simulations that are displayed are in accordance with automotive materials, 88% say they are appropriate, and 12% say they are not.

Statement 5 of the satisfaction of learning to observe using this virtual 3D object model of 96% stated that it was appropriate and 4% was not appropriate. Statement 6 knowledge construction in learning is very easy to understand by 84% stating it is easy and 16% stating it is not easy. Statement 7 application users can study observations repeatedly by 92% stating conformity and 12% not appropriate. The statement that 8 markers on the card are easy to access and through smart phone cameras, 96% are functioning properly and 4 percent stated that they are not functioning.

Distributing. The stage where the application is stored in a storage medium. At this stage, if the storage media is not sufficient to accommodate the application, then compression is carried out on the application. Distribution of applications to each application platform. Applications with the *.apk file format are distributed through the 3D (3-Dimensional) virtual laboratory web application and will also be published on the google play store.

Discussion. The application of AR/VR (Augmented Reality/Virtual Reality) technology in technical and social learning is very helpful in increasing learning motivation and at low cost in the academic and industrial. Several studies related to the use of AR/VR technology into various fields in education, industrial training, and science (Cawood & Fiala, 2007; Pamoedji, Maryuni & Sanjaya, 2017; and Puggioni, 2020).

The application of AR/VR technology in learning construction engineering, engineering, and architecture showed a significant increase in the use of AR/VR in the AEC (Architecture, Engineering, and Construction) industry from 2017 to 2018. The results showed that the residential and commercial sectors adopted the most of these tools, compared to other sectors; and sectors institution and transportation had the highest growth from 2017 to 2018. Industry experts anticipate solid growth in the use of AR/VR technology in 5 to 10 years, with the highest expectations for healthcare (Cawood & Fiala, 2007; Pamoedji, Maryuni & Sanjaya, 2017; and Noghabaei, 2020).

In the field of tourism, research conducted by B.M.A. Nayyar (2018), and other scholars, found the effectiveness of using virtual technology in guiding hospital consumers, besides that B.M.A. Nayyar (2018) also applied AR/VR technology to the tourism sector (Pamoedji, Maryuni & Sanjaya, 2017; Nayyar, 2018; and Lotfi, Hamblin & Rezaei, 2020).

Research conducted by J.S.H.L.H. Yip (2019), and other scholars, showed that learning videos embedded in AR (Augmented Reality)

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technology can improve the quality of learning, it is tested using pre-test and post-test. This increase is influenced by students' motivation towards learning interest and ease of access to repeat learning that is not understood (Cabero-Almenara *et al.*, 2019; Yip, 2019; and Pujiastuti & Haryadi, 2020).

Learning to use smartphones is currently done online and using smart devices. This is in line with the research conducted by A.M. Naciri (2020), and other scholars, that showed that learning cannot be done face-to-face, due to the danger of transmission of the COVID-19 (Corona Virus Disease-2019), but the strategy must be supported by active, interactive, and fun learning methods and content (Abidah *et al.*, 2020; Coman *et al.*, 2020; and Naciri, 2020).

CONCLUSION [3]

By using the multimedia application development method of MDLC (Multimedia Development Life Cycle), an application called a digital practicum card, called DPC (Digital Practicum Card), has been produced. DPC in a virtual laboratory is very helpful in the online practicum learning process and supports long life learning. This application is very suitable to be applied at this time, considering the government's recommendations and prohibitions for universities to carry out the learning and teaching process at home to avoid transmission and prevent the danger of COVID-19 (Corona Virus Disease-2019).

The DPC virtual laboratory application cannot only provide knowledge to students, but it also triggers student motivation in increasing the quality and intensity of practicum learning through virtual observation activities using DPC. This research can be developed further with a touch of the latest technology that will support fun learning with the touch of the latest technology, namely extended reality.[4]

References

Abidah, A. *et al*. (2020). "The Impact of Covid-19 to Indonesian Education and its Relation to the Philosophy of *Merdeka Belajar*" in *SiPoSE: Studies in Philosophy of Science and Education,* Vol.1, No.1 [April], pp.38-49. Available online also at: https://media.neliti.com/media/publications/316626-

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[4] ***Statement:*** This is to certify that our research is a product of our collaborative effort. It is an original, with some literature review from other sources. Our research is not plagiarized – relevant statements of authors in the literature review are properly cited. We certify further that our research has never been reviewed nor published in any other scholarly journal. This certification is issued on 22nd June 2021 for whatever legal and official purposes it may serve.

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the-impact-of-covid-19-to-indonesian-edu-df1bb916.pdf [accessed in Bandung, West Java, Indonesia: January 10, 2021].
Akçayır, M.G. (2017). "Advantages and Challenges Associated with Augmented Reality for Education: A Systematic Review of the Literature" in *Educational Research Review,* Volume 20, pp.1-11.
Alptekin, M.A. (2018). "Design Concept and Prototype for an Augmented Reality Based Virtual Preparation Laboratory Training in Electrical Engineering" in *Proceedings* of the IEEE Global Engineering Education Conference (EDUCON), pp.963-968.
Ana, A. (2020). "Trends in Expert System Development: A Practicum Content Analysis in Vocational Education for Over Grow Pandemic Learning Problems" in *IJoST: Indonesian Journal of Science and Technology*, Volume 5(2).
Andresen, B.B. (2002). "Multimedia in Education" in *Information Technologies at School: Conference Materials*.
Barry, D.S.O. (2015). "Anatomy Education for the YouTube Generation" in *Anatomical Sciences Education*, pp.90-96.
Cabero-Almenara, Julio *et al*. (2019). "Educational Uses of Augmented Reality (AR): Experiences in Educational Science" in *Sustainability,* Volume 11 [4990], pp.1-18. doi: 10.3390/su11184990.
Cawood, S. & M. Fiala. (2007). *Augmented Reality: A Practical Guide*. USA [United States of America]: Pragmatic Bookshelf.
Coman, Claudiu *et al*. (2020). "Online Teaching and Learning in Higher Education during the Coronavirus Pandemic: Students' Perspective" in *Sustainability,* Volume 12 [10367], pp.1-24. doi: 10.3390/su122410367.
Dede, D. *et al.* (2018). "Virtual Gasoline Engine Based on Augment Reality for Mechanical Engineering Education" in *AASEC Proceedings.* Bandung: EDP Science.
Giordano, D.A. (2015). "Teaching Algorithms: Visual Language vs Flowchart vs Textual Language" in *Proceedings* of IEEE Global Engineering Education Conference (EDUCON), pp.499-504.
Griffith, Selena, Kate Carruthers & Martin Bliemel [eds]. (2018). *Visual Tools for Developing Cross-Disciplinary Collaboration, Innovation, and Entrepreneurship Capacity.* USA [United States of America]: Common Ground Research Networks.
Gros, B. (2007). "Digital Games in Education: The Design of Games-Based Learning Environments" in *Journal of Research on Technology in Education*, pp.23-38.
https://en.unesco.org/covid19/educationresponse [accessed in Bandung, West Java, Indonesia: November 3, 2020].
Kanwar, A.K. (2019). "Changing the TVET Paradigm: New Models for Lifelong Learning" in *International Journal of Training Research*, pp.54-68.
Khosravi, M. (2019). "COVID-19 Pandemic: What are the Risks and Challenges for Schizophreni" in *Psychiatry*, pp.171-178.
Liu, Xinqi, Young-Ho Sohn & Dong-Won Park. (2018). "Application Development with Augmented Reality Technique using Unity 3D and Vuforia" in *International Journal of Applied Engineering Research,* Vol.13, No.21, pp.15068-15071. Available online also at: https://www.ripublication.com/ijaer18/ijaerv13n21_33.pdf [accessed in Bandung, West Java, Indonesia: November 10, 2020].
Lotfi, M.R., M. Hamblin & N. Rezaei. (2020). "Transmission, Prevention, and Potential Therapeutic Opportunities" in *Clinica Chimica Acta,*Volume 508, pp.254-266.
Luther, A.C. (1994). *Authoring Interactive Multimedia*. Boston: AP Professional.
Mobasseri, Saleh & Mohammad Mobasseri. (2017). "A Comparative Study between ABS and Disc Brake System Using Finite Element Method". Available online at: https://hal.archives-ouvertes.fr/hal-01624015/document [accessed in Bandung, West Java, Indonesia: November 3, 2020].
Mustika, M. *et al.* (2015). "Implementasi Augmented Reality sebagai Media Pembelajaran Interaktif" in *CITEC,* Volume 2(4), pp.1-14.
Naciri, A.M. (2020). "Mobile Learning in Higher Education: Unavoidable Alternative during COVID-19" in *Aquademia*, pp.20-29.
Nayyar, B.M.A. (2018). "Virtual Reality (VR) & Augmented Reality (AR) Technologies" in *International Journal of Engineering & Technology*, pp.156-161.
Nduna, N.J. (2017). "Promoting Effective Work Integrated Learning (WIL) and Recognition of Prior Learning (RPL) Practices in the TVET Sector Through Research" in *Vocational Education and Training in Sub-Saharan Africa*, pp.282-297.
Noghabaei, M.A. (2020). "Trend Analysis on Adoption of Virtual and Augmented Reality in the

Architecture, Engineering, and Construction Industry" in *Data*, pp.26-34.
Oram, S.A. (2019). "Mental Health and Violence: Opportunities for Change" in *The Lancet Psychiatry*.
Pamoedji, A.K., Maryuni & R. Sanjaya. (2017). *Mudah Membuat Game Augmented Reality (AR) dan Virtual Reality (VR) dengan Unity 3D*. Jakarta: Elex Media Komputindo.
Pot, Justin. (2018). "The Best Flowchart Software and Diagramming Tools". Available online at: https://zapier.com/blog/flowchart-diagramming-software/ [accessed in Bandung, West Java, Indonesia: November 3, 2020].
Potkonjak, V.M. (2016). "Virtual Laboratories for Education in Science, Technology, and Engineering: A Review" in *Computer & Education*, pp.309-327.
Puggioni, M.P. (2020). "A Content Creation Tool for AR/VR Applications in Education: The Scool AR Framework". *Paper* for an International Conference on Augmented Reality, Virtual Reality, and Computer Graphics, pp.205-219.
Pujiastuti, H. & H. Haryadi. (2020). "The Use of Augmented Reality Blended Learning for Improving Understanding of Food Security" in *Jurnal Pendidikan IPA Indonesia,* Vol.9, No.1 [March], pp.59-69. Available online also at: https://journal.unnes.ac.id/nju/index.php/jpii/article/view/21742 [accessed in Bandung, West Java, Indonesia: January 3, 2021].
Rahayu, S.L. (2018). "Educational Games as a Learning Media of Character Education by Using Multimedia Development Life Cycle (MDLC)" in *Proceedings* in the 6th International Conference on Cyber and IT Service Management (CITSM), pp.1-4.
Rajeswari, S.K. (2017). "A Smart Agricultural Model by Integrating IoT, Mobile, and Cloud-Based Big Data Analytics" in *Proceedings* of International Conference on Intelligent Computing and Control (I2C2), pp.1-5.
Rusmulyani. (2021). "Technical Vocational Education and Training (TVET) Innovation dengan Model Pelatihan Berbasis Kompetensi dalam Pengembangan Soft-Skill Sumber Daya Manusia" in *Jurnal Inovasi Penelitian*, pp.1495-1506.
Sutopo, A. (2003). *Analisis dan Desain Berorientasi Objek.* Yogyakarta: J&J Learning.
Utarbutar, F.T. (2017). "Kajian Signifikansi Faktor yang Mempengaruhi Penggunaan e-Learning pada Siswa SMK Global Informatika, Tangerang" in *Jurnal RESTI*, pp.9-18.
Wang, M.V.R. (2018). "Augmented Reality in Education and Training: Pedagogical Approaches and Illustrative Case Studies" in *Journal of Ambient Intelligence and Humanized Computing*, pp.1391-1402.
www.draw.io [accessed in Bandung, West Java, Indonesia: November 10, 2020].
Yip, J.S.H.L.H. (2019). "Improving Quality of Teaching and Learning in Classes by Using Augmented Reality Video" in *Computer & Education*, pp.88-101.

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