Development of Mobile Learning Applications with Augmented Reality to Build VHS Students' Critical Thinking

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Abstract— **Cameras and photography aids are one of the learning materials in multimedia vocational schools which are still mostly taught by the lecture method and the learning media used are less interactive such as printed books, so the process of understanding the material becomes less in-depth. This learning requires objects in the learning process, but because of the high price of photographic equipment, it is difficult for students to learn it either at school or independently. This study develops a mobile learning media for android about cameras and photography aids based on augmented reality which provides camera object observation features and photography aids in 3D and augmented reality so that it can trigger students' critical thinking patterns better. Assessment with UEQ on this learning media get an average value of Excellent. After using this learning media, students were tested for critical thinking and got the results that 66.6% of the total respondents were classified as high-level critical thinking, 25% classified as moderate level critical thinking, and the remaining 8.33% classified as low-level critical thinking. At the time of developing this learning media, he received advice from material and media experts in the form of navigation improvements, material revisions, and user interface revisions. The future development of this application requires a database system that can make it easier for teachers to manage student data in the application.**

Keywords—Photography, Mobile Learning, Application, Augmented Reality, Critical Thinking

I. INTRODUCTION

Learning media is the teacher's main weapon to convey messages in the form of structured learning materials to students so that they can understand the material and achieve learning objectives [1]. Learning media will give better results if they are designed based on how students learn [2][3].

Learning media is something that teachers need to prepare well because with learning media the material will be more easily conveyed and can be re-learned by students, in this era of the Corona Virus (COVID-19) pandemic, learning media isa major component in a learning process, because during pandemic, formal and non-formal learning processes in Indonesia are carried out online or online, this is done to prevent the spread of the corona virus [4][5]. COVID-19 is a pandemic that attacks most of the world's people, including Indonesia, the first positive case of COVID-19 in Indonesia was detected in Jakarta on March 3, 2020 [6].

Based on research related to learning in several vocationalschools, during the COVID-19 pandemic the learning media used in these vocational schools, especially in the era of the COVID-19 pandemic, were mostly pdf or ppt extension materials sent by teachers via google classroom and the WhatsApp application [7][8], this is done to save quota, materials with pdf and ppt extensions make learning less interactive [9].

The online learning model that is carried out in full is a new condition faced by students so far, online learning poses several obstacles because students' access to printed books or other teaching media is hampered or even does not get access at all [7]. This learning model allows teachers and students to carry out the learning process from a distance or from home, many teachers are not ready for online learning, because online learning requires learning media that supports the distance learning process [10]. The online learning model requires a mobile device such as a smartphone, tablet, or laptop that is used to interact with learning materials and also with teachers or students [4], mobile devices that are widely used by students in the online learning process are smartphones.

Statista Digital Market Outlook conducted a survey of smartphone users in Indonesia from 2015 to 2025, the survey concluded that smartphone users in Indonesia continued to increase starting from 2015 which was only 28.6% of the Indonesian population, 56.2% in 2018, until 2019 smartphone owners in Indonesia continue to increase to 63.3% and is predicted to increase to 89% in 2025 because since 2019 smartphone penetration in Indonesia has grown to 25.9% [11]. Stat Counter conducted a survey on

the Android version circulating in Indonesia starting from June 2017 with the lowest version range being 4.1 Jelly Bean with a percentage of 2.26% of the number of devices and the Android version that is widely used is version 5.1 Lollipop with a percentage of 34.84 devices. %. The Android version continues to develop until January 2021, the lowest version has switched to version 4.4 KitKat with a percentage of the number of devices of 0.97% and the Android version that is widely used is version Android 10.0 with a percentage of the number of users of 33.59% [12].

Based on these data, it can be concluded that most of the Indonesian population already use smartphones, and the Android version found on the smartphones of the Indonesian people on average ranges from version 4.4 KitKat to Andorid version 10.0 this is a good potential for the development of various kinds of mobile applications because most of the the application on the Play Store has at least an Android version ranging from 4.4 KitKat to Android version 10.0.

Mobile learning or mobile device-based learning is a learning media that has the advantage of instant access and can be done anywhere and anytime [13]. Learning in the classroom has limited time so that when there are students who are slow in capturing learning, the teacher needs to repeat the lesson and it takes up a lot of time [14][15].

Mobile learning applied in vocational schools must support student practicum activities because vocational subjects are practice-oriented and students are required to master technical skills [16][17]. Augmented reality is one of the techniques that can be used to help the process of introducing practical material because augmented reality is a technology that inserts digital information such as text, images, videos, or 3D objects into a real environment so that it allows users to interact in real time [18][19][20].

Printing Graphic Design (DGP) subjects are compulsory subjects in Multimedia Vocational Schools and are included in the C3 category in the 2013 revised Curriculum structure in 2018. Based on the KD Multimedia, DGP subjects consist of 19 theoretical competencies and 19 practical competencies. DGP subjects have basic competencies that discuss photographic equipment, namely KD 3.11 (Understanding Types of Cameras and Photography Aids) and KD 3.12 (Applying Digital Camera Operations and Photographic Equipment Maintenance).

The results of observations made in several Vocational Schools for multimedia expertise programs show that schools do not have enough cameras and photography aids for students to use to learn photography, this is something that is natural considering the high price of cameras and photography aids if they have to be purchased in large quantities, so students need to take turns in practicing using the camera [18]. The results of interviews with several vocational high school teachers majoring in multimedia can be concluded that students like DGP learning, especially when practicing using cameras and their assistive devices, although at the time of learning theory he had difficulty explaining the structure and types of cameras and photographic aids which were an old series, let alone a series. the latest, because the tools the school has are the middle-class series that are often used by beginners in learning photography. This problem makes the level of students'

understanding of the camera material and photography aids limited, so they cannot reach a critical understanding.

The results of the questionnaire given to students majoring in multimedia led to a conclusion that students' interest in learning with smartphones, students' motivation to learn subjects related to cameras, and students' interest in augmented reality can be concluded to have a fairly high percentage at 60% to 100% while The number of students who have reached the critical thinking stage is fairly low, which is only 40% of the total number of questionnaires.

The learning process should be able to invite students to practice and learn to think critically [21], critical thinking is a process of thinking in depth by improving the quality of thinking about an information [22]. Critical thinking skills are needed in learning activities, especially on material that is practical and requires a deep understanding of the structure of learning objects such as DGP subjects, especially material on cameras and photographic aids because each camera and photography aids has a different way of operation and application, especially if the brand is different, then a series of critical thinking such as the ability to identify and understand the logical relationship of the basic theory of photography to the working principle of an important tool is owned by students [23].

Learning that can be understood by students to the stage of critical thinking requires the figure of a teacher as an important element to improve the quality of learning [24], to achieve a critical level of understanding, especially in DGP subjects, teachers need a learning media, in the teaching process teachers need learning media that can stimulate the mindset of students to the stage of critical thinking [25].

Based on the description of the problem, a media in the form of an augmented reality-based mobile learning application was developed for camera material and photography aids. The choice of this solution is strengthened by previous research and the research has similar problem details, namely research conducted by I Made Widyana and team, in this study Widyana and the team developed an augmented reality application in learning photo camera recognition, the application is used to support the learning of photography for students of class XII State Vocational High School (SVHS) 1 Ubud [18].

The augmented reality application that will be developed in this study has a menu that is almost the same as the application in the research of I Made Widyana and the team, namely there are learning materials, augmented reality scans, and learning videos, but in this study an additional feature was developed in the form of an object menu that can be used. used to observe 3D objects directly without activating augmented reality cameras and without using markers, besides that the learning material in this application is not only about cameras but also about photographic equipment and how to care for them, so that augmented reality objects are also more than research. previously, so that the learning media that were previously in the form of ppt material, pdf modules, or BSE that do not yet support the complete visualization of learning objects with the development of augmented reality-based mobile applications are hoped to be a medium for fostering a critical mindset towards defense material. range of cameras and photography aids so that students understand better because they can observe the object of learning directly.

II. LITERATURE REVIEW

A. Learning Media

Learning media are everything that can be used by teachers to convey messages to students, so that they can stimulate the thoughts, feelings, and interests of students to learn [26]. The term media comes from Latin which literally means intermediary or introduction, the term media is very commonly used in the field of communication, therefore learning media is a medium used to communicate the learning process so that it can achieve learning objectives [1][27].

Learning media is an important component in the learning process because learning media are intermediaries that can clarify the presentation of messages or information from teachers to students so that they can facilitate the learning process and improve learning outcomes [28].

Learning media is a method or method used to convey material in the teaching and learning process, learning activities require a variety of learning media in order to increase interest in learning for students [29].

B. Mobile Learning

Mobile learning or mobile device-based learning is a learning media that has the advantage of instant access and can be done anywhere and anytime [30]. Mobile learning is learning that is carried out on the basis of mobility, mobile learning systems take advantage of the mobility properties of mobile devices or mobile devices such as smartphone [31][32].

Mobile learning is learning that involves the use of mobile device technology to obtain various information in the form of theoretical learning materials and practical learning so as to produce a change in the behavior of the users [33].

Mobile learning or mobile learning means learning through mobile devices such as smartphones, tablets and PCs. Mobile learning offers students the opportunity to engage in asynchronous instruction, wherever it is [34][35].

C. Augmented Reality

Augmented Reality (AR) is an environment that combines the real world with the virtual world, AR is a new way to overlay the real world with virtual world components [20].

Augmented Reality (AR) can be interpreted as a technology that combines 2D or 3D virtual objects into the real world, these 2D and 3D objects can be projected in real time [18]. Augmented reality is a suitable technology to be applied in the field of education [36][19]. Augmented reality can help students in observing and studying topics or events that are difficult to observe with the naked eye, such as microscopic objects or objects that are difficult to reach due to high prices or rare items [37].

D. Critical Thinking

Critical thinking ability is the ability to think at a high level so that it can solve problems systematically [38]. Critical thinking is a pattern of thinking that can be used in everyday life to solve problems in terms of interpreting, reasoning, and evaluating information so that the resulting decisions are valid and reliable [39].

Critical thinking skills are thinking skills that involve cognitive processes and teach students to think reflectively on a problem, critical thinking processes involve inductive thinking skills such as analyzing problems, recognizing relationships, determining cause and effect, calculating relevant data and making conclusions [40].

The ability to analyse, evaluate, organize information is a component of critical thinking skills aimed at making decisions and taking action to solve a problem [41]. Critical thinking is an ability that can help students in solving social problems, scientific problems, and practical problems effectively [42].

III. METHOD

The method used in this research and development is Design Thinking, this research focuses on the field of education, namely to develop an augmented reality-based mobile learning media that is applied to vocational students. Design Thinking is a development method that is suitable to be applied to the education sector, especially in the field of STEM (Science, Technology, Engineering, and Mathematics) [43], because Design Thinking is a collaborative method from many disciplines so that it gives birth to many ideas to create a product or obtain a solution to a problem [44].

The Design Thinking method (Fig. 1) has 5 stages of development, namely empathize, define, ideate, prototype, and test [45].

The test stage is an application test activity that has been developed, but before the application is tested on students, the application must be tested to material experts and media experts first to get validation about the suitability of the learning materials contained in the application and get validation about the feasibility of the learning media used. has been developed.

The application will be tested on students using the User Experience Questionnaire method which is carried out online, this method is an easy and efficient questionnaire to measure the User Experience (UX) of students, this method measures the level of user experience or UX through 26 elements categorized in 6 rating scales, namely Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. [46].
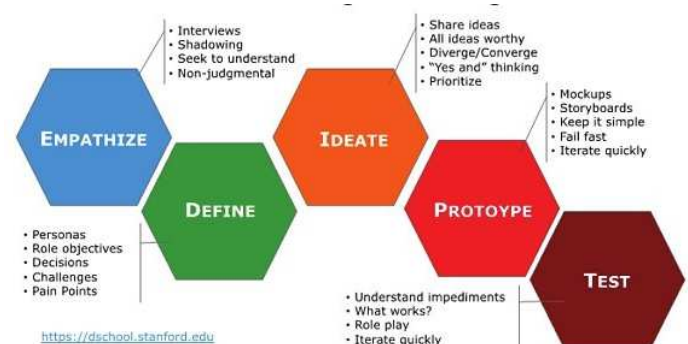

Fig 1. Phases of the Design Thinking Process

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IV. RESULTS AND DISCUSSIONS

A. Application Description

This Came.ar application was developed in order to make it easier for vocational students to learn camera material and photography aids in Printing Graphic Design subjects, this learning media consists of basic competencies (KD) 3.11 to 3.12 learning materials which contain material about the types and ways of maintaining cameras and tools. photography help. This camera learning application and photography aids called Came.ar was developed for mobile smartphone devices with the android operating system, augmented reality is applied to this application to provide an experience of observing learning objects in three dimensions so as to help construction of critical thinking patterns for Multimedia Vocational High School students, especially in camera learning and photography aids.

B. Design and Development

The home menu on the Came.ar application consists of 4 parts, namely the header, material slideshow, quiz slideshow, and menu button.

The scan menu contains 2 sections, namely "AR Scan Button" which is used to open the manual page to operate the augmented reality feature and "AR Mode Activate Button" to activate the smartphone camera and move to the "AugmentedReality Scan" page.

The "Scan Augmented Reality" page consists of 3 main components namely "Scan Indicator", "Zoom Button", and "Rotate Button".
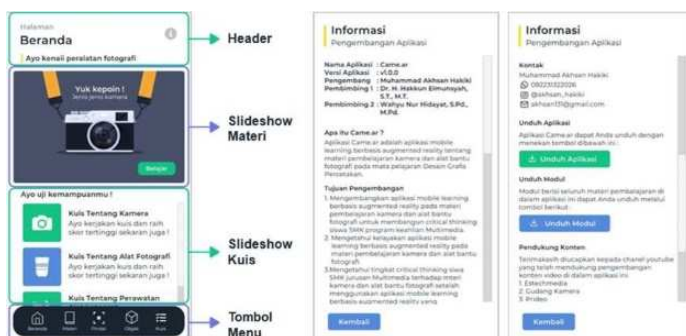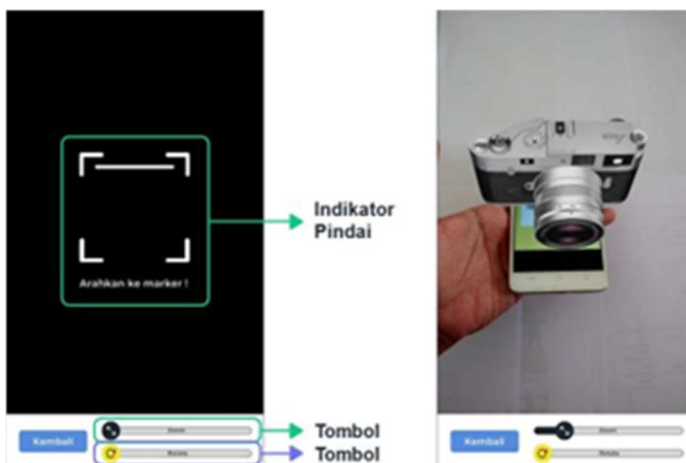

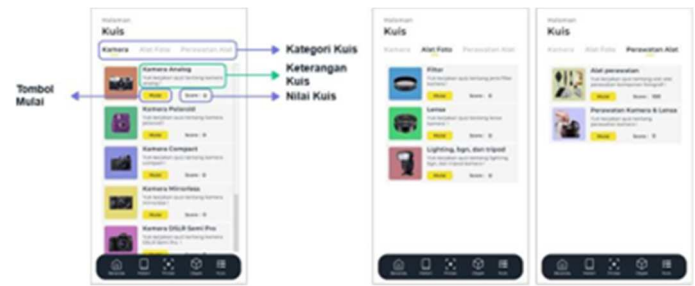Fig 2. Home Menu

Fig 3. Scan Augmented Reality

Fig 4. Quiz Menu

C. Data Presentation and Analysis

Material expert validation is carried out before the application product is tested to users, the material expert whovalidates is the Multimedia Department Vocational High School teacher. The material applied to the Came.ar application falls into the Very Valid category, the results of the material expert validation are summarized.

The Came.ar application before being tested on users is validated by media experts first, the media experts who validate are competent lecturers in the field of learning media development, especially Augmented Reality, the Came.ar application is in the Valid category.

The Came.ar application has been assessed as valid by material experts and media experts and is suitable for use as alearning medium, then the Came.ar application is tested for its user experience level by distributing questionnaires to Multimedia Department Vocational High School students who have used the Came.ar application.

Based on these benchmarks, it can be concluded that the Came.ar application has a very good user experience assessment result with a value above the average. The assessment was divided based on 6 scales, 5 scales received the Excellent predicate, namely the "attractiveness", "efficiency", "accuracy", "stimulation", and "novelty" scale and the remaining 1 scale, namely the "clarity" scale, received the Good predicate. The following is a graph of the UEQ Benchmark in Fig. 5 to simplify the analysis and reading process.

The level of critical thinking is measured through case study questions that students do after using the Came.ar application, the following are the results of measuring students' critical thinking levels, presented in Fig 6.
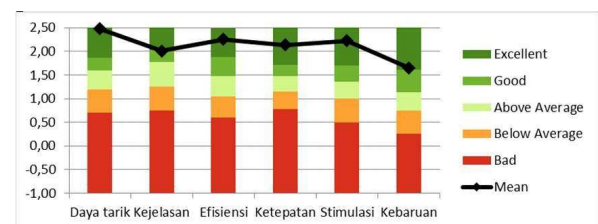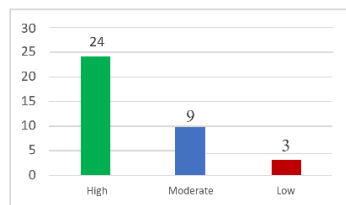

Fig 5. UEQ Benchmark

Fig 6. Distribution of students' critical thinking skills after using the media

Based on Figure 6, it can be concluded that there are 24 students or 66.66% of the total respondents have fulfilled most of the critical thinking aspects or can be interpreted as belonging to a high level of critical thinking, and there are 9 students or 25% of the total respondents classified as having moderate level of critical thinking, and only 3 students or 8.33% of the total respondents belonging to a low level of critical thinking. So it can be concluded that the criticalthinking level of most of the class XI VHS Multimedia majors after using the Came.ar application belongs to the high criteria. [47].

V. CONCLUSIONS

Came.ar is a mobile learning application designed to help vocational students learn camera material and photography aids, this application is designed based on augmented reality to make it easier for students to understand the object being studied.

The results of the validation and testing that have been carried out have concluded that for material expert validation the validation results are 94% with the "Very Valid" predicate, for media expert validation the validation results are 84.37% with the "Valid" predicate, for user trials experience with UEQ received an Excellent benchmark predicate for the attractiveness, efficiency, accuracy, and simulation scale, while for the clarity and novelty scale received the Good predicate, and for the critical thinking test the final result was that 66.66% of students received the high critical thinking predicate, Another 25% of students received the title of Moderate critical thinking, and the remaining 8.33% belonged to the predicate of low critical thinking.

Based on the analysis that has been made, it is concluded that the learning media that has been developed is valid, the user experience is good, and is feasible to be used as a tool in building critical thinking patterns in camera learning materials and photography aids.

The Came.ar application still requires further development, such as adding an online user database, optimizing application content so that it is smaller in size and of better quality and reduces user quota consumption.

ACKNOWLEDGEMENTS

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