Exploration of the augmented reality model in learning

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Abstract. Augmented reality is a technology that integrates virtual content into real environments in the form of mobile and desktop. This technology has begun to be developed in various fields, even as a learning medium with various models. We are exploring augmented reality models that have been developed by reviewing several journals related to augmented reality. We have collected 100 journals from various data sources with augmented reality keywords. We select 41 journals and we find 5 augmented reality models, including 3D models, 3D simulations, 3D animations, video models, multimedia models. There are two types of augmented reality, using markers and without markers, for augmented reality using markers requires a marker as a trigger for the emergence of augmented reality objects into the real environment, while augmented reality without markers does not require markers to trigger the emergence of augmented reality into real environments.

1. Introduction
Augmented Reality is a technology that integrates virtual content with the real world, which is efficient and able to enrich one's individual perception in studying abstract and complex subjects [1-4], so users can see and interact with these virtual objects in the real world [5]. The emergence of augmented reality (AR) was estimated in 1968, then developed for the first time to convey basic flight information to pilots and crew [6]. AR is different from Virtual reality (VR) if AR is used to combine a person's perception of the real world with digital content [7]. VR combines multimedia in it, including 360 videos, 3-dimensional interaction, stereo video, which produces a virtual environment where users can feel intuitive feelings and interact with virtual objects [8,9].

Augmented reality has 2 categories for visualization, namely using markers and without markers [10]. Markers are computer graphics symbols that are made and printed on a piece of paper which is a link between 3D models and smartphones [11]. Furthermore, the AR system will look for predetermined patterns to identify matches and reference positions, then visualize information virtually (sounds, images, 3D models, etc.) [12]. Meanwhile augmented reality without markers uses pop code to place digital data into images that have been made [13].

In recent years, augmented reality has become an important topic in research, it can be seen from the increasing results of research each year [14]. Augmented reality began to be used in various scientific fields, including the fields of health [15], science [16], construction [17], and education [18]. In the field of construction, 3D model visualization is able to provide an understanding of project documentation [17], in the world of education, augmented reality is used as an interactive medium for learning [19], which is easy to use and provides support to operate on a smartphone device [20]. The use of mobile devices and augmented reality applications can bring students motivation to learn [21], in addition,
augmented reality is also able to improve the performance of students, able to shorten practice time, making it possible to discuss more [20, 22]. However, AR technology has weaknesses in terms of detail [23], in addition to students who have high learning achievement less impact on their learning outcomes [24]. The purpose of this review is to explore augmented reality models in learning that can be used as a reference in research.

2. Theoretical framework
Multimedia learning theory explains how augmented reality has the potential to improve learning [25]. The multimedia principle states that students learn better by using words and pictures rather than just using words [26], which means that in presenting learning material that is relevant to integrating multimedia (video, image text) can improve student performance and induce students from less important cognitive load [27]. The theory can be expanded into augmented reality annotations by making two changes, namely: (i) images are replaced with real object systems, (ii) words are replaced with symbols and virtual text [28].

Augmented reality is a technology that can be used as a learning media based on a smartphone or desktop [29, 30]. Smartphone-based Augmented Reality or what can be called mobile augmented reality, use smartphones as a link between the virtual world into a learning environment, making it possible to learn anytime, anywhere [31]. Likewise, with desktop-based augmented reality that uses a computer device (PC) as a medium to visualize its virtual model [22, 30]. With 3D visualization produced by augmented reality, it makes it easier for students to understand the material they are studying [26, 32]. Augmented reality that is used in learning aims to facilitate students and provide new experiences in learning [33], which in the end augmented reality helps students manage their learning time in collaboration and independent learning [34].

3. Method
To obtain relevant articles, we use the keywords Augmented reality, augmented reality in learning, augmented reality in education, virtual reality, ICT for learning, and multimedia, the keywords augmented reality produce more and more comprehensive article findings on augmented reality, starting from the development of augmented reality to its implementation. The electronic databases used to support this research are ScienceDirect, Taylor and Francis, IEEE, Springer, Wiley, and Google Scholar. We used relevant journals as far back as 10 years, ranging from 2008-2018 and 1 supporting journal in 1997.

From the keyword "augmented reality" used in one of the electronic databases, namely ScienceDirect, we found 25,728 journals. Next, we filter more than 100 journals from various databases to be examined and understood in detail in order to obtain the suitability of the information needed. The journal that we selected is related to augmented reality models that have been developed by several researchers, the implementation of augmented reality and how to obtain data from these implementations. We also create a journal collection format and write it manually to make it easier to find supporting information when needed, table 1 below is an example of the journal collection format we made. For the method of developing augmented reality is not included in the discussion in this study.
3. Results

4.1. Augmented reality model

Augmented reality has been used as a learning medium with various models that have been created and developed by researchers who are adjusted to the level of education, ranging from early childhood education [37], elementary school [38], junior high school [39], high school [40], up to college [41], there are even studies that use augmented reality in the education of children with special needs [36]. From 100 journals collected, we reviewed 41 journals, we found various types and augmented reality models that have been created and used by researchers in learning including 9 augmented reality 3D models, 12 simulated 3D journals, 5 animated 3D journals, 3 journals in the form of videos, and 12 multimedia journals, which means that the developed media contains more than 1 augmented reality model.

4.1.1. 3D augmented reality model. 3D shaped augmented reality only displays 3D models on a smartphone device that can be rotated as well as scale and perspective sizes that can be changed with hand gestures on the smartphone directly [42]. It has been explained previously that augmented reality has 2 categories, namely using markers and without markers, using markers or not on the 3D AR model that has been made by researchers adjusted to the needs. There are three stages in making 3D augmented reality, the first is creating a physical model, the second is creating a virtual model, and the third is making them visible in AR applications using computers and smartphones [43]. 3D marker augmented reality model that has been created to display a product, the visualization of augmented reality 3D building appears in the setting/background of the real environment using mobile devices [17], there is also 3D visualization in real-world settings using cameras and computer devices [44]. Augmented reality by using a marker as an intermediary to bring up a 3D shape using a smartphone [42]. The 3D model

Table 1. Logbook journal.

| No | Research | Participant | Context | Method | Findings |
|----|----------|-------------|---------|--------|----------|
| 1  | Mobile augmented reality for teaching structural analysis. Yelda Turkan et al. [35] | 43 participants, consisting of junior, senior, and alumni levels. | The study was conducted in 2016 | - Pretest- Posttest - Survey | In this study, AR is used as a learning media, and the learning outcomes using AR do not improve student learning outcomes holistically, but the operational ease of AR provides increased experience in learning the concept of structural analysis. |
| 2  | Integrating augmented reality technology to enhance children learning in marine education. Su-Ju lu, Ying-chieh Liu [24] | 51 elementary school students from 2 schools in Taipei. | The study was conducted in 2010. | - Pretest- Posttest - Questionnaire | AR does not have a significant impact on student motivation, but it is effective in improving the performance of students with low achievement. |
| 3  | Augmented reality-based video-modeling storybook of nonverbal facial cues for children with autism spectrum disorder to improve their perceptions and judgments of facial expressions and emotions Chen-Hsu Chen et al. [36] | 6 children with special needs, consisting of 5 men and 1 woman. | The study was conducted in 2014. | - Questionnaire - Interview | AR that is used is able to attract students’ interest and teach students to recognize emotions in facial expressions. |
appears automatically after the smartphone device detects the marker label accordingly with the location of markers that have been made and printed on paper [4,45], using tracking techniques with markers will make the operation of AR easier to use [46]. A marker using the previous sheet has been made a pop code so that the 3D model will appear according to the pop code area [19].

4.1.2. Simulation augmented reality 3D model. The 3D shaped augmented reality simulator model allows users to visualize the surroundings in a real way through a device that is attached to the head, which then displays a virtual model on the screen right in front of the eye [22], there is also using google glass [47], but not only that, there are also AR simulator model which uses a camera mounted on top of the computer screen [3,39,48]. In augmented reality simulator models can use markers or not, according to the simulator model and the material to be taught. Example of an augmented reality simulator model using markers that have been developed for learning structural analysis [35], electromagnetic concepts, AR is used to visualize abstract [49]. The augmented reality with this simulation model the aim is to provide understanding by simulating a movement, loading or other abstract concepts into 3D [35,50-52]. Example of a markerless simulator that has been developed for learning, an augmented simulation model is used in the medical field related to the eye [22], The user is visualizing a model that is enlarged with hand movements to change the vector size with the help of a camera and computer screen [3]. The Augmented reality simulator model is used for learning activities that allow users to visualize abstract forms into 3D models in virtual form. This system can make virtual models appear in real-time where users can select and make observations directly [22,39]. It can be interpreted that the augmented reality simulator model that has been developed by several researchers both using markers and without markers has the same purpose, namely simulating an event or object into a 3D form that is connected with the real world.

4.1.3. Augmented reality 3D animation model. Augmented reality in the form of 3D animation is a 3D shaped model that can move, allowing users to see movement in more depth and from a different perspective, thereby reducing the cognitive load of students due to viewing abstract information through animated 3D models [37,53,54]. What distinguishes augmented reality model 3D animation with augmented 3D is that 3D animation can move while 3D AR without animation only shows a 3D model without motion. Animated 3D augmented reality model using markers that have been developed to help and know bacterial characteristics [55]. AR animation will provide dynamic demonstrations and information through markers tracked using AR hardware. Example of hardware that can be used to view/display 3D augmented reality animation. Hardware settings for displaying 3D animations to the private screen like mouse and keyboard become assembler tools and controls to play, pause, and playback animations and move virtual images in real conditions that are enlarged [56]. Virtual reality head-mounted display (HMD) with a small video camera mounted on the eye area. HMD is able to capture images on markers [55]. Example of an augmented reality 3D animation model without using a marker, where users can see animated 3D objects appearing at a real location at that moment [57,58], can be seen where silhouettes appear on the scanned location using AR to study [59].

4.1.4. Video augmented reality model. In this model the video is embedded in the augmented reality program, users can use the mobile application to find and unlock augmentation keys by pointing the tablet camera to trigger images that can be real objects in the surrounding environment [27]. This model can load videos in real form or videos in 3D. example of an augmented reality video model in the form of a storybook, in this case, the AR system will run the application when a user takes a tablet PC and points in front of the storybook, this system will display the virtual video shown in the book to represent the direct moments that occur in the scenario [36]. Notes in the notebook will be the trigger for showing videos [31]. Another example 3D video model that has been developed in a sewing workshop, the 3D video appears when a smartphone device is directed to a trigger image [18], which means that AR is designed using visual markers of physical objects that can be recognized by the AR system. The
augmented reality software allows users to see virtual reality originating from data embedded in physical markers, which helps users to see virtual images in a real way [54].

4.1.5. Multimedia augmented reality model. Multimedia-shaped Augmented Reality, herein in one augmented reality application consists of a combination of various media, can be 2D images, 3D models, animation, games, videos, simulations, [37,54,60-64]. Augmented reality multimedia model, allows users to learn through various types of media models in one augmented reality application [27,29]. Multimedia integration makes it easy for users to access various information needed directly in virtual form anytime anywhere [23,65,66].

5. Conclusion
Augmented reality is a 3D technology that can be used as a learning media in the form of cellphones or desktops using markers and without markers. The augmented reality model also varies from only 3D, 3D simulators, 3D animation, video, and multimedia, which each model is adapted to the research objectives. There are two types of augmented reality, the augmented reality using a marker and without markers. For augmented reality without markers, augmented reality objects can immediately appear in the real world without having to do a scanner on markers, while augmented reality using markers requires markers as a trigger for objects to appear in the real world.

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