MOBILE-BASED AUGMENTED REALITY FOR LEARNING 3-DIMENSIONAL SPATIAL BATIK-BASED OBJECTS

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Abstract

This study aims to develop an Android-based application in learning Batik to improve spatial intelligence of students in Indonesia. Along with the application development, pre-test and post-test are also administered to see whether students' spatial intelligence improves or not. The results show that the application is user-friendly since almost all students have Android-based smartphones so that they have no problems in using the application. They already understand that to use the App, the first thing they have to do is login with matching using usernames and passwords. Camera will be automatically activated once the login is successful. 2D and 3D objects will be reflected into Batik patterns by this App; however, if the object is only in a 2D form, the pattern will be unidentified. Considering those results, it can be concluded that the application is such a user-friendly learning medium for the students. The application also contributes to the learning process to become more interactive so that it is no longer teacher-centered.

Keywords: Augmented reality, Batik Indonesia, Local wisdom of batik, Vocational high school.

1. Introduction

Batik, a decorated cloth using wax and dye, has been established as a World Heritage Typical of Indonesia by UNESCO in 2009 [1-3]. Batik contains at least

three essential elements, namely artifacts, cultural values, and local wisdom elevated to a pattern as sociofact and moral/ ideas to be conveyed to the general public [4]. Due to its unique potentials, the use of batik in an educational context becomes important to be studied. The philosophy of batik introduces the elements of local wisdom, which is a function to improve a sense of local and cultural awareness among students.

The urgencies to develop spatial intelligence through Batik-based objects are to prepare students to be skillful human beings who are ready to face the 21st century. Character building can be also done with the learning of spatial intelligence. Improving students' spatial intelligence through Batik objects is one of the ways to preserve students' local wisdom which is an important part of character education.

Teaching and learning processes require some media to help students [5]. Learning media developed should be attractive so that learning process is interesting. Through media, teaching materials can be introduced to the younger generation with a more interesting and joyful way while, at the same time, integrating the latest technological developments. One technology that can accommodate these elements is the Augmented Reality (AR).

Nowadays, the use of AR technology in learning has been more widespread. It is seen as a pedagogical tool [6] and didactic tool [7] which possesses advantages because it contains interactive elements [6, 8], attractive [9-11], evocative [9], edutainment [12], and fun [8]. Learning that utilizes AR technology is loaded with a blend of learning theories and teaching methods that have a positive impact for students, such as improving spatial skills [13]. Spatial ability was meant insight into the ability of the room [14], where learners by using AR are trained to understand the space environment. Environment in this context is the natural environment of flora and fauna, historical sites, etc. The environmental richness will be translated in the patterns. Spatial ability in this case is the ability to translate the surrounding environment both material and non-material as a source of inspiration in designing batik. The first large-scale study (215 students) that analyzed whether spatial ability can be trained using an AR application and which specific aspects of spatial ability can be improved [15]. AR technology that is utilized in the study is able to present immersive learning experience [12, 16], the use of multimedia through Cognitive Theory of Multimedia Learning is able to motivate students to learn better [17-19]. The principle of situated learning is being able to develop the skills of learners in a setting resembling the actual environment [20] and based on natural feature [21]. It also contains principles of discovery learning that is capable of impacting on the emotional impact (see & feel) that will greatly assist learners appreciate teaching materials [22].

This study aims at developing AR for learning in Batik in improving students' spatial intelligence. The AR, which is an Android-based application is called Augmented Reality Batik Ikonik (ARtikon) Joyful. ARtikon-Joyful is designed as a medium of learning to introduce local wisdom of the philosophical values of batik. ARtikon-Joyful was used in batik learning in a special school. Moreover, AR technology in this study is used as a tool to introduce Batik so that the students will have better spatial intelligence. In addition to developing the application, this study also investigates whether learning Batik using this application can improve students' spatial intelligence. 26 students are involved to

be the respondents of the study. Their spatial intelligence is tested (pre-test) prior to learning using ARtikon-Joyful. After they have used it, their spatial intelligence is re-tested in the post-test to see whether their spatial intelligence is improving or not. In this study, it is also effective that learning Batik to improve students' spatial intelligence using ARtikon-Joyful will make learning more interactive so that it is no longer teacher-centered.

2. Material and Method

2.1. Data collection

To collect data, there are two instruments employed. The first instrument is the Android-based application namely ARtikon-Joyful implemented in the learning process. The other instrument in this study is a test measuring students' spatial ability. The test is conducted two times in pre-test, before the students use the application and in post-test, after they use the application.

2.2. Augmented book development

Prior to the development of the application, an augmented book was developed using Adobe Illustrator application which is a simple tool to make illustrations. The book was created to support the application and functioned as the location marker of AR application. This book was also created to help learners operate the application, which consists of batik patterns with their philosophy. Pictures were used as markers in the application, and learners search the markers in the application by a scanner installed in mobile phones to run the application.

The augmented book has a collection of batik motifs and markers. A number of batik motifs were from Sumedang as they have unique motifs that represent strong cultural values of Sundanese. The motifs were used in the project of AR development were the motifs of *Cadas Pangeran, Tjut Nyak Dien,* the flowers of *Wijaya Kusuma,* Lotus flowers*,* and *Naga Junun Jucung*. The markers, meanwhile, were pictures created using Vuforia SDK which can be detected and traced by the application. These markers have colors, unlike matrix data codes, QR codes, and traditional fiducial markers which are black and white. The images can be used as markers after they are uploaded as target manager into the database previously provided by Vuforia. The target manager can be accessed from https://developer.vuforia.com/target-manager.

2.3. ARtikon-joyful application

The development of ARtikon-Joyful application involves several steps. Firstly, the video story board of batik Sumedang philosophy was created, then video was made by using Adobe Premiere and Adobe After Effects. Secondly, 3D modeling of batik motifs was created by utilizing Blender software. The modelling includes the 3D building for *"Dendles & Pangeran Kornel," "Bunga Wijaya Kusuma," "Makam Tjut Nyak Dien," "Quran," "Pedang," "Kujang," "Naga Junun Jucun,"* and *"Bunga Teratai"*. Finally, the application was created using "Unity3D" software, which can be found for developing user-friendly multi-platform games [23]. Before using Unity3D, SDK extension of Vuforia should be

installed to get Augmented Reality features. The SDK extension can be downloaded in Vuforia website (https://developer.vuforia.com/resources/sdk/unity). The steps are:

   i. Some of the files have been imported into Unity3D. Those files are Vuforia-unity-6-2-6 unity package which is the unity package for working in mobile application; The markers (image targets) that have been downloaded with .unitypackage format (see: Augmented Book Development); Video with .mp4 format; and 3-dimensional modeling with blend format.

  ii. Creating a number of scenes on Unity3D which are saved in Assets folder.

 iii. Every scene in Unity3D consists of AR camera, image target (markers), and directional light. Image targets are set in Image Target prefab and change the dataset to database of markers.

  iv. In order to play videos, a video player has to be created.

   v. The last step is building process in Android platform. ARtikon-Joyful application set in player settings on API Level Android 4.2 (Jelly Bean). Then, android application is ready to be built and run. The result of application will be in apk format.

3. Results and Discussion

3.1. Implementation and experimentations

Figure 1 shows the algorithm process in designing the application. When starting the application, we will see Login. Then, username and password must be added for security. If the username and password do not match, the app will be back to Login menu. If login is successful, the camera will be activated. The camera will identify whether there are 2D and 3D pictures. If it is only 2D, errors will happen.

When the software is downloaded, there will be information on application operational success (see Table 1). In this table, there will be six aspects. To indicate that the software is successfully downloaded and is able to be operated, there will be "confirm" and "check-list" columns. This first aspect is related to installation process to Android-based smartphones. The second aspect is related to whether the application can run well or not. The third one is notifications telling if usernames and passwords are correct and also the LOGIN form. The fourth step is camera testing to detect markers. The fifth step is testing video players to identify audio and video files. The last step is testing the Play, Pause, Exit, and Stop in video players.
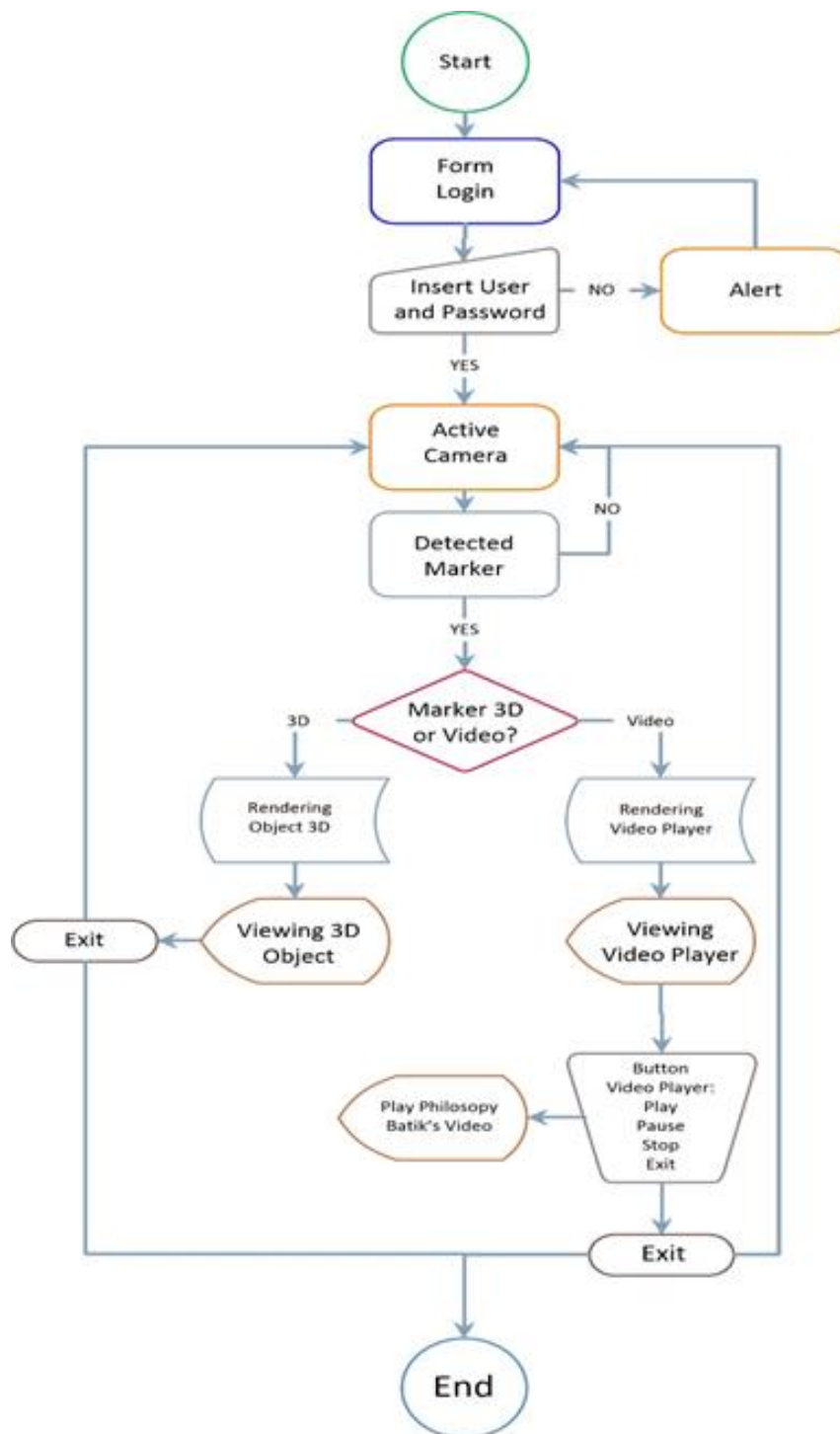
Fig. 1. Flow chart of ARtikon-joyful application.

Table 1. Test results of Artikon-joyful application.

No	Test	Expected results	Test results	Validation
1	The installation of APK files	Installation process to android-based *smartphones*	Confirmed	√
2	Run the installed application	Application can run well	Confirmed	√
3	Submit unregistered LOGIN FORM	Notification that username and password are incorrect and return to LOGIN FORM	Confirmed	√
4	Submit registered LOGIN FORM	Camera is active to detect markers	Confirmed	√
5	Marker detection	3D objects or video player will show if markers can be detected in the database	Confirmed	√
6	The functions of exit, play, pause, stop buttons in video player	Exit: close the video Play: start video Pause: pause video Stop: stop video	Confirmed	√
	Conclusion		**Confirmed**	**Valid**

Figure 2 shows the main interface of ARtikon-Joyful, a software developed based on Android operating system. In the first appearance of the menu, there will be several pictures indicating how to use the application. There are three steps explained in Indonesia language. The first button shows "*Buka Aplikasi*", which means open application. The second button tells "*Letakkan Marker pada Bidang Datang*" which functions as to put objects on the flat surface. To make sure that the marker can be read, the lighting should be adequate. The last button on the interface is "*Arahkan Kamera ke Arah Objek Marker*", which functions to shoot the camera to the object marker.

Fig. 2. The main interface on ARtikon-joyful.

The results of the use of the software can be seen in Figs. 3-5. Figure 3 depicts the appearance of Cadas Pangeran Batik. In the meantime, Figure 4 shows the results of the software to reflect the 3D-Batik version of a dragon pattern. That is how the application works to reflect objects using the markers so that it can finally show the Batik version in 3-dimention. Thus, the software should combine between 2D and 3D objects so that the pattern can be reflected in the software. If the objects are not complete, the reflection in the software will be unidentified (see Fig. 3).
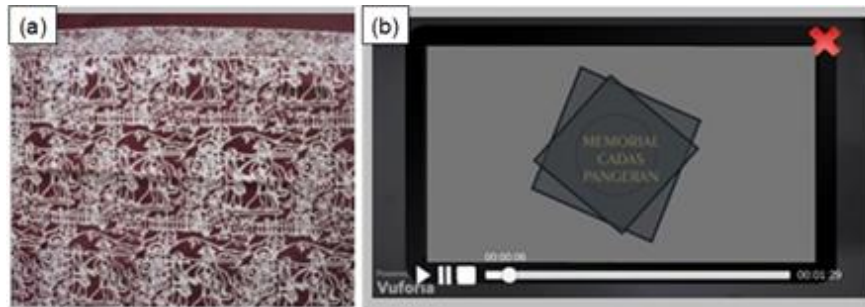

Fig. 3. An example on using ARtikon-Joyful
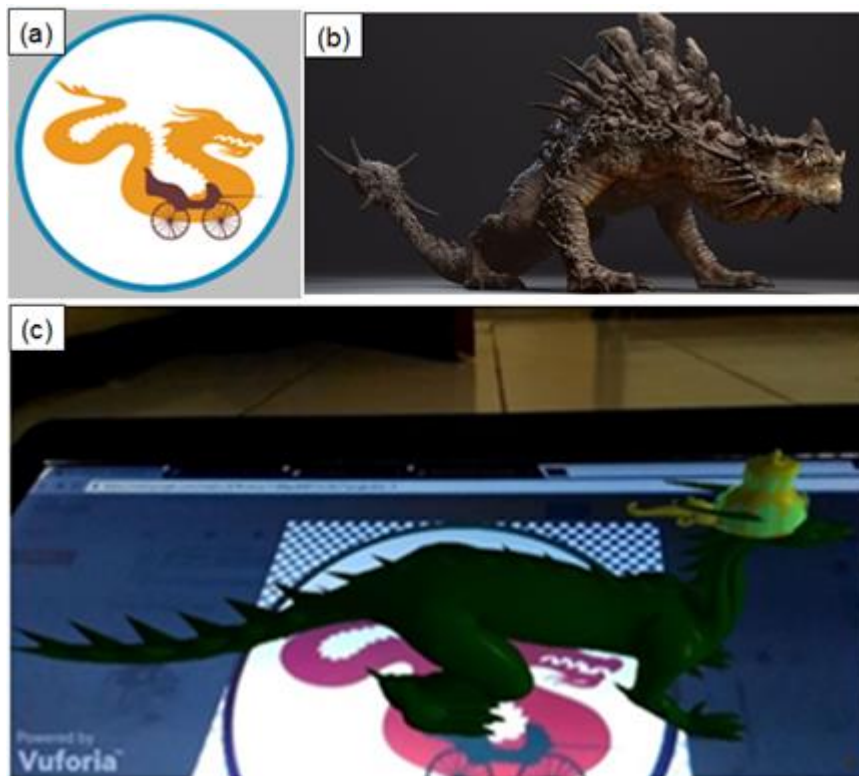**when using only 1 single 2-dimensional object.**

Fig. 4. Combination of 2- and 3-dimensional object using ARtikon-joyful.

To test whether the software runs well or not, three different Batik patterns are used (see Fig. 5). In the figure, it can be seen that the software is able to identify a certain Batik pattern.

The application was tested using black box technique, which is to test the functions of the features in the application. Based on the testing (see Table 1), the application was found to be successfully operated. The object of Binokasih pattern (see Fig. 5(a)), combined with the crown of Binokasih (see Fig. 5(b)) turns out into the 3-D picture shown in Fig. 5(c).
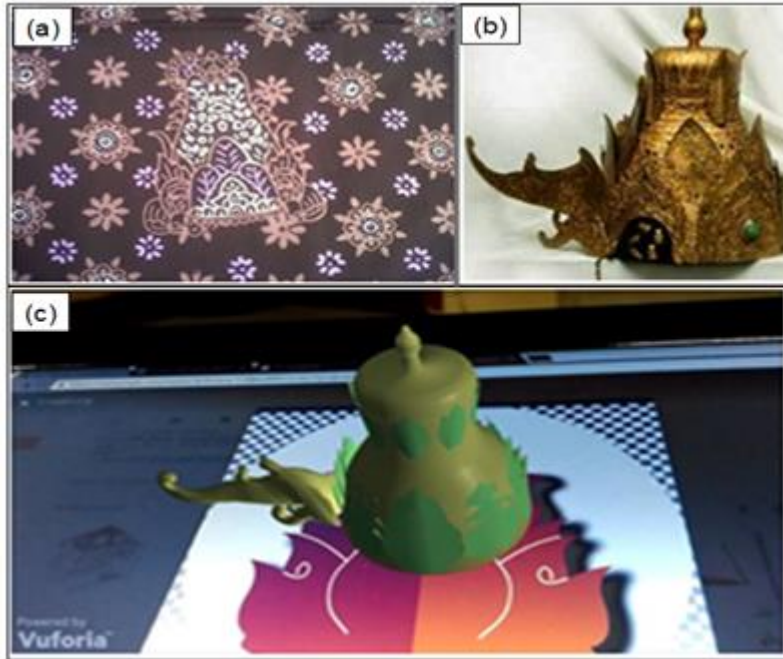

**Fig. 5. Other example of the combination of 2- and
3-dimensional object using ARtikon-joyful.**

The next testing is to obtain response times when loading the ARtikon-Joyful application. The test is required as this application contains a lot of 3-dimensional objects and videos. It is done to find out the minimum specification of the device to run the application. If the application is run on smartphone devices that have different specifications, then the result of the response time will also be different. The testing was done only at the time of loading the camera to a smartphone, which is to determine gap in response time. The test was conducted to three devices with different specification. The devices use Android v4.2 operating system at the minimum because the application uses API Level Android 4.2 (Jelly Bean). The response time testing was performed ten times for each device. The results show that device can only show the 3D objects, meaning that the minimum specifications to run the application was RAM 1GB and CPU Processor Quad-core. In this test, it can be concluded that the higher specifications of devices, especially smartphones on the RAM and processor loading at the camera in, the faster the application will run.

In this section, we illustrate some statistical analysis related to experiments conducted on the Vocational High School using the application. As shown in Table 2, it can be seen that Pre-test and post-test were taken by 28 students with the average score of 7.36 and 9.75 respectively, showing that the average score in post-test is greater in pre-test.

Table 2. Paired samples statistics.

	Mean	N	Std. Deviation	Std. Error Mean
PRETEST	7.36	28	3.369	0.637
POSTEST	9.75	28	2.824	0.534

4. Discussion

The first part of the discussion in the present study is the importance of developing this software. The selection of Android-based media is due to its practicality and friendliness. Almost all students nowadays have a smartphone so that it makes them easy to learn everywhere. Besides, this type of technology is user-friendly for both teachers and students so that they do not need a lot of time to adapt to the software. By doing so, students are triggered to have one of the most important skills in the 21 century which is computer and ICT literacy.

The second part of the discussion deals with Batik learning. Using ICT-based media, particularly ARtikon-Joyful help the students learn Batik more effectively. Since the purpose of the study is to see whether the application can improve their spatial intelligence, it has been proven that this software helps them understand the pattern more easily, more effectively, and in a fun way.

One of the strengths of this application is that it can reflect Batik patterns from objects in the surrounding. Students and teachers can both access this application anywhere and anytime they find interesting objects to reflect. On the other hand, this strength is also the drawback of the application since it can only reflect the combination of both 2D and 3D objects. When the object is merely a form of 2D or 3D, the application is unable to reflect them.

Nevertheless, students are overall interested in using the application, particularly in learning Batik. As the statistical computation of pre-test and post-test results show, the spatial intelligence of students with special needs increase significantly. Not only did they have better spatial intelligence, but they also seem to enjoy learning Batik more than when they learn it without the application. During the teaching and learning process using ARtikon-Joyful, students show more enthusiasm and motivation.

5. Conclusion

An application called ARtikon-Joyful has been successfully implemented. It is built by using Augmented Reality on mobile technology by utilizing several emerging software libraries as follows: Unity, Vuforia SDK, and Android SDK. ARtikon-Joyful contains the following features: loading a video for explaining philosophy of batik, loading 3D images, and other useful information, such as

history of batik, etc. In this project, we also provide data of design types of Sumedang's batik and their philosophy so that batik can be understood by interested readers. ARtikon-Joyful can help students enhance their spatial abilities improve. In addition, it has also been proven that the App helps create a more interactive teaching and learning process. In other words, teaching and learning process is no longer teacher-centered.

Acknowledgments

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