Augmented Reality Applied in Astronomy Subject

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Abstract. Mobile augmented reality is one of the most potential technology for education. Science astronomy is one of the subject that need to develop by mobile augmented reality technology. Purpose in this research is to create mobile augmented reality based on astronomy subject in Indonesian curriculum in junior high school. Animation that has been show in this application follow Kepler’s law about planetary motion. This research is R&D research and it follow instructional design type ADDIE. This researcher collected the data qualitatively from 2 experts, 2 teachers and 2 students. Each of participant will give suggestion to improve the quality of the application. Finally the application has been made with 16 marker. 11 explain about member of solar system, 3 marker about rotation and revolution of earth and moon, and 2 marker is about solar eclipse and moon eclipse. The application size is 47 Mb with Apk format. It can be use at least in android version 4.1 jelly bean and camera 13 MP. This application is ready to use for more large participant.

1. Introduction

Tradition method of education was carried out through face-to-face instructions where the knowledge and learning were all arranged by teacher [1]. Learning material were also based on static material such as papers in which static materials do not show any information in a dynamic way such as motion or continuous movement [2]. Some of this traditional method and learning material was work effectively, however there is an increasing interest of educators and researchers in introducing more useful method to improve the teaching and learning experiences. In this modern day technology becomes increasingly widespread and it integration has influenced and revolutionized the way of teaching and learning.

Science educators are always looking for a new way to teach and deliver the knowledge to other people. Nincarean and team [3] on their research state that how is the potential of mobile augmented reality in education. Augmented Reality (AR) is one of the latest technology that offer a new way to educate. AR is one of the technologies which considered as having potential for pedagogical applications. Although AR is becoming increasingly widespread and has more attention in gamered. But AR applied in sciences predicted give more improvement in education.

Science education is education that based on natural phenomena. Chiappetta [4] said that the essence of science is as a way of thinking, a way of investigating and body of knowledge. Science education based on the size of the object divided into two groups, micro science and macro science. Micro and macro science both the object of study is abstract and its suitable to use mobile augmented reality on teaching this topic.
Astronomy subject categorize to science macro. The object being discuss here is very large and abstract. Astronomy topic in Indonesia thought in junior high school grade with 3 times meeting. Based on latest Indonesia curriculum in astronomy topic students need to understand solar system, rotation and revolution of earth and moon, and its impact on life on earth. Astronomy topic always included in national exam [5].

The current research problem is to create mobile augmented reality in astronomy subject. Mobile augmented reality is augmented reality (AR) interfaces enable in smartphone. Students carrying smartphone through real world contexts engage with virtual information superimposed on physical landscapes. This type of mediated immersion infuses digital resources throughout the real world, augmenting students experiences and interaction [6]

2. Methodology

The purpose of this study was to create mobile augmented reality for astronomy subject. Many learning media have been made but there is no one develop it well by using augmented reality. Other researcher maybe develop it and create augmented reality of astronomy. But most of them did not follow the theoretical included in astronomy itself, such as Kepler law of planetary motion.

This research is R & D (Research and Development) and it used ADDIE instructional design. ADDIE Consist of 5 stages : Analysis, Design, Development, Implementation, and Evaluation [7]. This research started the analysis from latest Indonesia curriculum. Design based on pedagogical approach. Development by using augmented reality. Implementation by qualitative method in small scale participant 2 expert in education, 2 teacher and 2 students and evaluation based on feed back from expert, teacher and student.

3. Result and Discussion

Mobile augmented reality has been made with 16 marker about astronomy. It develop by using program unity, vuforia and blender. Blender application used to create the three dimensional animation. Vuforia used to create marker of augmented reality. and Unity program used to combine animation and marker that has been made in Blender and Vuforia and also export it into Apk so it can be use in mobile phone.

The Application in Apk format so that in can install in android device. The size of application is 49 Mb. The minimum specification phone that can use this application is in version 4.1 jelly bean with minimum free space memory 49 Mb. For the camera the more quality of camera the better application will detect the marker, researcher recommend to use camera at least in 13 MB to get good performance. It not recommend to use this application in area with lack of light because it will make the application hard to detect the marker.

There are 16 marker of this application. There are 11 marker explain about member of solar system. Content of this marker is about planet, orbital planet, sun, comet, and asteroid belt. In this marker the application will show the planet or member of solar system and below of planet animation there is short explanation about the planet. For more clearly it can be seen in picture below.
In this application 3 markers explain about revolution and rotation of earth and moon. The orbital of earth moving around the sun in this animation it follow Kepler law about planetary motion. There are three laws of planetary motion from Kepler. [8] (1) All planets move about the sun in elliptical orbital. In this animation all planet moving around the sun by elliptical orbit. (2) A radius vector joining any planet to the sun sweeps out equal areas in lengths of time. In this application the animation of earth surrounding sun follow this law it will move faster in closest area to sun and move slower if it in far away area from sun. (3) The squares of the side real periods (of revolution) of the planets are directly proportional to the cubes of their mean distances from the sun. in this application each of planet surrounding the sun based on their revolution time and its follow third law of kepler planetary motion.

The last part of this application with 2 markers, it will show the animation about solar eclipse and moon eclipse. The augmented reality will show the position of each sun, earth and moon. And also the
shadow that will appear when the eclipse. In example in moon eclipse, moon totally black because of there is no light come to it and there is no light reflection to the earth. For more clearly it can be seen in picture below.

![Image of eclipse](image.png)

**Figure 3.** Marker about solar eclipse and moon eclipse

## 4. Conclusion

Mobile augmented reality in astronomy subject by using the Blender, Vuforia and Unity junior school has been successfully designed for three meetings which include astronomy learning material for junior school. This design has been successfully done by following ADDIE design design model. The design results have been successfully made with the android application. This program is 49 MB in size and can be opened on a minimum android version 4.1 Jelly bean and memory capacity 49 MB. For the camera specification at least it use camera in 13 MP to make application easy to tracking. The results of making instructional media have been validated with by 2 learning media expert, 2 teacher and 2 student. This media can be used as an alternative choice of learning media and can be a reference to the teachers in the field of science to be able to innovate more or other parties who need.

## References

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