M-VSARL System in Secondary School Science Education: Lunar Phase Class Case Study

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***Abstract*—In this research, we introduced the Multi-viewpoint Smartphone AR-based Learning (M-VSARL) System in astronomy teaching to create the environment in which observation task can be done in class time in the classroom. In order to assess the learning effect of M-VSARL system, we conducted a lunar phases observation experiment in a junior high school. The assessment revealed that the system had high learning effect that assisted students to complete the lunar observation task. In addition, especially through using this system stimulated student's interest in lunar observation.**

***Keywords*-Smartphone Augmented Reality; Lunar Observation; Astronomy Education**

I. Introduction

Observation activity is very important part in the astronomy education to assist students to learn complex astronomy phenomenon and stimulate their interest in astronomy, such as the lunar phases[1]. However, because of time, place, weather limitation, such as the teachers have limited time to wait for students to complete the observation tasks, which take one week or month, even a year to complete, it is not practical to perform the observation activity in astronomy education. We introduced the Multi-viewpoint Smartphone AR-based Learning (M-VSARL) System [2] which utilized Smartphone AR and 3D or 2D contents in astronomy teaching to create the environment in which observation task can be done in class time in the classroom. In this research, we mainly investigate the learning effect of M-VSARL sytem in science education. In order to prove the learning effect of M-VSARL system in science education and investigate how the system is helpful to students, we conducted the practical teaching experiment on lunar phases observation in a junior high school. The M-VSARL system could bridge the gap between the classroom and real world in the astronomy education.

II. M-VSARL System for Lunar Phases

We used smartphone AR and Virtual Reality contents to develop the M-VSARL system for lunar observation. The M-VARML system has two main views: the AR viewpoint and the Universe viewpoint. To achieve the learning goal of planetary motion observation, we developed system functions based on learning indicators in science education. Each function matches a learning goal of an astronomy observation task. The function structure is as shown in Fig.1.The virtual moon is shown in the AR view appropriately maps the moon from the real sky which based on the current location, date and time, is as shown in Fig.2(a). In the AR view, students can observe the moon, its azimuth, and elevation angle in the sky and rotate the mobile device to observe the moons orbit from 1:00 a.m. to 12:00 p.m. using the "OneDay" function is shown in Fig.2.(a). Further, the "SetDay" function is to help students observe the periodic waxing and waning of the moon, the orbit, azimuth, elevation angle, age, and shape of consecutive moons in the sky in a particular location simultaneously, as shown in Fig.2.(b). At the same time, we developed the universe view to show the relationship of the sun-earth-moon orbit to study the mechanism of lunar phases based on moon age is as shown in Fig.3.

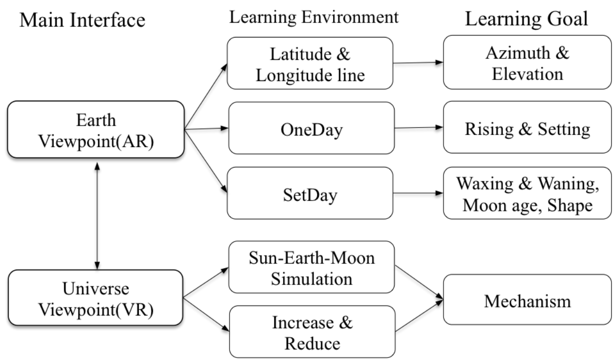
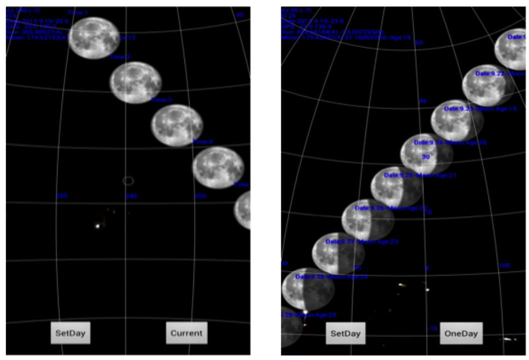


Figure 1. Outline of the M-VARML system.



(a) OneDay (b) SetDay

Figure 2. One Day and SetDay function.

III. System Implementation

The M-VARML system is developed on the Google Android operating system and software development kit.

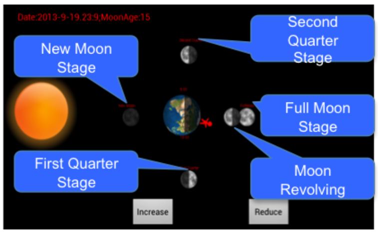


Figure 3. Step into Universe View.

(a) Experimental Group (b) Control Group

Figure 4. Experimental situations.

The developing code toolset is Eclipse, ADT, and Android 2.1 SDK. The programming language is Java. The application is supported by a range of smart phones and tablet devices that run on Android 2.1 or higher, and have the required sensors (i.e., camera, GPS, electronic compass, and accelerometer). Our M-VARML was implemented on an Android Smart phone. The mobile device was a Samsung Galaxy S3.

IV. Teaching Experiment

A. Experimental Procedure

To investigate the learning effectiveness of students after using the M-VSARL system for lunar phases observation, a teaching experiment was conducted in a secondary school in Anhui province, China. Two classes were randomly selected from the eight grades, one as the experimental group (34 students) and the other as the control group (36 students). This study used the experimental design for non-equivalent groups. This design requires a pretest and post-test for an experimental group and a control group. The experiment group used the M-VSARL system to observe and learn the lunar phases, whereas the control group used traditional way, which the teachers showed slides and videos to demonstrate the mechanism of the lunar phases in the classroom, as shown in Fig.4. After the post-test, a questionnaire was administered to the experimental group to evaluate the usability, users' satisfaction, and attitude toward the M-VSARL system for lunar observation.

B. Result and Discussion

In the pre-test stage, the mean average of scores for the control group is 31.03 out of 100, and the experimental group is the 28.79 out of 100, and the p-value ((significant level)) is $0.3322 > 0.05$. This showed that both group almost have the same level knowledge of lunar phases. However, in the post-test stage, the mean average of scores for the control group is 32.58 out of 100, as shown in the Table I, and the experimental group is the 43.45 out of 100, and the p-value is $0.0028 < 0.05$, which is shown in the Table II. Thus, the control group showed only slightly improvement of scores comparing with pre-tests, on the other hand, the experimental group obtained more obvious improvement of scores comparing with pre-tests. Comparing improvement of the two groups suggested that using the M-VSARL system did help students to improve their understanding of lunar phases more than traditional way in the classroom. Results of the questionnaires indicated that most students thought the system's function were very effective. Moreover, the students agreed that the system was easy to operate. They were able to operate the system to complete the moon observation tasks in the classroom, confirming the usability of system. Lastly, the students appeared to be highly interested in using the system to observe lunar phases. Students agreed that the system helped them enhance their motivation to observe lunar the in their daily life.

Table I
T-TEST ANALYSIS OF PRE-TEST IN TWO GROUPS

	N	Mean	SD	Diff	p-value
Control group	33	31.03	10.47	2.24	0.3322
Experiment group	34	28.79	8.11		

Table II
T-TEST ANALYSIS OF POST-TEST IN TWO GROUPS

	N	Mean	SD	Diff	p-value
Control group	33	32.53	17.32	11.33	0.0028
Experiment group	34	43.87	11.77		

V. Conclusion

In this paper, the M-VSARL system was developed and implemented in the junior high school in china. The results suggested that activities based on observation using M-VSAR system promoted understanding for students compared with the traditional way for lunar study. The M-VSARL system also stimulated students' interest on lunar phases observation in their daily life. Therefore, the M-VSARL system is a effective tool that bridges the real world and the classroom in astronomy education.

References

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