

SHORT STUDY

Design of learning media for the solar system lesson using animation and virtual reality

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Abstract

The solar system is an astronomy subject which is taught in Elementary Schools, particularly in Grade 6. This subject requires the teachers to teach creatively because the lecturing method in teaching is too common. Besides, in learning this topic, the media is highly needed to help students understand and comprehend the materials given. The media used in the current learning process is considered not sufficient because of the limited teaching aids and learning media. Therefore, based on the technology development, there are many multimedia technologies. One of them is VR which provides real-time interaction to what is displayed in the application. Hence, a design of learning media for the solar system lesson using animation and virtual reality was developed. This study aims to help students who are studying this lesson to have a better understanding of the lesson since they can interact directly with what they are learning.

Keywords: Solar system, Virtual reality, Animation

Introduction

The solar system refers to the collection of celestial bodies which consist of a star called the sun and all objects that are bounded by its gravitation. Those objects include 8 planets in an elliptical orbit, 5 dwarf planets, 173 identified natural satellites, and millions of other celestial bodies (meteorites, comets,

asteroids). Astronomy which is the scientific study of the solar system was taught in Elementary School, Junior High School, and Senior High School students [1].

Virtual Reality is a developing technology, particularly in gaming, entertainment, and medicals. Virtual Reality is rarely used in education because the current educational practice, spoken teaching method, reading books, and the watching of videos, are less interesting to attract students' attention. Subsequently, interest plays an important role in students' learning activities. There are several things which can influence students' interest in classroom learning, such as: students' realization of needs, realization of responsibility, students' mood, classroom atmosphere, and teaching media. From those five points, the last point, teaching media, is related to this study. The advanced information technology eases people in many aspects and various fields; one of them is in teaching and learning activity by utilizing the advanced technology such as interactive multimedia in order to assist in increasing students' learning interest. Interactive multimedia learning creates an interesting learning process so that the students are spared from boredom caused by less communicative teachers in delivering the materials. Learning through interactive multimedia is expected to be a solution to students' boredom as well as conventional learning method which is less communicative [2].

In learning Science subject, especially the solar system, an interactive and interesting learning media is highly needed for the students. The utilization of teaching visual aids in a form of Virtual Reality is advantageous in improving the learning process. As Virtual Reality has some entertaining aspects, it can encourage the students to learn and understand the topic comprehensively. Lecturing is the most common method used in the classrooms. The media used in this method can be people, objects, texts, audio, visual, videos, multimedia computers, and internet-based media. Virtual Reality is the development of computer multimedia utilization which is better in terms of quality compared to the previous teaching media.

The lesson about the solar system requires the teachers to teach creatively due to the limited teaching media, and students have to be able to imagine the solar system in order to understand them. Besides, the teaching aids used are just the solar system model-kit, video, or pictures. However, not all students can understand what is being taught because of those factors.

Based on those problems, an interesting teaching media is needed in order to deliver the solar system lesson and ease the student to portray the solar system clearly. Therefore, a method to teach the solar system method using animation and Virtual Reality was made. Additionally, it is considered more effective and it eases the students to understand the lesson being taught better.

Literature Review

The first study entitled "Augmented Reality of The Solar System as an Interactive Learning Aids for Elementary School Students Based on Android" states that recently, visualization technology has been developed greatly in games and entertainments. However, it is rarely used in education; whereas in teaching

Science, a new media to support the teaching and learning process is highly needed [3].

The second study is “Education Game Application of The Solar System Using Line Renderer Method Based on Unity 3D” which used entertainment to attract the children in understanding the topic better. However, there were positive and negative impacts which emerged during the playing of that game. A study from the University of Rochester in New York mentioned that the learning process through a game turns out to be understood faster. This application was designed using Rational Unified Process methodology [4].

From those studies, the advantage of this study is the design of teaching aid based on Virtual Reality and animation. This is performed such that the students who wear it will learn more interactively. They will enter the Virtual Reality world and see all the things in the space as well as the explanations about the planets enlisted in the school curriculum.

Media is the plural form of medium which can be defined as a mediator or transmitter of communication from the sender to the receiver [5].

Learning is a combination which consists of humane elements, facility materials, equipment, and procedures which complies with each other to achieve the learning goal [6]. Basically, there are 3 learning formula which are considered as advanced:

1. Learning is an attempt to organize the environment in order to create learning condition for the students.
2. Learning is an attempt in preparing students to be good citizens.
3. Learning is a process of helping students to face society daily life.

Audio visual aid is a modern instructional media that suits the current development (science and technology development) which includes the media that can be seen and listened to [7].

Animation refers to a series of continuously fast moving pictures, and the pictures are related one to another. At the beginning, animation is a series of pictures which is moved simultaneously such that it looks live [8].

The solar system is a group of celestial creatures which consists of one sun and all the things that are bounded by gravitation [1].

Planets are celestial creatures which revolve around the star in a certain orbit and speed [9].

Virtual Reality is a technology which enables the user to interact with an environment which is simulated by a computer, the real environment which is imitated, or an environment that exist only in one’s imagination [10].

Methodology

In the design of the solar system teaching aid using animation and Virtual Reality, mix method is chosen. The mix method creates facts that are more comprehensive in studying the research problem. This is because this method has the freedom to use all the data collection tools to suit the data needed. Mixed method is a method that combines qualitative and quantitative approach in methodology (the data collection step), and it mixes two approach at all steps of the research process. Besides, linear strategy was used in order to apply simple

logical sequences at the planning stage because its component has been understood relatively. This strategy is suitable for a planning type which has been conducted several times. A step which begins after the previous step is finished and so on [11]. The research step about the design of learning media using animation and Virtual Reality is shown in Figure 1.

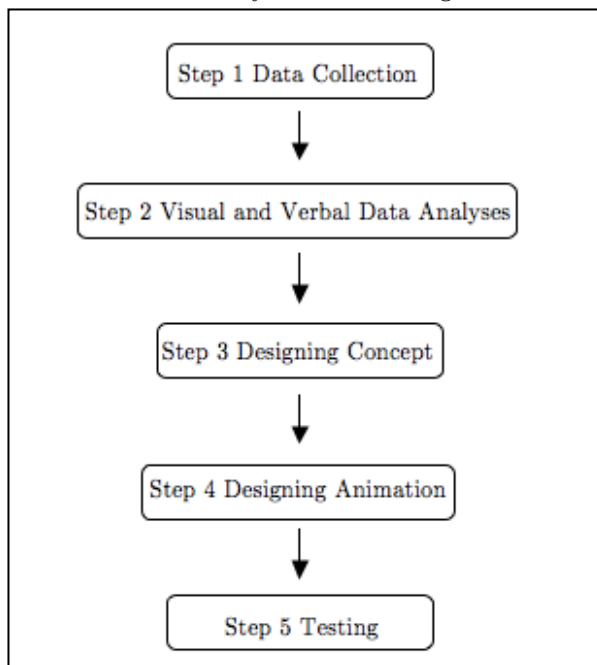


Figure 1. Linear Strategy

Step 1: Data Collection

Primary data and secondary data were collected. The primary data were used to look for the main information source of the study, while the secondary data were used to support the primary data. Primary data were collected through direct interview with Science teachers in grade 6 from 4 different Elementary Schools in Ambarawa and also with students in grade 6. The results of the data collection are:

Teachers

The interview with the grade 6 Science teachers' results shows that the learning process in the solar system lesson was conducted using limited study kits. The limited study kit led to low students understanding. However, learning using students' simple handcrafts is expected to help students understand the lesson and solve the problems within the groups or as individuals.

Students

During the interview with the 6 grade students, it was observed that there is a lack of understanding about what the teachers deliver and what the students understand. Besides, since there was no other media than video and pictures, there was a lack of students' interest about the lessons.

Unstructured interview, an interview that allows the researchers to not use a systematical and complete interview questions in collecting the data, was performed in this study [12].

The secondary data collection was conducted to support the data collection of the primary data. Collecting references from internet and journals were conducted to collect the secondary data.

Step 2: Visual and Verbal Analyses

After the data had been collected, they were analyzed and processed into several important points which were needed in the designing process. Therefore, the results of verbal data were shown below:

- In the classroom learning, the lesson delivered in the class include: name of planets, rotation period, planets revolution, and other celestial things that exist in the solar system in the Milky Way.
- On the sub-unit explanation, not all the students understood and could name all that they had been taught.
- Regular learning program and learning system tends to make the students to become lazy in paying attention, because they lacked the study kit and learning video.

After the interview and observations, the visual data were structured. Hence, the visual data were collected from NASA and the International Aeronautics Administration.

The dark atmosphere in the space with some appearance of nebula cloud, celestial things and stars, and the appearance of the galaxy can be seen in Figure 2.

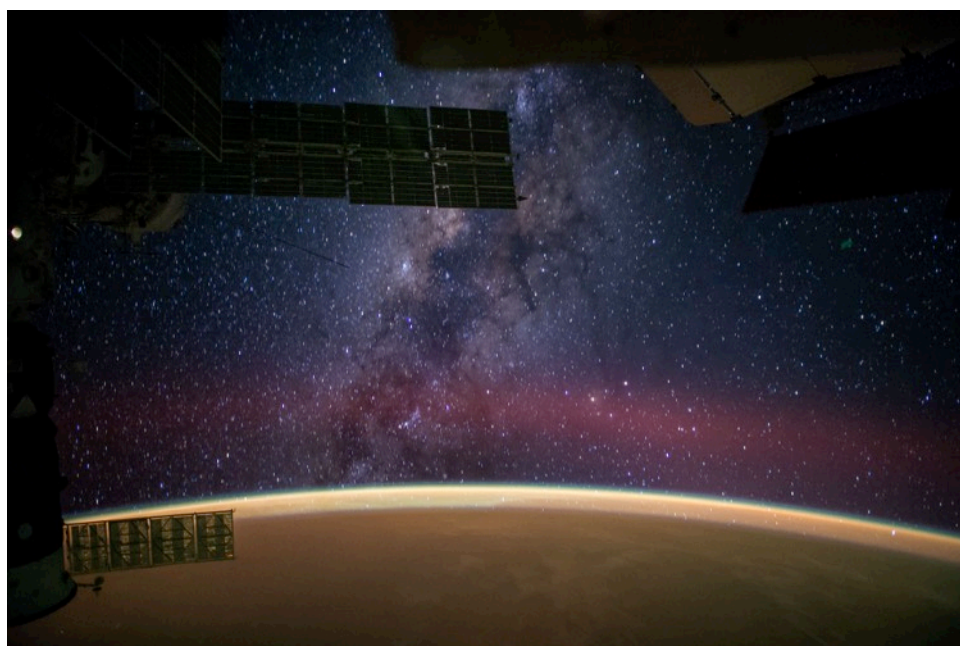


Figure 2. The Space Picture

In the Milky Way solar system, there are 9 planets that were admitted by NASA and the International Aeronautics Administration. They are: the Mercury, the Venus, the Earth, the Mars, the Jupiter, the Saturn, the Uranus, the Neptune, and the Pluto. However, in Elementary School lesson, based on the current curriculum, there are 8 planets since Pluto was not included. The pictures

of the planets which were admitted by NASA and the International Aeronautics Administration are shown in Figure 3.

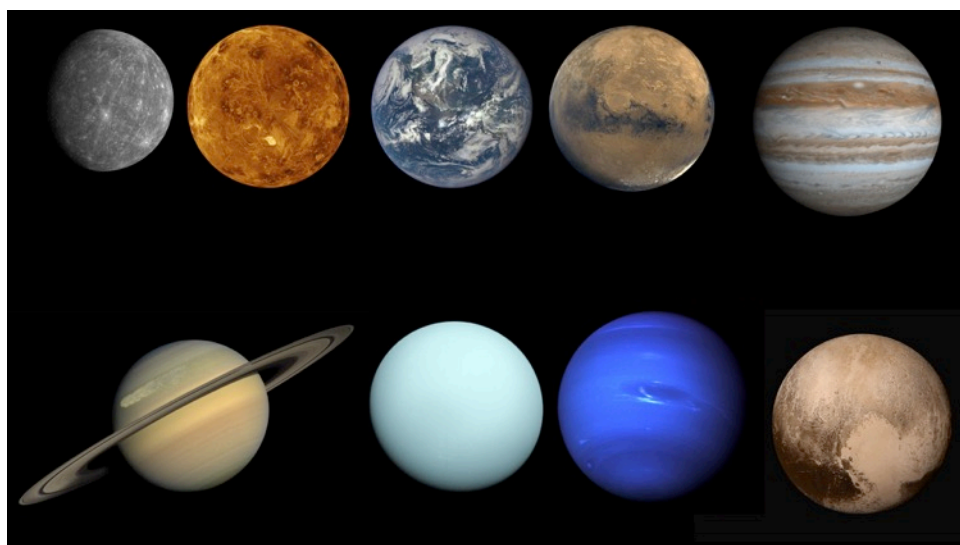


Figure 3. The planets in the Milky Way solar system

Other than interview and observation, in order to acquire information related to the students' understanding toward the lesson about the Solar System, a questionnaire was used. The questionnaires were distributed to the respondents (Grade 6 Science teachers and students).

The questionnaires were distributed to 20 Grade 6 students and the data collected can be seen in Table 1.

Table 1. The total percentage of questionnaire respondents

Questionnaire Questions for Teachers and Students				
No	Questions	No	Uncertain	Yes
1	Do the students understand the definition of solar system?	2	12	6
2	Can the students name the planets in the Milky Way consequently?	6	5	9
3	Can the students name the inner and outer planets?	8	5	7
4	Can the students name the celestial things?	3	14	3
5	Is the teaching media used easy to understand?	1	3	16
6	Is there any other media used than the study kit?	14	3	3
7	Is the currently used media effective?	3	11	6
8	Is a new media needed in this learning process?	0	2	18
	Total	37	55	68
	Percentage	23.10%	34.40%	42.50%

Step 3: Designing Content Media

The third step is the designing process of the content media for the solar system learning. This step is divided into 3 stages: the pre-production, production, and post-production.

Pre-Production

Pre-production is the initial determination of what the content is. Here, there are several steps at this stage: idea, concept, and technique used.

Idea

Based on the interview results, the first idea is to use Virtual Reality as a media due to the limited availability of media. Besides, students will be able to understand better if they see, listen, and interact directly.

Concept

The VR concept that would be made was in a form of animation, in which the students can directly see, know, and listen to the information about the solar system in the Milky Way. The information provided was in a form of text and audio to ease students' understanding.

Animation

The fly-through animation technique was used in making the VR. This animation is a picture movement that can be viewed from all directions. For example, top view and side view depends on the camera setting and the set of animation strips made. This technique would be combined with the camera 360o technology. This is done so that the students will be able to view all the space contents freely. The unlimited views were supported by the framing view on a simple animation using fade-in.

Production

In this step, the learning media was designed and made. The animation making process and the shape of the media were adjusted to the idea that had been planned. Therefore, this makes it possible for the media that was made to meet the learning requirements and ease the learning system in classrooms. The image which has been made for VR can be seen in Figure 4.

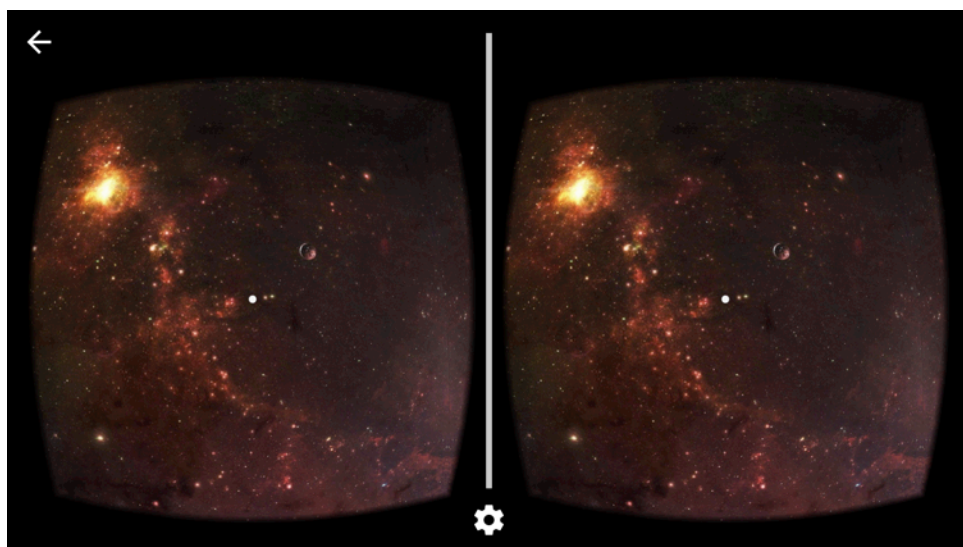


Figure 4. The atmosphere used in VR media

After designing and making the media, the audio used for incorporating the information into the learning media was made and recorded. Some examples of the recorded audio are shown in Figure 5.


 35.wav	RIFFINFO_INAM	RIFFINFO_IART
 36.wav	RIFFINFO_INAM	RIFFINFO_IART
 37.wav	RIFFINFO_INAM	RIFFINFO_IART
 38.wav	RIFFINFO_INAM	RIFFINFO_IART
 39.wav	RIFFINFO_INAM	RIFFINFO_IART
 40.wav	RIFFINFO_INAM	RIFFINFO_IART
 41.wav	RIFFINFO_INAM	RIFFINFO_IART
 42.wav	RIFFINFO_INAM	RIFFINFO_IART
 43.wav	RIFFINFO_INAM	RIFFINFO_IART
 44.wav	RIFFINFO_INAM	RIFFINFO_IART
 45.wav	RIFFINFO_INAM	RIFFINFO_IART
 46.wav	RIFFINFO_INAM	RIFFINFO_IART

Figure 5. The examples of audio information stock

The recording process was done using a laptop. The recording was carried out at night to reduce noise and unwanted sound disturbance in the audio. Besides, a closed area was chosen in the recording process. This makes it possible to have a clearer sound and eliminate or reduce unnecessary sound.

Post-Production/ Editing Process

The editing process was conducted to increase or decrease the sound decibel. Besides, in this stage, the clip audio fragments were combined into one so that the media making process will be easier. Hence, the audio editing process is displayed in Figure 6.

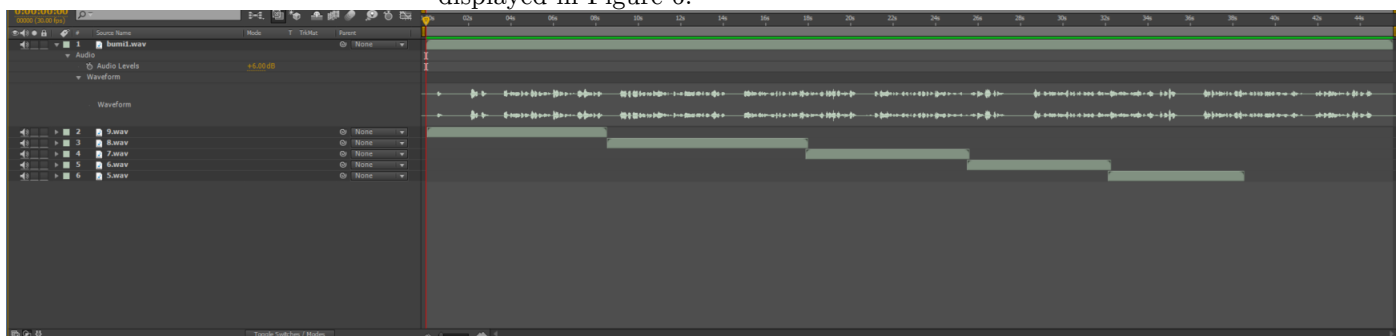


Figure 6. Audio editing process

The back sound chosen was an instrumental music. A space-fun theme instrumental music was chosen to match the solar system theme so it can consolidate the ambience and increase the students' interest and enthusiasm in the learning process.

After that, the development method was performed based on the prototype method. Prototype method is a fast development and a framework testing of a new application through interaction process repeatedly. Thus, this is usually used by the information system and business experts. Prototyping was known as a fast application design because it simplifies and accelerates the system design [13]. The prototype method is illustrated in Figure 7.

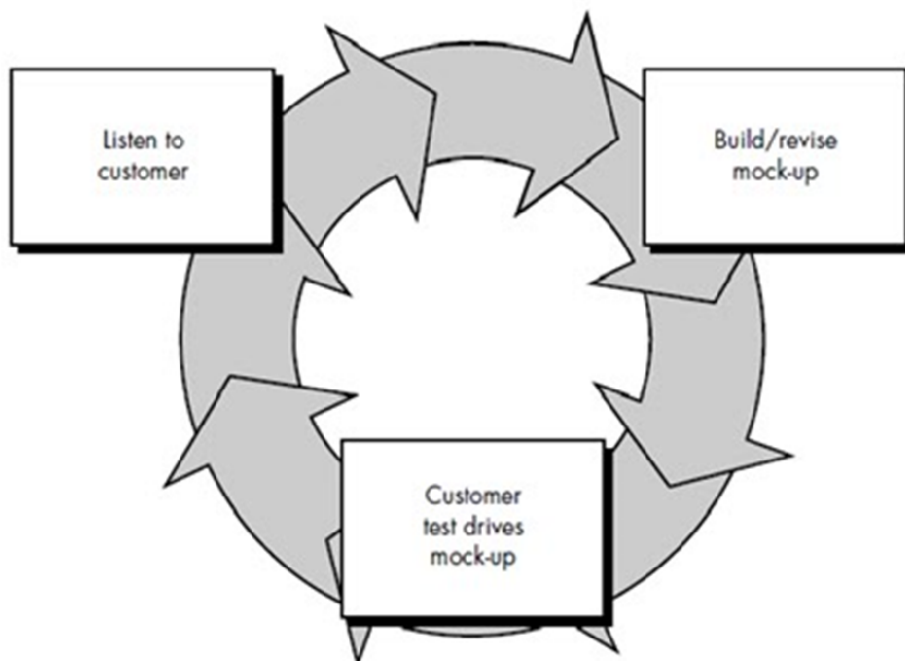


Figure 7. The prototype method cycle [13]

This method is commonly used in a system development method. This method meets up with user's satisfaction. Furthermore, there are several stages in this step:

Listen to Customers

This process was based on customers' requests about the system that would be developed. By doing so, the customers tend to be directly involved in the system planning. The references acquired from the customers to the designers were expected to meet the requests offered. In this method, assigned teachers provide the references to the writer in form of video, pictures, globe, and study kit, which in the future would be the content of the designed Virtual Reality application.

Build/ Revise Mockup

At this stage, the requests or references given were processed to meet the current requests or references. The application was made and the expected content for the Virtual Reality was compiled at this stage.

Customers Test Drive Mockup

After the designing process was finished, the application was tested with the customers or the experts to see whether the application had met the requirements or the requests. If the application had not met the requests, it would be revised to meet the current references or concepts. The application trial was conducted with a Virtual Reality expert to see the system's appropriateness. After it was approved, then the application trial was

conducted with the assigned teachers to see whether the learning contents in the application were appropriate for the current curriculum or not.

In the system development, after finishing the planning process, a trial would be conducted directly by the Virtual Reality expert. Therefore, every prototype trial was documented. The prototype trial result can be seen in Figure 8:

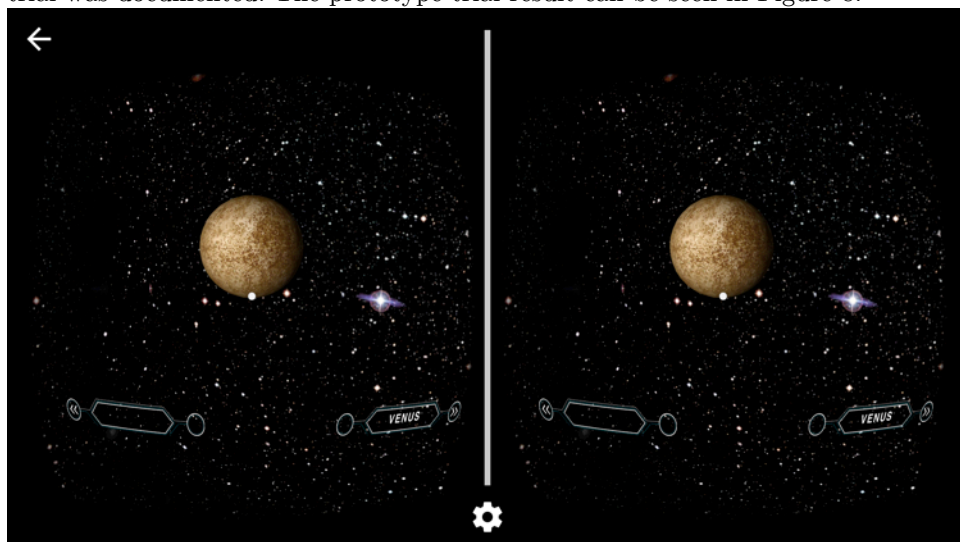


Figure 8. The result of the 1st prototype

The result of the 1st prototype evaluation was lighting adjustment. The camera position was behind the sun when moving from one planet to the next planet. As a result, students had difficulty in looking at the detail of the observed planet. The atmosphere was empty, and there was no celestial things seen. Besides, “help” and “exit” were added to the main menu to ease the usage of this Virtual Reality application.



Figure 9. The result of the 2nd prototype

The 2nd prototype (Figure 9) evaluation results were the BGM sound and information sound which is a bit too loud. Also, information sound is needed to give echo effect which can illustrate the space atmosphere better.

Result and Discussion

The learning media of this study was divided into 2 parts; the main menu and the media information content. In the application main menu, there are three buttons: “start”, “help”, and “exit”. The “start” button is used to start the program and the learning process. The “help” button is used for the new users or someone who has never used this application before. The purpose of having this button is to ease the users’ access and help them understand the function of the buttons on the application. This would make it possible for them to use the application smoothly and know the content provided. Then, the “exit” button is used to end the learning application. Figure 10 displays the interface of the main menu buttons and their functions.

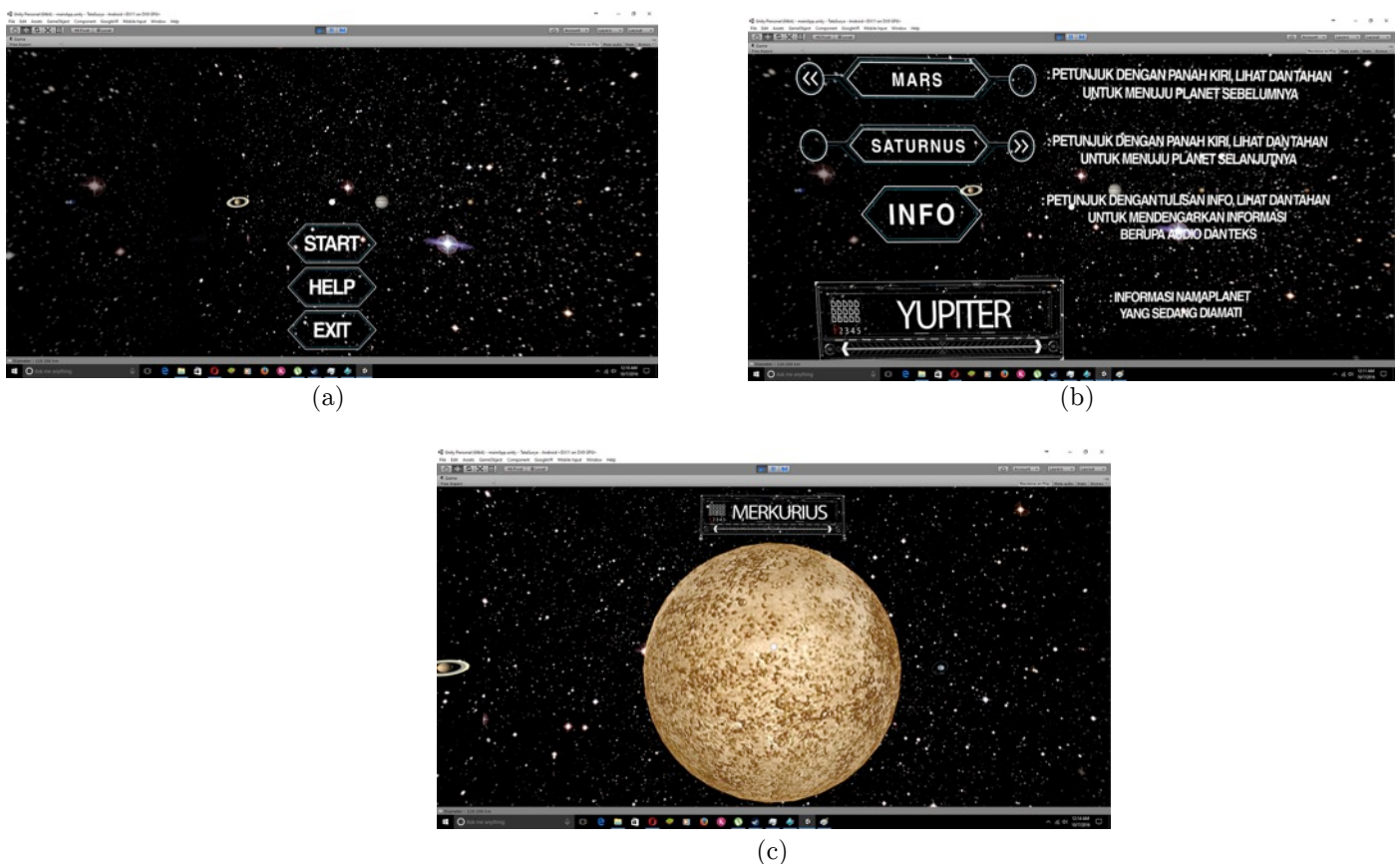


Figure 10. (a). Menu Display, (b) Help Display, (c) Application Display

The first testing was conducted with the teachers in 4 Elementary Schools in Ambarawa. The first testing was about whether all the contents that were compiled were appropriate to the lesson being taught to the students based on the current curriculum. The teachers evaluate the content in the application whether the content of the application had fulfilled all the aspects that will be taught to the students. From the graphic and the way to deliver the information through sound and animation, this application was quite good and interesting for the students. The teachers expected that this application could be developed systematically. Also, it is seen to be more interesting as the VR technology was potential for the students.

The second testing was conducted with the students in 4 Elementary Schools in Ambarawa. The questionnaires were distributed to the students and the results from 20 students were shown in Table 2.

Table 2. The results from the questionnaires of 20 respondents (students)

No.	Options	ANSWERS				
		SD	D	U	A	SA
1.	The media used in the learning process is not effective enough	2	0	2	12	4
2.	Need a new learning media	0	0	3	8	9
3.	Virtual Reality learning is quite helpful in understanding the solar system lesson	0	1	3	11	5
4.	In the Virtual Reality application, the pictures and sound give the impression of entering a virtual world which is shown in the VR	1	1	3	5	10
5.	The information provided in the VR application is appropriate with the material based on the curriculum	0	0	1	11	8
6.	The narrator voice and the informational text are clear in delivering the information needed	0	0	3	13	4
7.	The picture and graphic quality have illustrated the planets clearly and the space atmosphere	1	1	7	8	3
8.	Students can understand the material and content provided	0	1	3	12	4
9.	Students are able to put the planets in the correct order after using the media	0	0	3	7	10
10.	Students are able to mention the information about the planets well and comprehensively	0	1	2	4	13
11.	Students understand the planets' position, distance, shape, and orbits more detail	0	0	1	5	14
12.	Students can be more focus in learning the materials using VR media	0	1	2	1	16
	Total	4	6	33	87	90
	Total Percentage	1%	2%	16%	40%	41%

SD – strongly disagree, D – disagree, U – undecided, A – agree, SA – strongly agree

The likert questionnaires result showed that 80% of the students considered that the application which is a combination of the Virtual Reality and animation was very helpful for them in understanding and comprehending the lesson about the solar system because they could interact with them and see them directly.

Conclusion and Suggestion

Based on the testing result, it can be concluded that the teaching media using Virtual Reality and animation is successful in attracting students attention to understand deeper the lesson about the solar system. This media has successfully delivered the information in terms of the solar system lesson based on

the current curriculum. Besides, this media also introduced the Virtual Reality and its benefits to the students and teachers.

For future study, it is suggested to develop the materials by designing other animations (such as: comets, the planets' orbit) and improve the graphic quality of the planets and the space to make them more realistic.

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