Development Virtual Reality IPA (VR-IPA) learning media for science learning

F A Monita[1] and J Ikhsan[1]

[1]Science Education, Universitas Negeri Yogyakarta, Sleman, Indonesia

Corresponding author**:** friestamonita@gmail.com

Abstract. The science laboratory facilities in schools are inadequate. Therefore, the researcher developed a science learning media by utilizing virtual reality technology in the form of application that runs on smartphone. The objectives of this study are: (1) to determine the validity of VR-IPA media; (2) to determine the practicality of VR-IPA media from the science teachers; and (3) to determine students' responses to VR-IPA media. This media development used the ADDIE development model. The instruments used were media validation sheets, science teachers' assessment sheets, and student response sheets. The result shows that: (1) the validity of VR-IPA media is in very good category; (2) the practicality of VR-IPA media is in very good category; and (3) the students' responses to VR-IPA media are very good. In brief, it can be concluded that VR-IPA media is suitable for use in science learning.
Keywords: *learning media, virtual reality*

1. Introduction

Globalization era is considered as era in which virtual reality can reach everyday life through electronic devices such as smartphones [1]. Virtual Reality (VR) has an overall reality simulation concept, which is built on a computer system using a digital format. Building and visualizing this alternative reality requires hardware and software that is powerful enough to create a real experience [2].

Furthermore, VR application is also a gateway to travel that has never been visited before, even the trip is impossible to go on. One of the examples is when a user wants to see and feel the city of Paris but he is hindered by costs, this VR application can help the person to feel a sense of being in the city of Paris. Based on this illustration, VR can facilitate someone to visit places that are difficult for them to reach. Moreover, this simulation can be applied in science learning that allows students to explore new domains, make predictions, design experiments, and interpret results [3]. Finally, technology makes learning more fun because students are able to control and have their own role in learning [4].

Current technology plays an important role in supporting the learning process. When teachers use it in their classrooms, actually, they want to attract the attention of students, so they can improve effective learning. It is clear that learning new material in the traditional way is not very fun for students who now depend on technology. Therefore, a change in the learning environment has become a necessity [5].

One of the environments that supports the science learning process is the science laboratory facilities. The laboratory gives students the opportunity to learn abstract concepts and generalizations through 'real' material media. As students interact with learning material, their teachers, and also their

classmates, they gradually strengthen their knowledge and develop the basic manipulative skills and attitudes needed for future work in science. As most new secondary science curricula emphasize learning science processes rather than just the acquisition of knowledge, one should expect that a large portion of the laboratory period will be devoted to investigative activities [6].

In fact, not all schools apply enough learning activities in the laboratory, because school laboratory equipment and materials are inadequate. The most of the materials and laboratory equipment that were claimed available but, in fact, were obsolete. In addition, it was also found in other schools that two to five microscopes of different sizes did not function properly. Ironically, these schools claim to have equipment that is available for use, but is not suitable for use [7].

Based on the background of this research, the researcher developed a science learning media by using Virtual Reality application that can be run on smartphones. This research was conducted to develop a learning media which is suitable for use in research based on the validity of experts, practicality of science teachers, and students' responses

2. Research method

This development research uses the ADDIE model. The research stages include: (1) Analyze; (2) Design; (3) Develop; (4) Implement; (5) Evaluate. However, this study only discusses up to the development stage. The product in this development research is *Virtual Reality* IPA (VR-IPA) application that contains Solar System material. In addition, the researcher also collected responsesheet to find out the students' responses to VR-IPA media. The number of students who filled in the response sheets was of 32 students of class VII at SMPN 8 Yogyakarta. The instruments used in this study are (1) expert validation sheet, (2) teacher assessment sheet, and (4) students' responses sheets.

Data analysis used for the results of the experts'validation and science teachers' assessment sheets were conducted by (1) tabulating all data obtained, (2) calculating the average score of each aspect by using equation 1; (3) converting the average score of each aspect into a qualitative scale value of 5. Furthermore, the conversion of product feasibility interval scores can be seen in table 1.

$$x = \frac{\sum x}{n} \quad \text{..... (1)}$$

Notes:x = total score of each validator for each aspect, Σ x = average score and n = number of validators.

Table 1. Product category criteria interval conversion.

Score Interval	Category
Xi + 1.8 Sbi $<\bar{X}$	Very Good
Xi + 0.6 Sbi $<\bar{X} \leq$ Xi + 1.8 Sbi	Good
Xi – 0.6 Sbi $<\bar{X} \leq$ Xi + 0.6 Sbi	Fair
Xi – 1.8 Sbi $<\bar{X} \leq$ Xi – 0.6 Sbi	Poor
$\bar{X} \leq$Xi – 1.8 Sbi	Very Poor

Notes: X = average final score, Xi = ideal mean, calculated by using the following equation ($Xi = \frac{1}{2}\ (ideal\ highest\ score + ideal\ lowest\ score)$) and Sbi = ideal standard deviation, calculated by using the following equation ($Sbi = \frac{1}{6}\ (ideal\ highest\ score - ideal\ lowest\ score)$).

Meanwhile, data analysis used for the results of students' responses sheets were conducted by (1) tabulating all data obtained, (2) calculating the average score of each aspect by using equation 2, (3) matching the average score of each aspect with the criteria in table 2.

$$\sum x = \frac{Total\ Score}{Total\ Maximum\ Score} x\ 100\%$$

Table 2. Students' response category criteria.

Range (%)	Category
86 – 100	Very Good
76 – 85	Good
66 - 75	Fair
56 – 65	Poor
0 – 55	Very Poor

3. Results and Discussion

This development research was initiated by conducting an interview with science teachers at SMPN 8 Yogyakarta and from the interview, it revealed that practicum in science learning still rarely done. The teachers claimed that the teaching aids for the science practicum particularly the Solar System material could no longer be used because they were damaged.

In the development of VR-IPA learning media at the design stage, the researcher took several sub-chapters in the Solar System material that comprise (1) rotation and earth revolution, (2) moon phase, and (3) eclipse. The selection of the subchapters in the Solar System material was based on the consideration of the opinion of the science teachers and the materials involved natural science events that commonly occur in everyday life. VR-IPA media is an application that runs on an Android smartphone. The design of VR-IPA media can be seen in the following image.

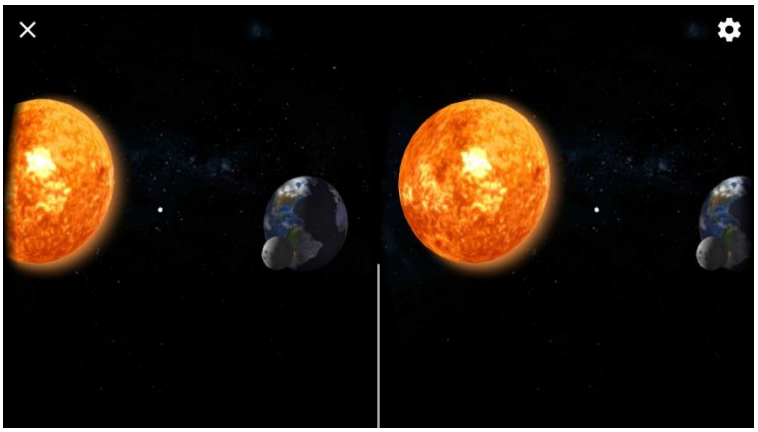

Figure 1. The sun, earth, and moon object design.

Figure 2. The concept of earth rotation and revolution object design.

Figure 3. The concept of moon phase object design.

Figure 4. The concept of eclipse object design.

Furthermore, the validation was carried out by experts in order to determine the feasibility of the product produced. The validation of VR-IPA media was carried out by two validators, i.e. learning media expert and material expert validators. Learning media expert reviewed the components of Virtual Reality in the visual, audio, navigation, and manipulation aspects. The result of the validation assessment conducted by learning media expert is presented in table 3.

Table 3. The result of learning media expert validation.

Aspect	Average Score ($\bar{X}$)	Interval	Category
Visual	8	7.20 <$\bar{X}$	Very Good
Audio	1	0.80 <$\bar{X}$	Very Good
Navigation	2	0.67 <$\bar{X}$	Very Good
Manipulation	2	1.50 <$\bar{X}$	Very Good

Table 3 shows that VR-IPA media is categorized as very good according to learning media expert. It can be seen from every aspect of the assessment is in very good category. It is further explained that in the visual aspect, the appearance of the environment colour and virtual objects are attractive, 3D graphics appear to be real, the objects' affordance stands out so that they appear to be functioning, the change in feedback given is apparent; in the audio aspect, the clarity of the sound seems real; in the navigation aspect, it eases the users to move the media; and in the manipulation aspect, it enables the users to modify the object to another form. Meanwhile, material expert reviewed from the material content of VR-IPA media on the aspects of conformity of objectives, clarity of instructions for use,

clarity of performance, and material. The result of the validation assessment conducted by material expert is presented in table 4.

Table 4. The result of material expert validation.

Aspect	Average Score ($\bar{X}$)	Interval	Category
Conformity of Objectives	3	2.40 <$\bar{X}$	Very good
Clarity of Instructions for Use	3	2.40 <$\bar{X}$	Very good
Clarity of Performance	4	3.21 <$\bar{X}$	Very good
Material	6	4.80 <$\bar{X}$	Very good

Table 4 shows that VR-IPA media is included in very good category according to material expert as every aspect of it has a very good category. It can also be seen that the aspect of the objectives of the practicum with core competencies and basic competencies are appropriate; the aspect of clarity of media usage instructions looks coherent, concise, and easy to understand; the aspect of clarity of performance contains data collection procedures that stimulate the students' performance; and the aspect of material is already correct, easy to understand, and in accordance with core competencies and basic competencies. Moreover, the practicality test was assessed by two science teachers. The result of the assessment can be seen in table 5.

Table 5. The result of practicality test by science teachers.

Aspect	Average Score ($\bar{X}$)	Interval	Category
Visual	9	7.20 <$\bar{X}$	Very good
Audio	1	0.80 <$\bar{X}$	Very good
Navigation	1	0.80 <$\bar{X}$	Very good
Manipulation	1	0.80 <$\bar{X}$	Very good
Conformity of Objectives	3	2.40 <$\bar{X}$	Very good
Clarity of Instructions for Use	3	2.40 <$\bar{X}$	Very good
Clarity of Performance	3	2.40 <$\bar{X}$	Very good
Material	5	4.00 <$\bar{X}$	Very good

Table 5 shows the practicality of VR-IPA media which has a very good category. This can be seen from all aspects of having a very good category. Meanwhile, the results of students' responses to VR-IPA media can be seen in table 6. Table 6 shows that according to students, the science materials in VR-IPA media have very good facilities and the virtual reality display is also very good. The students show enthusiasm in using VR-IPA media. This is considered very good because the teacher must get the attention of students and make them excited before the teacher gives the concept of learning material [8]. Students state,that are very interested in navigation in a virtual reality environment. Students feel the ease of using VR programs and provide enjoyment in learning, a sense of reality and ease of understanding concepts. Virtual Reality helps students actively participate and immerse themselves in learning activities so that they are preferred over other multimedia programs [9].

VR technology can improve the students' abilities and gain the interest in learning by using generative learning strategies. Students will learn to actively participate in the learning process and construct the meaning of the information obtained [10]. Technological innovation like VR can help teachers to create exciting new opportunities to support various types of interactive learning environments. VR definitely can act as an interactive learning environment, even better than learning by using 2D technology. Student who participate in learning with VR get higher learning outcomes than students who use 2D technology. The VR simulation technique used in his research is also more effective in helping students to get better learning outcomes [11].

Table 6. The result of students' responses of VR-IPA media.

Indicator	No	Statement	Score (%)	Total Score (%)
Ease of Materials to be Understood by Students	1	The presented materials are clear	100	98
	2	The materials become interesting to learn	100	
	3	The media is easily accessed in learning	91	
	4	The operation instructions of the media are easy to understand	100	
The display in VR-IPA is attractive	5	Brightness of the object does not dazzle the eye	88	94
	6	6 The brightness of the environment does not dazzle the eyes	88	
	7	Matched object colors	97	
	8	Matched environment colors	97	
	9	Environment colors are matched with the reality	94	
	10	The font size can be read properly	94	
	11	The object size is suitable so that it can be observed	94	
	12	The button is in the same place	91	
	13	The audio sounds properly	97	
	14	The given feedback is appropriate	100	

Table 6 shows that according to students, the science materials in VR-IPA media have very good facilities and the virtual reality display is also very good. The students show enthusiasm in using VR-IPA media. This is considered very good because the teacher must get the attention of students and make them excited before the teacher gives the concept of learning material [8]. Students state,that are very interested in navigation in a virtual reality environment. Students feel the ease of using VR programs and provide enjoyment in learning, a sense of reality and ease of understanding concepts. Virtual Reality helps students actively participate and immerse themselves in learning activities so that they are preferred over other multimedia programs [9].

VR technology can improve the students' abilities and gain the interest in learning by using generative learning strategies. Students will learn to actively participate in the learning process and construct the meaning of the information obtained [10]. Technological innovation like VR can help teachers to create exciting new opportunities to support various types of interactive learning environments. VR definitely can act as an interactive learning environment, even better than learning by using 2D technology. Student who participate in learning with VR get higher learning outcomes than students who use 2D technology. The VR simulation technique used in his research is also more effective in helping students to get better learning outcomes [11].

The benefits of using virtual reality technology for learning. First, VR technology can increase students' motivation and involvement. Students have deep experience and learn 3D models that can enhance their learning experience. Second, it allows constructivist learning approaches because students are free to interact with virtual objects that support them to investigate, develop, and get object feedback in VR. Third, the latest technological advances facilitate access to VR with smartphones, tablets, and videogame devices. Complex devices are no longer needed, and students can

access VR content that is shared through public online platforms. Finally, students feel immersive when interacting with concepts, objects, and processes with the help of using VR hardware [2].

However, several weaknesses in implementing VR technology can also occur. One of them is the difficulty in operating VR program or application. VR system requires the users to adapt to certain operating method. They suggest to ensure that before implementing VR in the classroom, teachers must be trained first. Meanwhile, students must also receive some relevant training before using a VR system to ensure smooth use in the learning process [12].

4. Conclusion

The VR-IPA media developed is considered suitable for use in science learning. This can be seen from the excellent validity, excellent practicality and excellent student responses. Thus, Virtual Reality technology can be an innovation in developing learning media as it makes students enthusiastic in learning and provides real experiences for them.

References

[1] Cellan-Jones R (2016, January 1) *2016: the year when VR goes from virtual to reality*. Retrieved from http://www.bbc.com/news/technology-35205783
[2] Gutiérrez J M and Mora C E 2017 *EURASIA Journal of Mathematics Science and Technology Education* **13** 469–86 https://doi.org/10.12973/eurasia.2017.00626a
[3] Steinberg R N 2013 *American Journal of Physics* **68** S37-S41 https://doi.org/10.1119/1.19517
[4] Wartinbee E (2009, April 1) *The Value of Technology in the EFL and ESL Classroom: using the smartpen to enhance the productivity and effectiveness of ESL instruction* Retrieved from http://hdl.handle.net/1803/2910
[5] Lari F S 2014 *Proc. Int. Conf. on Current Trends in ELT (Urmia)* vol 98 (Amsterdam: Elsevier) p 1672–7 https://doi.org/10.1016/j.sbspro.2014.03.592
[6] Ogunniyi M B 2007 *European Journal of Science Education* **5** 37–41 https://doi.org/10.1080/0140528830050207
[7] Owoeye J S 2016 *Asian Social Science* **7** 64-74 http://doi.org/10.5539/ass.v7n7p64
[8] Allison D and Hodges L 2000 *Proc. of the ACM symposium on Virtual reality software and technology (Seoul)* (New York: ACM) p 160–5 https://doi.org/10.1145/502390.502420
[9] Shim K C, Park J S, Kim H S, Kim J H, Park Y C and Ryu H I 2003 *Journal of Biological Education* **37** 71–4 https://doi.org/10.1080/00219266.2003.9655854
[10] Parong J and Mayer R E 2018 *Journal of Educational Psychology* **110** 785-97 https://doi.org/10.1037/edu0000241
[11] Kim P and Kim P 2007 *Interactive Learning Environments* **14** 37–41 https://doi.org/10.1080/10494820600697687
[12] Liu D, Bhagat K K, Gao Y, Chang T W and Huang R 2017 *Virtual, Augmented, and Mixed Realities in Education* ed D Liu, C Dede, R Huang and J Richards (Singapore: Springer) chapter 7 pp 105-30