The Development of Learning Media for The Kinetic Theory of Gases with Augmented Reality Technology

Rifqa Gusmida S.B
Nur Islami, M. Rahmad

Faculty of Teacher Training and Educational Sciences, University of Riau
Email: rifqa.gusmida@gmail.com

ABSTRACT

Nowadays, Augmented Reality takes on a new purpose in education. Augmented Reality enables in influencing the effectiveness of learning, especially to learn abstract phenomena using a concrete way. The objectives of this research were developing, designing and validating the learning media for the theory kinetic of gases with Augmented Reality. The methodology of this research followed the Research and Development (R&D) method using instructional design type ADDIE, includes the step of analysis, design, development, implementation, and evaluation. Sources of data were the assessment sheet provided to 6 validators. Aspects assessed included designing, pedagogical, learning content and ease of use. Furthermore, data were analyzed descriptively to determine the result and the validity. The result showed that validation assessment of all aspects got average score 3.55 with a very high category. Therefore, concluded the learning media is declared valid, it is eligible to be used as the learning media of physics.

***Keywords**: Augmented Reality, Kinetic Theory of Gases, Learning Media*

Introduction

Physics is a branch of the science that study natural phenomena or non-living system, physics uses a process consisting of observation, measurement, analysis, and conclusion. The conclusion must be based on a scientific attitude, objective, in accordance with the facts, honest, patient, not easily give up, tenacious and meticulous in taking a conclusion. However, in practice, physics is studied through a mathematical approach. Though the lesson of physics is not only to understand in terms of mathematics but furthermore that is able to understand the concept contained therein, understand the root of the problem so that it can be solved mathematically (Bagus, 2010).

The nature of the physical matter is composed of concrete and abstract concepts. There are phenomena that are clearly visible and felt by the human senses, in several cannot because of the limitations of the human sensory apparatus. If not using the tools to learn it, learners will have difficulty observing the phenomenon being studied. Thus, learners only know the phenomenon of the teacher's verbal explanation. Ika (2014) argues verbal explanations are received and processed by learners differently. For students who are difficult to imagine, students will only be

accustomed to memorizing the concept of physics without knowing the real process. Students who can imagine does not mean to be more understanding because the explanation will be visualized differently by each student according to the level of his imagination. That way learners cannot master the concept appropriately resulting in misconception. From the lack of concept, learners will be more difficult to solve the problems of physics both theoretically and mathematically. If left unchecked will have an impact on the low learning outcomes of learners.

In the learning syllabus Curriculum 2013 in Senior High School, learners are required to be able to understand the physics learning materials about the kinetic theory of gases in explaining the characteristics of gas in enclosed spaces (Kemendikbud, 2013). M. Chandra (2014) says that in studying the kinetic theory of gases, there are many abstract concepts in the discussion of microscopic particle behavior of the gas and its relation to macroscopic quantities. The abstract characteristics of the material will be easily understood when it is related to daily experience visualized in learning, therefore it is necessary for the media to enable the simulation of the material of the kinetic theory of gases in microscopic phenomena so that the concepts of the kinetic theory of gases are easy understood by learners.

Brown in Larlen (2014) revealed that learning media used in learning activities can affect the effectiveness of learning. With the media, the teacher can explain about the material that will be delivered easily, as well as the students, will also easily understand the material. One suitable medium to help study the kinetic theory of gases is computer media. Computer media is able to make concepts that become abstract concretely with static and dynamic visualization. In addition, the computer can make the explanation of the concept of physics more interesting, thus increasing the motivation to learn and understand it.

Nowadays, the development of information technology quickly and uncontrollably so that the impact is also felt in the world of education. This resulted in the development of instructional media, which offers alternative learning media for the implementation of teaching and learning activities. In line with these developments, the new technology emerged in the form of Augmented Reality. Augmented Reality is very useful in improving the teaching and learning process because Augmented Reality technology has visualization aspects that can arouse the interest of learners to understand concretely material presented through three-dimensional visual representation by involving user interaction in Augmented Reality frame (Wibisono, 2011).

Based on the explanation, Augmented Reality technology will be suitable to be used as one of the solutions of the problem in studying material of the kinetic theory of gases. Augmented Reality is able to visualize real-time behaviors of gas particles in three dimensions virtually and learners can interact with these virtual objects. So that the movement of particles will look more real and more easily understood. The use of Augmented Reality in learning has been done before by Tri (2013) who conducted research on the implementation of Augmented Reality as the teaching medium of the solar system. The results showed that the use of Augmented Reality can improve participants' understanding of the solar system lessons because it is supported by additional reality so that learners have a picture of the solar system and can interact with the models of the planets. Not only that, Danacom *et al.*,(2013), in his journal on Mobile Augmented Reality:

the potential for education describes some researchers who successfully adopted Augmented Reality into the classroom to improve the participants' learning experience.

Therefore, it is necessary to develop the learning media by utilizing Augmented Reality technology. This study aims to design and create valid learning media using Augmented Reality technology on the kinetic theory of gases material. Accordingly, it is expected that this learning media can help students to master the concept of the kinetic theory of gases and become an alternative learning media for teachers in explaining the material of kinetic theory of gases.

Methodology

This research was conducted at the Learning Media Development Laboratory of the Physics Education University of Riau. This research starts from the design until finally the media is validated. Four months research period from February 2016 to June 2016. This research uses R & D method (Research and Development) by using instructional design model of ADDIE type including analysis, design, development, implementation and evaluating.

The ADDIE model begins with an analysis of teachers, students, and the curriculum. It analyzed the difficulties of teachers and students in teaching and learning process. The results of this analysis can be used as a reference in the design and development of research products to be made. Steps started from the making of History board are ideas that will be designed, which includes material, designs of three-dimensional objects, markers and modules Augmented Reality. These designs are evaluated to be in accordance with the problem analysis. After the designs process continues with the development of the program. This development is evaluated to be in accordance with the designs that have been done. Implementation is a concrete step to implement the system that has been created. The media or products that have been developed will be tested to the experts for testing in the process of adjustment to achieve the quality of the desired system, then the evaluation. If not appropriate, repaired again to achieve the desired results. If the implementation phase is in accordance with the expected, then the media developed can be tested its feasibility (tested the validity of content and construct validity). For the evaluation phase is done at each stage of the ADDIE model.

The object of this research is learning media device using Augmented Reality on the kinetic theory of gases material. Source of data in this research is validity assessment score given by validator which is 3 lecturers of the Physics Education University of Riau as media expert and content of the lesson and 3 high school teachers in Pekanbaru as the expert user. Validator validates the learning media evaluates the learning media and then fills in the validation questioner adapted from the development of media criteria written by MohdJasmy*et al.*, (2014). Data analysis technique used in this research is descriptive analysis technique by using descriptive statistics. Statistics used to analyse data by way of describing or describing the data that has been collected as it is (Sugiyono, 2015). Determination of validity level of instructional media using the Likert scale, to design aspect, pedagogy, content, and ease of users with valid criteria in the high and very high category.

Result and Discussion

Physics learning media is designed with the basics of learning and learning theory, which is constructive learning. The approach and

strategy used in designing this medium are scientific.

Learning Media Design

The development of this medium was made for three meetings consisting of several materials and equipped with exercise. Each meeting begins with an apperception. This apperception is adapted to the material. The next process is to create markers using Photoshop applications and three-dimensional objects using the Blender application. The design results are evaluated before proceeding to the development stage (Figure 1).

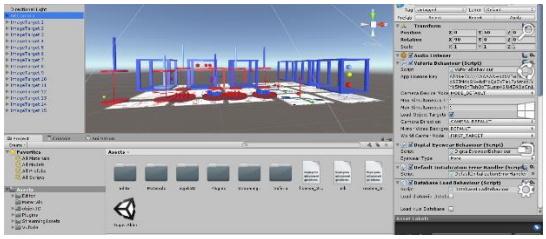

Figure 1. Graph of The process of integrating between three-dimensional objects and markers

Learning Media Results

The result of making this instructional media is the application in *.apk* format. With the format of learning, media products can be used on any Android-based mobile phone. Learning media provides information on the material of the kinetic theory of gases through writing in Augmented Reality module and virtual animation (Figure 2).

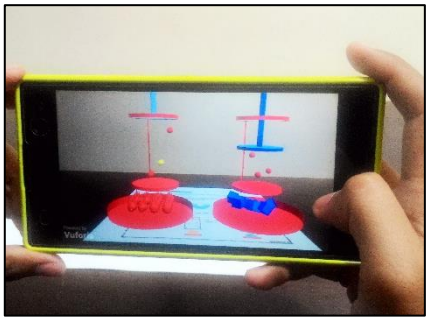

Figure 2. Graph of Representation of Augmented Reality

The Augmented Reality module is divided into 2 parts, the beginning, and the contents section. In the beginning consists of cover, instructions for media usage, learning instructions for students. The content section consists of competencies, subject headings, material concepts, motivations, drawing markers, sample questions, exercises, and evaluations. Augmented Reality module is 32 pages printed in A4 size. On the page containing the marker will bring up the animated visualization of the kinetic gas material through the mobile phone camera by directing the camera on the marker image contained in the Augmented Reality module.

The application of kinetic gas theory can run on mobile phone devices with a resolution of at least 480x800px and can run offline (not connected to the internet). Mobile phone devices that support gas kinetic theoretical applications use a minimal operating system version 2.3 (Ginger Bread) and 24.2Mb of memory storage.

Test Media Validity

Test Validation of learning media is done on 4 aspects of design aspect, aspect pedagogic, learning aspect and user amenity aspect. Validation is done 2 times, where the first validation for repair and second validation for assessment. The suggestions given validator during the first validation can be seen in Table 1.

Table 1. Data Revised aspects

No	Saran Validator
1	Correct the apperception phrase to be more motivating

2.	Fixed a three-dimensional object that shows the collision process
3.	Fixed a three-dimensional object that shows the gas particles as point particles
4.	Differentiate markers and other images by adding dashed box lines
5.	Make a grid to make the learning indicators reach
6.	Changing the practice samples on Gay Lussac's law
7.	Replace the word marker in the module into a three-dimensional object
8.	Changing the title and subtitle design to see the difference between the two

The validation results from expert content and users can be seen in Table 2 and Table 3.

Table 2. Data Average scoring score of each aspect by content and content expert

No	Aspect	Score	Description
1	Aspects of Design	3,48	Valid
2	Pedagogic Aspects	3,63	Valid
3	Aspects of Learning	3,53	Valid
4	Aspects of User Ease	3,52	Valid
	Validity Score	3,54	Valid

Table 2. is an overall assessment of content and content expert. The highest score is in the aspect of pedagogic with score 3.63 whereas the lowest value is in the aspect of design with score 3,48. With an average score of 3.54.

Table 3. Data Average score of assessment of each aspect by the user's expert

No	Aspect	Score	Description
1	Aspects of Design	3,52	Valid
2	Pedagogic Aspects	3,56	Valid
3	Aspects of Learning	3,63	Valid
4	Aspects of User Ease	3,52	Valid
	Validity Score	3,56	Valid

Table 3. It is an overall assessment by user experts. It is seen that the highest score is in the learning aspect with score 3.63 whereas the lowest value is in the design aspect and the ease aspect of the user with the score 3.52. With an average score of 3.56.

Discussion

Validation of learning media is done on 4 aspects, namely design aspect, pedagogic aspect, learning content aspect and user amenity aspect. The validation result of physics learning media using Augmented Reality technology from all aspects has a validity value of 3.55. This is evidenced in Table 4

Table 4. Data Assessment of overall validity

No	Aspect	Score	Description
1	Aspects of Design	3,50	Valid
2	Pedagogic Aspects	3,59	Valid
3	Aspects of Learning	3,58	Valid
4	Aspects of User Ease	3,52	Valid
	Validity Score	3,55	Valid

The highest score is in the pedagogic aspect with point 3.59 while the lowest value is in the design aspect with point 3.50. With the final value is 3.55 then the learning media using Augmented Reality technology on the material of kinetic theory of gas class XI class is declared valid in the very high category.

This research is expected in line with research Tri (2013) who conducted research on the implementation of Augmented Reality as a medium of instruction of the solar system. The results showed that the use of Augmented Reality can improve participants' understanding of the solar system lessons because it is supported by additional reality so that learners have a picture of the solar system and can interact with the models of the planets.

The minimum specification of the Blender app is a dual-core or equivalent processor and 2 GB of RAM. Recommended specifications are i5 or equivalent core processor and 8 GB RAM. Laptops used in the manufacture of learning media are only able to meet slightly above the minimum specification so that each animation is made on average 60 frames, consequently some animations look less real. The Augmented Reality application does not have a close button because of the researcher's limitations in terms of programming, but this can be anticipated by pressing the home or back button on android if you want to exit the application. For markers 4 and 5 there is a delay when displaying the animation, this has been minimized by fixing the marker, but until now this still happens sometimes.

Conclusion

Physics learning media using Augmented Reality technology on the material of the kinetic theory of gas class XI SMA has been successfully built. The development of learning media has been declared valid with a very high category. So that the learning media is worthy of use as a medium of physics learning for high school students XI High School.

The results of this study can be used as one alternative solution in the selection of physics learning media in teaching materials abstract the kinetic theory of gases. And, can be a reference for those in need, especially educators in the field of science to continue to innovate. This research is expected to be further developed in the field of reliability and practice test.

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