Development of virtual reality technology in environmental pollution media learning content for junior high school students

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Abstract. Virtual Reality is a learning media that allows students to independently find out, explore, and build their own knowledge in the context of learning resembling the desired environment in the delivery of learning content. The development of virtual reality has a role to bring students into an environment in this case the sea coast and as if students will experience the view of a clean or uncontaminated coastal environment and a polluted coastal environment. In developing this virtual reality product, the developer uses the ADDIE model which consists of 5 steps, namely: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. The trials in this study involved content experts, media experts, individual tests (3 students), small group tests (9 students), and large group tests (25 students). The result of content expert validation was 83% (High). The results of media expert validation were 90% (Very High). The results from individual tests amounted to 85% (High). Small group test results at 87% (High). Large group test results at 84% (High). The conclusion of this development research, virtual reality learning media about "environmental pollution" is very suitable to be used as a learning media to support teachers in delivering learning content.

1. Introduction

Currently, the world is entering an era where the industrial revolution 4.0, also known as the Fourth Industrial Revolution ("4IR") where the use of technology to dominate in human life. In this era of rapid technological developments and unlimited creativity caused by the development of the Internet and digital technology, in which this era has affected many aspects of life in the fields of economics, politics, kebudayaan and even to the world of education. Along with the development of the industrial revolution 4.0 in this era must be balanced with the readiness of the human resources (HR), which can contribute to the realization of the so-called industrial revolution 4.0. With the need for qualified human resources, education must be in tandem with the development of the industrial revolution 4.0 thus was born the concept of educational revolution 4.

Education 4.0 is a response to the needs of the industrial revolution 4.0 where humans and technology in harmony to create new possibilities. Schwab (2017) rapid technological growth led to a breakthrough artificial intelligence, nanotechnology, biotechnology, autonomous vehicles, and 3D printing is an example of the vast current technological developments. The number of technological breakthroughs have influence in the world of education so that education and technology combined with each other to produce human resources who are ready and responsive. In supporting the
advancement of education in Indonesia in the education 4.0, the government has set about the technology needs within the various laws and regulations of the republic of Indonesia. One was listed in Permendiknas No. 41 of 2007 on Processing Standards, according to the Graduate Competency Standards and Standard Fill the learning principle used in point to 13 Permendiknas No. 16 of 2007 states that "The use of information and communication technologies to improve the efficiency and effectiveness of learning".

The use of information and communication technology in learning so far has not done effectively because teachers still use the lecture method and the book as a source of learning, so that students feel bored and drowsiness during the learning and impact on student interest in learning to decline. Great interest influence on learning activities, the greater the students' interest in learning the material presented by the teacher more easily understood by the students. To increase the interest of students a teacher must design and implement appropriate learning models so that students are more interested and feel good about the activities pembelajaran, the use of the book it is less effective for merasang desire of students to become interested in learning because the book is not representative, not interactive because the book is a medium 2D.

Active learning can be done if students are interested in the activity of delivery of material from teachers, interactive and fun. Selection of teaching materials become the main focus for attracting the interest of students in the learning process, the selection of the wrong materials will reduce the interest of student learning, because students are not interested in what is delivered by teachers with teaching materials or media that is used. The use of books in the subjects of Science of Nature (IPA) with the material of environmental pollution as the teaching materials used by teachers will have a direct impact to the students if the environment is polluted, it is inversely if the student environment clean and not polluted because students do not feel the incident submitted by teachers through the media or teaching materials such as books.

According to Lin (2017) The use of teaching materials in education era 4.0 apply digital teaching materials to achieve the goal of national competitiveness that will replace the traditional teaching model. Thus the need for media that can make students able to feel or bring students to feel how the environment is polluted and unpolluted environment. The emergence of education 4.0 in tandem with the industrial revolution that made the technology in the field of education progress and renewal, one of which is Virtual Reality (VR) in the form of technology virtual reality that brings the user to interact with the images digitally in an environment simulated by computer (Computer-Simulated Environment). An environment that is imitated or really is an environment that only exists within (Adnan, Ristekdikti Vol.8.1.2018).

Previously been investigated on "The Potential of Augmented Reality to Transform Education into Smart Education" by kiryakova, et al. (2018) which presents the advantage of augmented reality as one of the technologies that can create an environment that combines reality and virtuality that becomes an opportunity to apply new teaching methods in education.

It has been further researched on "Using Virtual Reality and Augmented Reality in Learning Object: a case study for teaching engineering drawing" by Pohlmann, and Da Silva (2019). In the present research a new generation method for learning teaching techniques draw with the technology of Augmented Reality and Virtual Reality.

And the latter has been investigated on "Development of Virtual Reality instructional media on material introduction of fiber optic splicing and termination" by Arkadiantika (2019). In research carried out to facilitate the students to practice cutting and splicing of fiber optic cable in virtual reality in android smartphone because the cost of the equipment and materials used in practice expensive for budgeted.

In this study focused on the matter of environmental pollution in the subjects of natural science, in response to the information and communication technology innovation as a learning medium that will bring students into the learning environment delivered by the teacher. From the above explanation it is necessary to create a virtual reality-based learning media android to learn about the environment is
polluted or not polluted for students of SMPN 1 Kamal. instructional media aims to help students understand how the environment is good and bad.

2. Methods
The method used in developing virtual reality learning media "environmental pollution" ADDIE this model is described in the following graph:

![Chart 1. Stages of Development ADDIE Model (source: Sink, 2014).]

2.1. Analysis
The analysis phase is the stage where the researcher conducting digging for needs analysis information, in the form of survey activities or classroom environment to determine what things is the basis, priorities, and objectives of product development of instructional media Virtual Reality environment pollution. Some things that are usually analyzed at this stage that the learning objectives, analysis of student characteristics, learning environment analysis, analysis of problems in learning, and learning media analysis to troubleshoot problems that occur during the learning. In this analysis phase must be obtained data is correct, because the stage of the analysis affect the next stage. If ditahap analysis is done correctly, the process of development will be more directed and focused so that problems can be solved in the learning process.

2.2. Design
The design stage is the stage where the developer makes design or alternative solutions in the form of a blueprint. The design of the design or blueprint should be based on data obtained in the analysis phase should correspond to the learning objectives, student characteristics, learning environment with a problem that should be addressed, and in accordance with appropriate learning media types. The blueprint can be made in the form of design sketches, schematics, flowcharts, storyboards, screenplay, script, design, design drawings, and illustrations used as a basis and clarify the direction of development of instructional media to be created. In the design phase, to be carried out with precise, specific, and clear so as to facilitate the developers to do the next stage.

2.3. Development
The development stage is the stage where a blueprint that has been made in the design phase and then developed to become a real product in the form of specific learning media. At this stage, the developer
dealing in making or modifying materials in such a way to be a real learning media that are ready to be applied in the learning environment or classroom.

2.4. Implementation
Implementation stage is the stage where the developer to implement or realize the media that have been made in the development phase into the real scope of learning. Implementation in the development environment should be applied in a way that the real and not just modest. In terms of learning media as a whole must be fully implemented and developing a comprehensive in scope, not just to the presentation of instructional media in passing. Must be applied within the scope of development, especially in the classroom.

2.5. Evaluation
Evaluation stage is the stage where the developer conduct an evaluation to determine the extent of adherence to pembelajaran media refers yan development objectives have been determined in the previous stage. At this stage, will be presented the results of the evaluation of the validator (expert) and the students (learning media users). The evaluation results of two such developers will bring the scope of quantitative and qualitative data. The quantitative data in the form of respondents' assessment in the form of numbers or percentages relating to the feasibility study media are developed. While the qualitative data from the evaluation results will display the data in the form of criticism, and suggestions regarding products developed learning media.

3. Result
From the results of the development that has been made, the next step is to test the feasibility of a product that has been developed is a virtual reality learning media “Environmental Pollution” to the students of SMPN 1 Kamal to determine the effectiveness, efficiency and attractiveness of the media by using a questionnaire that has been prepared. Filling in the questionnaire using a scale of five ratings of products, namely: (1) Very low, (2) Less High, (3) High Enough, (4) High, (5) Very High. After the questionnaires were collected, each question in the questionnaire will be calculated according to the percentage formula I. Komang Sudarman (2006) are as follows:

\[
\text{Percentage of answers} = \frac{F}{N} \times 100\% \tag{1}
\]

Information:
F = The total value of the respondents
N = Total the maximum value

Results of the analysis of this data is used to revise the product development, evaluate the product, and provide further advice on the use and development.

4. Discussion
From the data results of the validation performed by Setya Chendra Authority, S.Pd., MT as a validator of media experts, diketehui average percentage of the overall value of learning media Virtual Reality in terms of learning media is 90%. This shows that the Virtual Reality instructional media products included in the qualification of "Very High" and no revisions are required. Meanwhile, data from the results of the validation performed by Mochammad Yasir, S.Pd., M.Pd. as validator content experts, diketehui average percentage of the overall value of Virtual Reality instructional media in terms of subject matter is 83%. This shows that the instructional media products based Virtual Reality environment pollution included in the qualification of "High" and doesn't require revision.

The above data comes from a due diligence questionnaire conducted in the form of media experts and subject matter experts. So that the results obtained with high values of criteria indicating that media-based learning virtual reality environment pollution can be directly used by the user and
does not require revision. It is not in spite of the attractiveness of the media that is interkatif. In addition, the user interface design is very interesting and clarity of delivery of content in the media is able to be an added value in improving the quality of teaching media.

From the data generated during the testing of individuals consisting of 3 students of SMPN 1 Kamal, discovered that the average percentage of the overall value of virtual reality learning media is 85%. This shows that the Virtual Reality instructional media products included in the qualification of "High" and do not require revision. From the data generated during the small group trial consisting of nine students of SMPN 1 Kamal, discovered that the average percentage of the overall value of learning media Virtual Reality is 87%. This suggests that virtual reality learning media included in the qualification of "High" and do not require revision. Recently the results of a large group trial consisting of 25 students of SMPN 1 kamal, it is known that the average percentage of the overall value of learning media Virtual Reality is 84%. This shows that the product of development that consists of virtual reality learning media for environmental pollution is qualification in the "High" qualification and does not require revision.

The above data comes from a questionnaire feasibility test conducted for students of SMPN 1 Kamal, so that the results obtained with high value criteria that indicate that virtual reality learning media environment pollution can be accepted and used by SMPN 1 Kamal. It is inseparable from the attractiveness of teaching media in the form of display media in the form of Virtual Reality, sounds that users seemed to sense the state of the environment is seen, the use of which is due to sensors, gyroscope, the use of the object of interest, in accordance with the content taught, the user will feel immersion into the virtual environment, and learning media virtual Reality can be used anywhere using android smartphone VR along with tools Box.

| No. | Screenshot Media Virtual Reality | Description |
|-----|---------------------------------|-------------|
| 1.  | ![Screenshot](image1) | - The Home view of the virtual reality environment pollution.  
- "KI / KD" option to determine the basic competencies and core competency of learning.  
- "Clean" option to enter the environment as clean.  
- "Contaminated" option to enter into a contaminated environment. |
| 2.  | ![Screenshot](image2) | - Menu display material that displays information about environmental pollution, all kinds of pollution, impacts and ways to tackle pollution. |
| No. | Screenshot Media Virtual Reality | Description |
|-----|---------------------------------|-------------|
| 3.  | ![Screenshot](image1.png)       | - Menu KI / KD displays about core competence and basic competence raised in the matter of environmental pollution. |
| 4.  | ![Screenshot](image2.png)       | - Menu instructions shows how the use of virtual reality media lesson "Environmental Pollution". |
| 5.  | ![Screenshot](image3.png)       | - Menu setting displays about the Audio settings of this VR learning media. |
| 6.  | ![Screenshot](image4.png)       | - See bio for the development of instructional media virtual reality "Environmental Pollution".  
- Collaboration informatics education of students and lecturers of the university Trunojoyo. |
| No. | Screenshot Media Virtual Reality | Description |
|-----|---------------------------------|-------------|
| 7.  | ![Screenshot Media Virtual Reality](image1.png) | • User Views out of the virtual reality learning media.  
• Displaying notices to go out or not. |
| 8.  | ![Screenshot Media Virtual Reality](image2.png) | • Virtual reality display environment clean.  
• Users will be brought into the immersion feel clean environment without pollution.  
• Backsound cheerful for clean environment.  
• Featuring fish, coral, turtles.  
• Featuring a clear sky.  
• Featuring a clean coastal environment |
| 9.  | ![Screenshot Media Virtual Reality](image3.png) | • Virtual reality display polluted environment.  
• Users will be taken to feel immersion into the environment is polluted.  
• Backsound music using dirty instruments tense atmosphere.  
• Featuring fish carcasses.  
• Environment filled with garbage. |

## 5. Conclusion
From the research development of instructional media that has been done, it can be concluded that the instructional media virtual reality "environmental pollution" has been declared fit at the test level of effectiveness, efficiency, and attractiveness. Learning media presents the experience to users or students to feel a clean environment and a contaminated environment as to be directly in a virtual reality which has been simulated in such a way. The advantage of this learning media is the user or student can feel the experience of being in the environment that has been created in such a way. From the use of this medium users or students can easily distinguish how environmental pollution and give a positive message to always keep the environment.
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