The 3-D animation of radiation concept using augmented reality technology

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Abstract. Radiation concept in Nuclear subject in Physics Learning include some devices, such as Geiger Muller counter, Wilson cloud chamber, scintillation detector. This research aims to visualize the radiation concept from that device using augmented reality technology. The result shows the 3-D animation can: describe the mechanism of the Geiger Muller counter detector to detect radiation; describe the mechanism of Wilsons fog chamber detects radiation; and describe the mechanism of the scintillation detector tool to detect radiation. All the markers developed to get a decent value to be used as a medium for learning physics about radiation concept.

1. Introduction
The combination of learning media based on computer technology with the appropriate learning strategies surely can improve students' understanding of various skills. These forms of exploration can be through interactive simulations [1], dynamic robot interactions [2], simulation and computational modeling [3], PhET simulation [4], spreadsheets [4], and virtual environments [5-7]. The virtual environment can be in the form of learning media based on virtual reality (VR) and augmented reality (AR).

AR is currently one of the trends in various fields, including the field of teaching and learning [5]. The virtual environment has been shown to improve students' performance in writing [8], improve mathematical conceptual and procedural skills [1,9], or enhance the understanding of Physics concepts [10]. AR, as a learning media, can combine experience in terms of reality and imagination and even facilitate learning in children with special needs [7]. Based on these advantages, the development of AR as a medium to improve the effectiveness of learning is a must urgent.

An initial analysis must precede the development of AR in each learning material. One was carried out in the form of material analysis. In Physics lessons, many concepts are indeed suitable if the delivery uses AR, for example, to visualize concepts with abstract characters. The concept of radiation is one of them because the activities of learning activities cannot be like laboratory activities in general [10]. This study aims to create augmented reality objects to visualize the concept of radiation through AR technology. These objects include Geiger Muller counter, Wilson cloud chamber, and scintillation detector.

2. Method
This research was conducted through three stages, namely analysis, product design, and evaluation. Radiation concept in Nuclear subject in Physics Learning include some devices. The Geiger Muller
counter is performed to understand the pulse shape dependence on operating voltage [11-13], and it is of practical interest to further extend the usage areas of these detectors [14,15]. Wilson cloud chamber to observe atmospheric phenomena [16] and that chamber is sensitive to nuclear radiation [17], and Scintillation detector [18]. These three objects were developed based on the analysis of learning objectives [19]. This analysis has implications for the selection of learning strategies, student assignments, evaluation, and other educational properties.

3. Results and discussions

Figure 1 and figure 2 shows the animation from the Geiger Muller counter. This animation aims to enable students to describe the mechanism of the Geiger Muller counter detecting radiation.

![Image of Geiger Muller counter animation in 2-dimensions view.](image1.png)

![Image of Geiger Muller counter animation in 3-dimensions view.](image2.png)

Figure 1. The Geiger Muller counter animation in 2-dimensions view.

Figure 2. The Geiger Muller counter animation in 3-dimensions view.

Figure 3 and figure 4 animated shows Wilson's cloud chamber aims for students can describe the mechanism of Wilson's cloud chamber detect radiation.

![Image of Wilson's cloud chamber animation in 2-dimensions view.](image3.png)

![Image of Wilson's cloud chamber animation in 3-dimensions view.](image4.png)

Figure 3. Wilson's cloud chamber animation in 2-dimensions view.

Figure 4. Wilson's cloud chamber animation in 3-dimensions view.

Figure 5 and Figure 6 show scintillation detectors. This animation aims to enhance the students understanding to describe the mechanism of the scintillation detector to detect radiation.

![Image of scintillation detector animation.](image5.png)

![Image of scintillation detector animation.](image6.png)
Figure 5. The scintillation detectors animation in 2-dimensions view.

Figure 6. The scintillation detectors animation in 3-dimensions view.

After product development in the form of an AR object, an expert evaluates it. This evaluation is in the form of an assessment of the quality of AR objects produced and suggestions for improvement. This stage provides a very good interpretation of the Physics learning media experts. Suggestions given include adjusting the size of the object so that it can be easily implanted in an android application, which is the final form of the product being developed. Our AR animations have been developed compared to references (shown in Table 1).

Table 1. The comparison result of research with the reference.

| Aspect                | Reference [20] | Our Results |
|-----------------------|----------------|-------------|
| Contents of AR        | 100%           | 88%         |
| Interface AR          | 100%           | 100%        |
| Material conformity   | 81.33%         | 100%        |
| Average               | 93.77%         | 96%         |

From table 1, the comparison includes three aspects such as contents of AR, AR interface, and material conformity. First, the contents of the AR aspect the value from the reference is 100%, while the results of the study are 88%. The weakness in the research is the number of animations to explain the radiation concept is little. Second, the validation of the interface aspects from reference results and analysis get the value 100%. In this study, the interface components are assessed by the aspects of Layouts and Designing effective navigation. Third, the validation of conformity material aspects the value from reference results is 81.33%, and research is 100%. The reference does not discuss details about conformity material, but the study obtained that value because the animation made a match with the concept of physics and did not cause misconceptions.

4. Summary
The result shows the 3-D animation can: describe the mechanism of the Geiger Muller counter detector to detect radiation; describe the mechanism of Wilsons fog chamber detects radiation; and describe the mechanism of the scintillation detector tool to detect radiation. All the markers developed to get a decent value to be used as a medium for learning physics about radiation concept.

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