Developing an instructional media based on Augmented Reality animation for 3R topic (Reduce, Reuse, and Recycle) of thematic learning

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Abstract. An instructional media based on the recent technology is essentially required for thematic learning. This research and development aimed at developing an instructional media based on Augmented Reality animation for 3R (Reduce, Reuse, and Recycle) lesson. It employed an ADDIE development procedure that consist of five stages: analysis, design, development, implementation, and evaluation. The Product was validated by two experts; media and content experts. The trial was administered to 20 students and teacher as the prospective users. The instrument of this research was a questionnaire. The results of the instructional media based on Augmented Reality animation development for 3R lesson (Reduce, Reuse, and Recycle) confirm that the product is valid and feasible.

1. Introduction
The presence of modern technology plays a role as an effective instrument within a learning activities of student’s thematic lesson. Technology is indeed applicable to be used as a supporting element of an instructional media [1]. It is undeniable that the instructional media distinctly facilitates teacher to deliver lesson contents. In addition, the instructional media used by teacher constitutes an effective instrument to improve an understanding of students on certain lesson topic they studied [2,3] An attractive, accessible, and appropriate instructional media as a matter of fact plays a role as practical teaching facility. When the instructional media used by teachers is developed following the current development of technology, particularly if it is developed by integrating Information and Communication Technology (ICT), it becomes a remarkable supporting facility to support learning process [4-6]. In addition to its practicality, recent instructional media based on ICT promotes remarkable innovation and creativity to the users such as the teachers. However, recently, the implementation of instructional media during learning process is only limited to information delivery [7]. Teacher needs to design their own instructional media that is in accordance with the ability and characteristics of students; considering that teacher knows best their students.

Issues related with environment and climate changes are not an up-to-date one [8]. One of the lesson topics that discusses a sustainability of environmental protection is about waste and garbage management topic. If the waste and garbage are not maximally and efficiently managed, it would have a further consequential effect in the near future [9]. These days, the management of waste and garbage has attracted an attention from the related stakeholders [10]. However, the measures taken by the related stakeholders were not accommodated effectively. Waste and garbage are generally manageable through appropriate measures [11]. A general approach to manage waste and garbage is a 3R
procedures (Reduce, Reuse, and Recycle). This general procedure is possible to be implanted in individuals by first choosing the type of waste based on its characteristics [12-14]. To habituate the 3R procedure, it can be integrated into lesson content.

Recently, the learning activities have adopted thematic learning approach that focuses on the contextual learning strategy, including the lesson that discussed the phenomena of waste management. The learning related to 3R procedures (Reduce, Reuse, and Recycle) is important to be taught to students to communicate the understanding about low-carbon education [15]. The learning related to 3R procedures is practically able to be taught to students by using an instructional media based on information and communication technology; i.e. Augmented Reality Animation (AR) using Android.

This research aimed at developing an animation instructional media based on Augmented Reality (AR) for thematic lesson of elementary school students about 3R topic. An animation instructional media based on Augmented Reality by using Android platform is one of the brand-new technologies for studying. It captured a real picture of waste and garbage and transformed it into an animation of 3R results [16,17].

2. Methods
This research and development employed a systematic model of ADDIE. The development research based on ADDIE procedure consisted of five stages as follows: (1) the stage of analysis; (2) the stage of designing; (3) the stage of development; (4) the stage of implementation; and (5) the stage of evaluation. The developed product was then validated by media and content experts and was tested on teacher and students. To develop the instructional media based on AR, it utilized (1) Hardware that consisted of: laptop and smartphone; (2) Software that consisted of: Windows 10 Home operating system, Unity 3D, Blender; (3) Other materials such as pictures card with waste images.

3. Results and discussion
The application of AR animation is in the form of mobile application. It is accessible anywhere and anytime, but it is only accessible though Android based smartphone with camera. The development of AR animation for 3R topic was as follows: menu structure arrangement, uml programming, and interface designing. The detailed development is presented in the following Figure 1.

The development result of AR animation media enables to change a real object into a virtual object in a short time since if we practice to have a real 3R process, it takes a relatively long process to obtain the results. It starts with a marker in the form of a real object image then scan it with Android based smartphone to detect. If the real object has been detected, an animated 3R image will appear and if it has not been detected, scan the object again in order to show the animation. The process that can be carried out through the instructional flow is shown in Figure 2:
Figure 2. The instructional phase of augmented reality media.

The process of instructional media is through: 1) Marker-Based AR presented from the merging of computer vision and image processing functions to find information from an image directly, 2) Tracking marker is an image scan of the database assisted by Vuforia as a service provider for the tracking marker process with computer vision as a motion analyser for image extraction, the Vuforia extraction process uses the NFT method, NFT is the process of detecting the presence of markers by looking at all the features; 3) Vuforia SDK for mobile devices for making AR applications on android, Vuforia is in unity, Vuforia AR extension for unity; 4) Unity 3D is a multi-platform based application that can operate in numerous operating systems and can publish to various file type formats, such as: exe, apk and others [18].

AR animation application display can be used by students as a learning process before learning with the augmented reality media. The students need to follow the instructions: 1) downloading and installing the application, 2) running the application, and 3) selecting the menu on the media homepage. The menu provided is the 3R procedure and students can choose one of them. The developed media, it provides examples of items that are no longer used, for example the used drinking bottles. In figure 3, this presents an animation that explains the Reduce procedure from a drinking bottle; The bottle can be used as a refill bottle to minimize waste. In figure 4, this presents an animation that explains the procedure of reusing bottles of drinking; the use of bottles can be changed into alternative containers. Then, in picture 5 it presents an animation that explains the Recycling procedure of a drinking bottle. Bottles can be modified as new and alternative items.
Based on the results of validation by experts appointed in the augmented reality animation media after being calculated using the formula: \( P = \frac{\sum x}{\sum ax} \times 100\% \), the scores obtained are presented in Table 1:

| Validator            | Results | Criteria |
|----------------------|---------|----------|
| Content Expert       | 86%     | Valid    |
| Media Expert         | 92%     | Valid    |

Based on Table 1, the score obtained from the content expert validator was 86% and the media expert was 92%. Therefore, the Augmented Reality animation media was declared valid. Furthermore, Augmented Reality learning media was tested on students and teachers. The scores obtained during the trial process are presented in the following Table 2:

| Respondents | Results | Criteria |
|-------------|---------|----------|
| Teacher     | 84%     | Practical|
| Student     | 83 %    | Good     |

Based on Table 2, the instructional media based on Augmented Reality is practical and interesting to use for thematic lessons on 3R topics (Reduce, Reuse, and Recycle). Furthermore, the results of the instructional media based on Augmented Reality research is accessible, practical, and interesting to be applied as a supporting element of the learning process [1,3,17]. This media plays a role as an alternative element to facilitate teachers in explaining waste management to be reused by students [9,19]. This media is accessible by using Android-based smartphone which is currently widely used by everyone, including students. This media is categorized as an interactive learning media because students interact directly with the content of lessons in the media [2,20,21].

This instructional media based on AR animation that is flexible in its use is attractive to most students, thus it can increase learning motivation of students [4,16,17]. In addition, this media can be used and accessed anywhere because it is installed on an Android-based mobile device [5,6,21]. Not to mention, through the implementation of the instructional media based on AR animation, it can encourage students to have a positive attitude related to waste management. Students will be more aware of waste problems and can recycle them to minimize future waste problems [9,11-13,19].
4. Conclusion
The development of the instructional media based on Augmented Reality animation for 3R lesson was used five stages of ADDIE development model. Based on the results of needs observation, it was conducted a program, design, and Content media development of the AR. Then, the media was assessed by the media and content experts as well as was trailed to students and teacher of elementary school. The revision was made based on the suggestions to create a qualified product as the instructional media based on Augmented Reality animation using Android-based smartphone.

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