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Research paper

Learning Media based on Augmented Reality Game

Endah Sudarmilah[1]*, Nurul Ustia[2], Dony Nuryanto Bakhtiar[3]

[1]Informatics Department, Faculty of Communication and Informatics, Universitas Muhammadiyah Surakarta
**Corresponding author E-mail: Endah.Sudarmilah@ums.ac.id*

Abstract

Augmented reality serious game has benefits in the fields of psychology, health, and education. The learning process using AR media has a potential to be developed. The study aimed to utilize Augmented Reality Educational Game (AR EduGame) as a learning media for elementary school students that is entertaining in the form of video games but can stimulate students' cognitive. The software prototype was designed, tested by the black-box method, and assessed by expert judgment method (elementary school teachers as experts) and usability assessment (students as users). The implementation results show that the AR EduGame was had quality and feasible learning media with the percentage of interpretation of more than 80% by both users and experts. It could be concluded that these AR EduGames can be considered a quality learning media especially in learning Indonesian Culture regarding *gamelan* and traditional dances.

Keywords: *AR EduGame; Expert Judgement; Usability; Children; Learning Media*

1. Introduction

Serious Game is a field of game development science that is widely developed nowadays [1]. Apart from providing comfort in playing, a serious game also has other serious goals such as health and psychological therapy, training and simulation, education, simulation, and also education [2]. Serious games can be classified as the games with technological, medical, and social objectives [3].
Recently, serious games involve a combination of virtual and real environments, which is known as augmented reality (AR) technology [4].
Augmented Reality merges (integrates) real-world objects learning into a virtual world or on the contrary, applying virtual object learning to the real world [4].
AR serious game has been used in many fields, including psychology, health, and education [3]. The implementation of AR Educational Game (EduGame) is discussed in this paper.
The study aimed to utilize AR EduGame as an entertaining learning media for elementary school students in the form of video games, but it can stimulate students' cognitive [5]. This study was expected to contribute more variations in student learning media in the form of video games (AR EduGame) which will further provide a positive step for improving student learning. The learning materials applied to this AR EduGame discussed Indonesian culture, specifically regarding *gamelan* (traditional musical instruments from Java Island) and variants of traditional dances from Indonesia.
We have conducted a preliminary study that developed and systemically tested the AR EduGame regarding Indonesian Culture discussing gamelan and traditional dances [6]. Then, it was continued with this paper that discussed the results of educational expert judgment by elementary school teachers and the results of AR EduGame usability tests by users, which were elementary school students.

2. Method

The method used in this study was the modified waterfall method, which is a part of the software development life cycle (SDLC) model [7].
This study began with the requirement analysis and ended with the implementation of the detailed steps that were taken. The study method is described in Figure 1.

2.1. AR EduGame Requirement Analysis

Requirement analysis was done by interviewing elementary school teachers and students and observing the curriculum of fourth-grade elementary school students in Indonesia. The results were factors required for developing AR EduGame [8] [7] regarding Indonesian culture.

2.2. Design of AR EduGame

In this step, the AR EduGame was designed. This step was done in the previous study, with activities in chronological order, the design of use case diagram, activity diagram, mock-up, and storyboard preparation [6]. The end result of this step is fined concept for AR Edugame that would be implemented on the next step.

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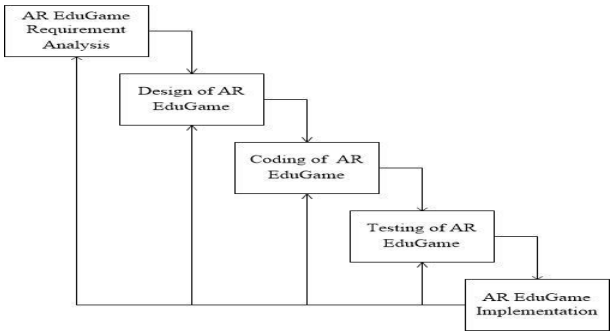


Fig. 1: Study Method

2.3. Coding of AR EduGame

In this step, the built software concept was actualized using the help of some programming tools, namely:
1. Unity3D
2. JAVA Platform (JDK)
3. Android SDK
4. Vuforia SDK

Unity 3D software and JAVA Platform (JDK) are used to compile AR EduGame assets and interactions built. Android SDK is conducted to emulate AR EduGame software into a more portable mobile platform, while Vuforia SDK is used to access its AR object markers.
The output of this step was the prototype of the AR EduGame as a learning media regarding Indonesian culture, particularly *gamelan* and traditional dances.

2.4. Testing of AR EduGame

The AR EduGame prototype system was tested by the black-box method to determine whether the AR EduGame system can function properly and as expected.
The test aimed to assess whether the game runs appropriately, including each interface and button works according to the design and whether the improvements needed [6].

2.5. AR EduGame Implementation

Before the AR EduGame was implemented as a learning media, it was assessed by expert judgment (elementary school teachers) and by elementary school students (usability assessment).

3. Results and Discussion

AR EduGame prototype regarding Indonesian culture that had been tested was then implemented on elementary school teachers and students. The AR EduGame's interfaces of *gamelan* and traditional dances are displayed in Figure 2.

3.1. Expert Judgement Assessment

Expert judgment assessment of the AR EduGame [9], [10] was done by 12 elementary school teachers who evaluate the material and the use of the AR EduGame. The assessment was done based on the questionnaire that was given to the teachers.
The questionnaire of expert judgment assessment had 12 items that explored the benefits and the use of AR EduGame from the teachers' perspective during the learning process.
The questionnaire items were validated using the t-test analysis. The results show that eleven items were considered valid and one item was invalid [11]. Meanwhile, the reliability test using the Cronbach alpha analysis yielded a value of 0.921. This value means that the questionnaire was reliable and it could be used to test the other AR EduGames [12].
The expert judgment results were then analyzed to assess the percentage of interpretation (PI) [13] of 11 valid questionnaire items. The result shows that every item obtained the PI value of more than 80% as can be seen in Figure 3 and detailed score in Table 1. The PI values show that the elementary school teachers considered the AR EduGame as a quality learning media regarding Indonesian culture, particularly *gamelan* and traditional dances.





Fig. 2: Example of AR EduGame Interface

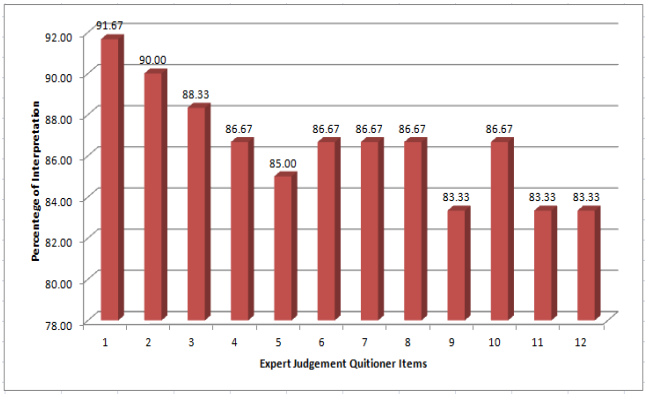


Fig. 3: Percentage of interpretation of expert judgment by teachers

3.2. Usability Assessment

The usability assessment of AR EduGame [14], [15] was carried out by 34 elementary students who had received the subject which contained Indonesian culture before. Students assessed the content and the use of the AR EduGame using the compiled questionnaire items.

The questionnaire of usability assessment had 10 items that evaluated users' experience of the AR EduGame. The questionnaire items are described in Table 2.

The questionnaire items were validated using the t-test analysis. The results show that nine items were considered valid and one item was invalid [11]. Meanwhile, the reliability test using the Cronbach alpha analysis yielded a value of 0.680. This value means that the questionnaire was reliable and it could be used to test the other AR EduGames [12].

The usability assessment results were then analyzed to assess the percentage of interpretation (PI) [13] of nine valid questionnaire items. The result shows that every item obtained the PI value of more than 80% as can be seen in Figure 4. The PI values show that the elementary school students considered the AR EduGame as a quality learning media regarding Indonesian culture, particularly *gamelan* and traditional dances.

Table 1: Expert Judgement based on Questionnaire Items

No	Questionnaire Item	Score	PI
1	The use of AR Edugame as a learning media	55	91.67
2	The use of AR Edugame as a learning media aids the teachers in the learning process	54	90.00
3	The use of AR Edugame as a learning media helps students to understand the material in the learning process	53	88.33
4	The display of the AR Edugame is interesting	52	86.67
5	The application menu is clear	51	85.00
6	The marker can be easily detected by cameras	52	86.67
7	The AR Edugame application is easy to use	52	86.67
8	The 3D Model in the AR Edugame application is interesting	52	86.67
9	Materials in the application meet the standard of the curriculum taught in the school	50	83.33
10	The exercise questions help the understanding of the materials by the students	52	86.67
11	The application runs smoothly in the smartphone used	50	83.33
12	The application is interactive	50	83.33

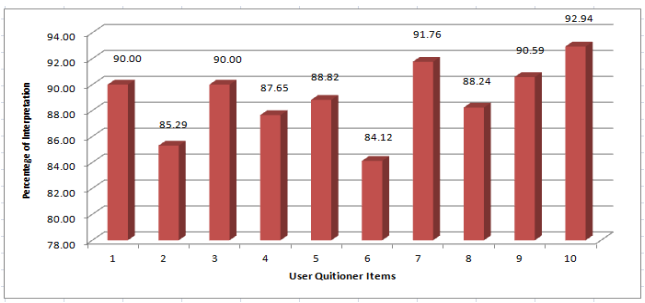


Fig.4: Percentage of interpretation of usability assessment by students

4. Conclusion

To sum up, the results that the percentage of interpretation (PI) value means that the AR Edugame can be considered a quality learning media. The results show that the AR Edugame had the PI value of more than 80% on both the usability assessment by the students and expert judgment by the teachers.
These Augmented Reality (AR) EduGames of Indonesian Culture regarding *gamelan* and traditional dances had been tested by the black-box method and yielded positive results before.

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Table 2: Percentage of Interpretation (PI) of Usability Assessment by the students

No	Questionnaire Item	Score	PI
1	The display of the AR Edugame is interesting	153	90.00
2	The application menu is clear	145	85.29
3	The marker can be easily detected by cameras	153	90.00
4	The AR Edugame application is easy to use	149	87.65
5	The 3D Model in the AR Edugame application is interesting	151	88.82
6	Materials in the application meet the standard of the curriculum taught in the school	143	84.12
7	The exercise questions help the understanding of the materials by the students	156	91.76
8	The application runs smoothly in the smartphone used	150	88.24
9	The application is interactive	154	90.59
10	The application helps students to understand the material in the learning process	158	83.33

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