The effect of android-based earthquake game toward Bengkulu City elementary school student’s knowledge about earthquake disaster preparedness

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Abstract. Earthquake is one of the frequent natural disasters which is still unpredictable. Nevertheless, we can always be able to reduce and prevent its negative impacts by implementing earthquake disaster preparedness. This study aimed to examine the effect of an android-based earthquake game on Bengkulu City elementary school student's knowledge about earthquake disaster preparedness. The subjects were fifth-grade elementary school students in Bengkulu City. The quasi-experiment research was conducted using Matching – Only Pre-test Post-test Control Group Design. Android-based earthquake game software used as a treatment in the experiment group. Data were collected using a multiple-choice test sheet instrument. The result found that the experiment group means knowledge about earthquake disaster preparedness was higher than the control group. It concluded that there was a significant difference between experiment group and control group. The advantages and limitations of the android-based earthquake game and its implication to earthquake disaster preparedness education discussed

1. Introduction

Earthquake is one of the frequent natural disasters around the world. Indonesia is one of the countries which have frequently faced it. According to BMKG (Indonesia Meteorology, Climatology, and Geophysics Council), there are 400 times earthquakes occur every month in Indonesia [1]. From 1991 to 2007, there have been 24 times big earthquake throughout Indonesia territory. The most significant scale earthquake happened on 24th December 2004 in Aceh. Its scale was 9.3 Richter scale. It followed by the giant tsunami causing a hundred thousand death toll and rising the loss of properties worth billions of dollars. The second giant earthquake occurs in Yogyakarta on 26th May 2006, causing unusually severe infrastructure damages. Other big earthquakes have occurred in Bengkulu province. In two decades, there have been happened some giant earthquakes in Bengkulu, such as on June 4, 2000, September 12, 2007, or August 13, 2017.

Earthquake is one of the worst natural disasters because its negative impacts have affected many aspects of human life. Besides causing the loss of properties and death tolls, the earthquake also evoked acute stress disorder symptoms and depression on its victims. The earthquake disasters had caused psychological effects such as Posttraumatic Stress Disorder (PTSD), depression, and anxiety symptoms
The levels of psychological distress were found to be higher after the first earthquake for those who reported damage from that earthquake, who evacuated, and who suffered financial loss. The children's severity of PTSD was mainly affected by the presence of PTSD and the severity of depression in the father [3]. The rates of PTSD and depression were higher in the site closer to the epicenter [4]. Besides, there was the relationship between acute stress disorder symptoms, depression, traumatic event exposure, and resource loss after earthquakes occur [5]. It concluded that severe earthquakes could cause long-lasting morbidity [4].

Although there have been many research activities conducted by researchers to understand earthquakes, it is still unable to be predicted when and where it will occur. In other words, the earthquake is always unpredictable. Nevertheless, we can still be able to reduce and prevent its negative impacts through earthquake disaster preparedness. Disaster preparedness is one stage of broader activities known as disaster management. The steps of disaster management are preparedness, response, recovery, assessment, prevention, and mitigation [6]. Disaster preparedness involves the preparation of a counter-disaster plan, forecasting, and warning of the disaster, maintenance of resources needed during and after a disaster, and training of the related personnel [7].

Earthquake disaster preparedness should be implemented, especially for children, because they are the most at risk for the negative effects of disaster [8]. Children are psychologically vulnerable and may develop post-traumatic stress disorder or related symptoms. They are physically susceptible to death, injury, illness, and abuse. Furthermore, they often experience disruptions or delays in their educational progress as a result of disasters. He continued that children have special needs and may require different forms of physical, social, mental, and emotional support than adults. Peek then found that, however, children also can contribute to disaster preparedness, response, and recovery activities. We must to improve children's access to resources, empower them by encouraging their participation, offer support, and ensure equitable treatment. It can promote their resilience to disaster awareness are prerequisites for preparedness [6]. Programs for earthquake disaster preparedness in developing countries was conducted through education [8]. Earthquake experience is not the prime factor in enhancing awareness toward earthquake disaster. When it confined to school education, can provide useful information as the knowledge base for earthquake [9]. Disaster-related training is most useful for individuals with high educational attainment [10]. Living in a community with a higher proportion of women who have at least a secondary education increases the likelihood of disaster preparedness. He also found that formal education can increase disaster preparedness and reduce vulnerability to natural hazards.

Disaster preparedness education for children was conducted through formal or non-formal education. This programs for children in schools have strengthened resilient communities by enabling them to withstand shocks, cope with emergencies when they occur and bounce back from disaster impact. Some aspects of disaster preparedness program in school correlated to the level of student preparedness [11]. The characters were having funding for preparedness activities and a school-based emergency preparedness coordinator. The aspects were positively associated with measures of school preparedness, including the perceived level of preparation, availability of emergency equipment and supplies, the extent of interagency coordination, and provision of in-service training.

Student’s level preparedness extremely depends on the school programs [11]. Whereas, the schools still have limitations and weaknesses in implementing disaster preparedness. The limitations included disaster plans, availability of emergency supplies, training, and interagency coordination. Majority of public schools still does not consistent to implement policy and procedure to face crisis or disaster [12]. The weakness of schools program was still a different perception of school principals concerning crisis preparedness training [13].

To resolve the school’s limitations and weaknesses, the schools have to improve their disaster preparedness programs [12]. Some aspects of preparedness programmed have to improved including written disaster plans, emergency response training, availability of equipment and supplies, and implementation of the state-mandated Standardized Emergency Management System (SEMS). Emergency response training is one of the aspects which is directly related to students or children. So,
this aspect has to get more attention from school principals. This aspect has to be planned, designed, developed, and be implemented so it can increase student’s awareness and preparedness about disasters.

This study wants to examine the strategy to increase student’s awareness and preparedness toward earthquake disasters. The procedure was the implementing of an android-based earthquake game in Bengkulu City elementary school. The research aimed to answer the question: —Is there an effect of android-based earthquake game toward Bengkulu City elementary school student's knowledge about earthquakes disaster preparedness? —Do an android-based earthquake game more effective than other learning media or tools?. The literature review has been done before the application tested empirically.

2. Methods
The subjects for this study were fifth-grade elementary school students from some primary schools in Bengkulu City. They were selected as research subjects because they live in West Coast Sumatra Indonesia, which is near the subduction zone where earthquakes frequently occur. Some of them have been selected as samples by random cluster sampling. There were two student groups as samples which were randomly selected from 25 statistically matching groups of students from all elementary schools in Bengkulu City. The matching criteria were determined from the mean of student’s science GPA in the prior semester. We assumed that a similar student’s science GPA represents the similarity of their ability. The result of sampling was Elementary State School number 58 cluster A as a control group and Elementary State School number 74 cluster A as experiment group. There were 26 students in the control group, while there were 27 students in the experiment group.

Android-based earthquake game software was used in the experiment group. The software was developed by IT expert (one of the members of this study). It had been tested and validated by appropriate research subjects who were elementary school students in Bengkulu City. It had been copied and installed in Android-based smartphones before it was used in the experiment. It is being planned to upload to the Google Play store so that it can be downloaded and installed to a smartphone by all android users. When the software has been installed, it can be used to play an earthquake game. This game has two main menus, including video and game. The video menu consists of animation video about the earthquake disaster and its preparedness. The video describes what earthquake disaster is and how to rescue when an earthquake occurs. The game menu consists what preparing activities before an earthquake occurs, how to rescue when an earthquake occurs, and what activities have to do after an earthquake occurs. The game was made using animation.

Student’s knowledge about earthquake disaster preparedness was collected using Multiple Choices Test Sheet Instrument. We developed the instrument by ourselves. There were initial fifteen test items as an instrument draft. The items represent some knowledge indicators about earthquake disaster, including how it occurs, what its impact for humans, how to rescue when it occurs, and what activities have to be done after it occurs.

Experts firstly validated the items. There were two involved experts, including earth science experts and language experts. The experts examined some instrument aspects including the content of instrument, construction of instrument, indicators representation, word selection, the grammar of item sentences, and suitability of using sentences with children development. There were some revision notes from experts. We then followed up on it by revising. The revision result was given to experts to be re-examined to get a valid instrument.

The instrument validated by experts was empirically tested on elementary school students. The samples for instrument testing were selected from the research population involving fifth-grade elementary school students, but they were separated from the samples of research which would be engaged in giving treatment. By analyzing test result data empirically, it was got ten valid test items. Because the ten items still represented all determined indicators, they were set as a test instrument. Its reliability was analyzed statistically using the Alfa Cronbach of 0.71. It is shown that the instrument was reliable. It was concluded that the instrument was valid and reliable, so it could be used to measure the dependent research variable.
The research has been done using the Matching – Only Pre-test Post-test Control Group Design [14]. There were two matching groups of students, including the experiment and control group. Both the experiment and the control group were given different treatments.

Before both groups got treatment, they were given a pre-test. The pre-test that were given to both used the same instrument. The pre-test was carried out in the early teaching and learning process. There had been ten minutes to provide pre-test. After the pre-test, the instruments which have been filled up by students were obtained to be directly examined and analyzed as quickly as possible. Its result was used to ensure whether both groups were matching or not. The analysis result shown that both were matching. So, both could be used as research samples.

Once both groups had been matching, they were given treatment which was the teaching and learning process using some learning media and tools. The teaching and learning in both was the same model, the discovery learning model. The experiment group got additional treatment with an android-based earthquake game, while the control group only got an earthquake rescue procedure book and presentation slide of earthquake rescue simulation. The discovery learning model was selected because it has become the main and compulsory learning model within education curricular in Indonesia. All teachers in Indonesia have been familiar with the model. The model was also extremely appropriate to science learning which is the field of this research. The model was conducted at the same time by different teachers. Both of teachers who taught in each group have been trained to do the same activities throughout the teaching and learning process.

The discovery learning model which had been conducted in this research has six stages, including stimulation, problem statement, data collection, data processing, verification, and generalization [15]. Stimulation (first stage) was given to students by the presentation of earthquake's pictures, including pictures about damages and death tolls because of earthquakes. The students were encouraged to make question-based on the pictures (problem statement stage). The teachers facilitated and guided the students to make relevant and good questions. Students asked many questions in both research groups, but not all questions were followed up. Some questions which were chosen to be investigated further were —what is an earthquake?—why is earthquake occurs?—what are earthquake negative impacts?—what are we have to provide before an earthquake occurs, and —how to rescue ourselves when an earthquake occurs?.

Then, the students were instructed to seek and obtain relevant data to answer prior questions (data collection stage). In this study, data sources had been provided by the teachers. In the control group, provided data sources were earthquake rescue procedure book and PowerPoint presentation slide of earthquake rescue simulation. While, in the experiment group, an android-based earthquake game was only their data source. There were small groups that were provided one smartphone for each group. Android-based earthquake game has been installed into each smartphone.

In the control group, the students classically processed data through observation toward presentation, which was presented by the teacher in front of the class (data processing stage). Then, they discussed a book about the earthquake in small groups. While, in the experiment group, the students processed data in only small groups, which each group has three or four members. The small groups discussed information (video and games) which has been provided within the android-based earthquake game in their smartphones.

The student's data processing results, in the control group as well as in the experiment group, were examined by the teacher through the student’s classical presentation and simulation (verification stage). In both groups, they presented general information about the earthquake. Then, they also simulated earthquake rescue activities when an earthquake occurs. The students in the control group simulated the earthquake rescue activities based on the earthquake rescue procedure book while the experiment group was carried out the simulation based on the android-based earthquake game. The teachers in both groups gave feedback to each presenter based on the student presentation.

The students were facilitated by the teachers to conclude the learning at the end of the learning process. The students were also encouraged to conclude and believe that the earthquake simulation could be applied in all situations when earthquakes occur (generalization stage). Before the learning process
finished, the students in both groups were given a post-test with the same instruments. The post-test instrument was also similar to the pre-test instrument. The time for the post-test is ten minutes.

3. Results and discussion

This research result showed that an android-based earthquake game could increase student’s knowledge about earthquake disaster preparedness. This is similar to Many’s finding that using video games could increase a student’s knowledge [16]. Although the content of games is the difference, the similar characteristic of games makes games can improve the cognitive aspect of students.

Once post-tests in both groups have been carried on, and data obtained. Then t-test was done to analyze the difference student’s knowledge about earthquake disaster preparedness between the experiment group and the control group. The result found that android-based earthquake game group mean (M = 87.08, SD = 14.35) knowledge was higher than control group mean (M = 79.46, SD = 11.88). Therefore, the null hypothesis was rejected, t (53) = 2.17, p < .05, which means that there was a significant difference between the experiment group and the control group.

The study result shows that the increase in student’s knowledge in the experiment group is higher than the control group. This result has proven that an android-based earthquake game is more effective than other learning media. In this study, another media were an earthquake rescue procedure book and presentation slide of earthquake rescue simulation used in the control group. Android-based earthquake game is more effective because the game is more interesting and fun than books or presentation slides. We found that students are more interested in the android-based earthquake game than the rescue procedure book and presentation slide of earthquake rescue simulation. Students in the experiment group more enthusiastic in investigating learning resources. This finding is similar to Bouzid’s report [17] that game application in learning is useful, enjoyable, and easy to use. It also can stimulate students’ interest in learning. This is also suitable for today's student’s preferences, more like digital games than physical games [18].

Android-based earthquake game has an advantage which is efficient in time. The using of earthquake game applications within the learning process was not spend much time, especially to simulate earthquake rescue. It was not as long as simulation using earthquake book, a demonstration by teachers, or presentation by PowerPoint slides. So, this application can become a good part of disaster preparedness programs.

In this study, the number of used smartphones provided by the researcher team was limited. Not all students had been given the smartphone. So, smartphones were utilized by student groups, instead of by personal. Each group, which had three or four members, used one smartphone to play an android-based earthquake game alternately. It is expected that the android-based earthquake game will be more effective if every student has a smartphone, and each student will personally use it. But, that still has to be proven further, which is a more effective method using smartphones between small groups or in personal.

Using an android-based earthquake game requires specific support devices, such as smartphones or tablets. In Indonesia, not all elementary school students have smartphones. So, this study has the limitation that it is only applied to specific student groups or schools in which each student has had a smartphone or tablet.

However, we still recommend that this application can become part of earthquake disaster preparedness programs in the schools. Schools that want to use this application as a part of their disaster preparedness programs have to provide support devices, such as tablets or smartphones. Schools can give those or propose aid letters to the government or non-government organizations which concern disaster management. This research result can also become a consideration for organizations or schools to give aids and to support devices so they can access and implement this application.

Android-based earthquake game was uploaded to the Google Play store. So, it can not only be used by teachers and students in schools but also be utilized by communities who frequently face earthquake disaster. Nonformal education can also use it in their learning process to increase awareness and knowledge about disaster preparedness.
4. Conclusion
We conclude that the android-based earthquake game has a good effect on student’s knowledge about disaster preparedness. It is better media than other media, such as books, presentation slides, or simulation videos. It was effective and efficient learning media which can improve student’s awareness and knowledge about earthquake disaster preparedness. It will be more functional if schools can provide support tools, such as tablets or smartphones.

We propose to teachers and educators in elementary schools to use this game application to increase student’s knowledge about earthquake disaster preparedness. We also suggest to schools to utilize this application as part of school programs of disaster preparedness. Nevertheless, the using of earthquake game applications has to notice some aspects such as the availability of support devices by students or in schools, and student’s and teacher’s experience in using digital devices.

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