DE GRUYTER OPEN

Research Article

Disaster Risk Reduction for Earthquake Using Mobile Learning Application to Improve the Students Understanding in Elementary School

Endang Widi Winarni

Elementary Education Department,
Education Faculty,
University of Bengkulu,
Indonesia

Endina Putri Purwandari

Informatics Department,
Engineering Faculty,
University of Bengkulu,
Indonesia

Doi: 10.2478/mjss-2018-0040

Abstract

Indonesia is located in the ring of fire and frequently hit by tectonic earthquake. Education could be one of the strategic and effective efforts to reduce the earthquake risk. Therefore, there is a need to provide knowledge about the earthquake disaster mitigation, especially in elementary school, and to grow the "Safety Culture" in school. This paper focuses on how the integration of mobile learning application in elementary school could enhance the ability of disaster risk reduction especially for earthquake mitigation in Bengkulu, Indonesia. The type of research was Pre-Experimental Design with one-group pretest-posttest design. Data collection was a test of students' understanding of earthquake disaster mitigation that includes pre-disaster, disaster, and post disaster. The independent variable was learning to use mobile learning application. The dependent variable was students' understanding of earthquake disaster preparedness. The pre-test and post-test results show that the value of t (0.975) for two-tailed test on the distribution of student (t) dk *is 58 and obtained t-table is 2,001 and the calculation* t *is -8.02; therefore, the null hypothesis is rejected. This implies that there is an influence of educational mobile application to the students for earthquake disaster mitigation. The experiment also shows that educational mobile application influences the students understanding about earthquake disaster preparedness. Thus, mobile learning application can be effective tools for earthquake education, because it displays the earthquake information in more interactive manner.*

Keywords: *disaster risk reduction, earthquake, mobile, learning application, elementary school*

1. Introduction

A natural disaster is an event that can threaten at any time and cause damage and loss of life. One of the natural disasters is the earthquake. Two aspects that have an important role in improving the resilience of vulnerable communities and natural disasters are education and communication (Paton et al, 2008). The United Nations formalized The Sendai Framework for Disaster Risk Reduction 2015 – 2030 with the main purposes of reducing the number of deaths, injuries, and impacts caused by disasters from human and nature. We need to strengthen public education and

awareness in disaster risk reduction (UNISDR, 2015).

Indonesia is located in the ring of fire and frequently hit by tectonic earthquake. Therefore, people in this country should have the attitude, knowledge, and skills about disaster awareness, in orde to lower material and immaterial risks. Geographically, Bengkulu is one of the six regions in Indonesia that have potential earthquake disasters. Education, through disaster preparedness learning, is one of the strategic and effective efforts to reduce the earthquake risk. The disaster risk reduction could be integrated into the basic competence content of certain subjects. Therefore, the community including elementary school students in the Bengkulu province frequently experience natural disasters of tectonic earthquake. With this condition, Bengkulu people should have the attitude, skills and knowledge for disaster preparedness so that the material and immaterial risks that the community bears lower. The development of attitudes, skills, and knowledge can be achieved through education. Therefore, there is a need to provide knowledge about the earthquake disaster mitigation especially on elementary school children, and to grow the "Safety Culture" in schools.

The advances of technology especially mobile devices have changed the face of education. Games are environmental variables that could affect the acquisitive learning and conceptual ability of people. Fun and enjoyable games will facilitate the learning processes and satisfy most of the kid basic needs (Dye et al, 2007). Mobile phone application along with learning and teaching activities may help the learning process and increase its inner motivation and interest by creating challenges and adventures to the players (Chizary, 2017). Since the general goal of education in primary school is to prepare students for lifetime learning and to acquire innovative scientific literacy to live in society as a citizen, employee and parent, it is essential for them to acquire knowledge, skills, and necessary attitudes for a suitable life (Oldknow, 2005).

Earthquake disaster mitigation application is a useful educational application to add insight, knowledge, and understanding of children in the effort to overcome the impact of earthquake disaster. This is because, sometime community feel that the earthquake impact is low, then they are less motivated to prepare themselves for the disaster. It becomes a challenge for researchers to provide sufficient knowledge before a disaster occurs so that the community can prepare themselves (Shaw, 2004). Educational mobile application is a special application designed to teach the users a particular learning, developing concepts and understanding and guiding them in training their abilities, and motivating them. Educational application has some advantageous aspects when compared to conventional learning methods. One of the significant advantages is the mobile application can improve the child’s memory so that they can memorize the lessons in a long time compared to conventional teaching methods. The learning media must be able to attract many people and to assist student learning activity. There are many educational applications for the android platform which provides an interesting and interactive learning systems.

Learning approach using mobile applications is not popular with school environment in Indonesia yet. Indonesian schools are still based on the learning centered class and geared towards examinations. Mobile devices, which include tablets, smartphones, PDAs, can be used to improve the quality of student’s learning and address education gaps when integrated into the classroom as an innovative learning resource (Reeves, 2017). Darmanto (2016) built a system of mandarin language mobile learning for senior high school students. The students reported that this application is decent, specifically for students. Martono (2014) developed mobile learning for university students as a flexible learning media. The results show that 95% users enjoyed using mobile application. Mani (2016) presented the findings to enhance knowledge in the community about the eruptive hazards and to combine traditional education with video games. Chizary (2017) developed a descriptive survey method integrated with educational games that influence motivation and enhance Intelligence Quotient (IQ) for elementary students. According to these researchers, teaching and learning with mobile devices are innovative and unique. The materials can be accessed anywhere, and anytime. Also, they encourage the student achievement, enhance social interactions, adapt to many learning resources and learning experiences.

Other researchers have focused on mobile devices to create student collaborative efforts and to increase the engagement in Madrid, Spain (Kucirkova, 2014). The application provided specific features and content that could influence the degree of children engagement to learning task as an

educational value. Reeves (2017) suggests that integrating mobile learning in specific content using informal student feedback can effectively increase early childhood students' academic achievement. Educational researchers must continue to provide empirical evidence to illustrate the power of mobile learning.

This paper focuses on how the integration of mobile learning application for elementary schools could enhance the ability of disaster risk reduction especially for earthquake mitigation in Bengkulu, Indonesia. The paper considers the emergence of earthquake education; it presents the development of mobile learning application specifically designed to earthquake awareness among children in elementary schools in Bengkulu, Indonesia. The mobile learning application was designed to educate children about preparing for earthquake disasters by game and simulation.

2. Disaster Risk Reduction

There are many impacts of natural disaster, including the destruction of infrastructure facilities as well as the loss of anything that led to trauma especially for children. Children affected by the disaster experience double burden in addition to physical injuries and they also experience psychical trauma. Psychically, children experience stress and trauma because of the calamity that befall. According to Winarni (2016) Disaster Risk Reduction (DRR) is a series concept and activities aimed to reduce disaster risks through systematic activities and to analyze and manage the adverse effects of disasters. The framework of disaster reduction, awareness and alertness, preventive and curative attitudes need to be nurtured and internalized to become cultural values in a community. Winarni (2015) states that disaster preparedness education could be integrated with disaster prevention concepts into education curriculum in schools, from elementary school to university. Disaster Risk Reduction (DRR) in elementary schools aims to nurture: (1) the human values and attitudes towards disaster risk; (2) the understanding of disaster risk and motivation; (3) the knowledge and skills for disaster prevention both individually and society; and (4) emergency response capability (Winarni, 2016).

3. Method

The type of research was a Pre-Experimental Design with one-group pretest-posttest design (Winarni, 2012). This design was chosen because it aimed to determine the influence of learning with mobile applications for earthquake education and disaster preparedness to improve the understanding of students about disaster mitigation. The population was four groups of grade fifth students from SD IT Iqra '1 Bengkulu City. One sample group was randomly taken, namely group VB as the experimental group. This school is located in the earthquake hazard zone. The syllabus covered a complete set of information about earthquake and some earthquake effects in human life.

The instrument was a test on students' understanding of disaster preparedness. Participant utilized smart phone to practice the earthquake disaster mitigation application. Students' understanding of earthquake disaster mitigation included pre-disaster, disaster, and post disaster. The experimental group received guided instruction using a mobile device until the end of the class period. The data analysis technique was performed using self-t test and the data were also tested by normality with Saphiro Wilk test (Winarni, 2011).

The learning steps as a treatment were:

1) Early stages of learning, teachers provided motivation for students through questions and answers, and provided some examples of earthquake events and losses.
2) The teacher explained the steps that need to be taken when an earthquake occurs at school, at home, and in a public place.
3) Students in groups consist of 5 - 6 students then operated mobile educational apps on mobile phone devices.
4) The teacher acted as a facilitator, the teacher guided students to identify the problem of learning materials and explained what needs to be explained further.

5) After students understood the necessary disaster preparedness actions, the teacher asked them to perform a self-sustaining simulation in groups.
6) In the last fifteen minutes, the teacher asked the class representative to deliver the results in front of the class, as a common perception and conceptual understanding. The teacher asked the other students to advise the work of other groups and provided different solutions.

The Pre-Experimental research design (Winarni, 2011) was described as follows:

$O_1 \ X \ O_2$ (1)

With:

O_1 : Pretest before preliminary study with mobile application of earthquake disaster mitigation

X : Treatment with disaster risk reduction learning using earthquake mobile application

O_2 : Posttest after the disaster risk reduction learning using earthquake mobile application

Calculation of test results in this study using the formula in the equation (2).

$$t = \frac{\overline{D}}{S_{\overline{D}}} \quad (2)$$

where :

$$\overline{D} = \frac{\sum D}{n} = \overline{X}_1 - \overline{X}_2$$

$$S_{\overline{D}} = \frac{S_D}{\sqrt{n}}$$

$$S_D = \sqrt{\frac{\sum (D-\overline{D})^2}{n-1}}$$

with:

$D =$ pair of scores $X_1 - X_2$

$\overline{D} =$ the average of D

$S_{\overline{D}} =$ Standard deviation of D

The hypothesis formula:

$H_0 =$ There is no effect of educational mobile application on the student understanding of earthquake disaster mitigation

$H_1 =$ There is an effect of mobile educational game application to the child's understanding aspect of earthquake disaster mitigation.

By hypothesis criteria:

The null hypothesis is accepted if $-t_{(1-1/2\propto)} < t < t_{(1-1/2\propto)}$, the value $t_{(1-1/2\propto)}$ is obtained from the distribution list with a chance(1-$1/2 \propto$), otherwise null hypothesis is rejected.

4. Results and Discussion

This application is an educational game application for the earthquake mitigation of natural disaster based on the Android platform. This application presents the information about earthquake which is accompanied by the video of earthquake stages, the types of earthquakes and how to mitigate them. The process of mobile application is divided into two main menus, namely education game and earthquake simulation. This application provides the story and instruction in how to play the application. User can select the application level start from before, during, to after an earthquake happens. User can also choose the education video such as earthquake simulation video, earthquake mitigation video, and how to save yourself in an earthquake. The mobile application diagram of earthquake is shown in Figure 1.

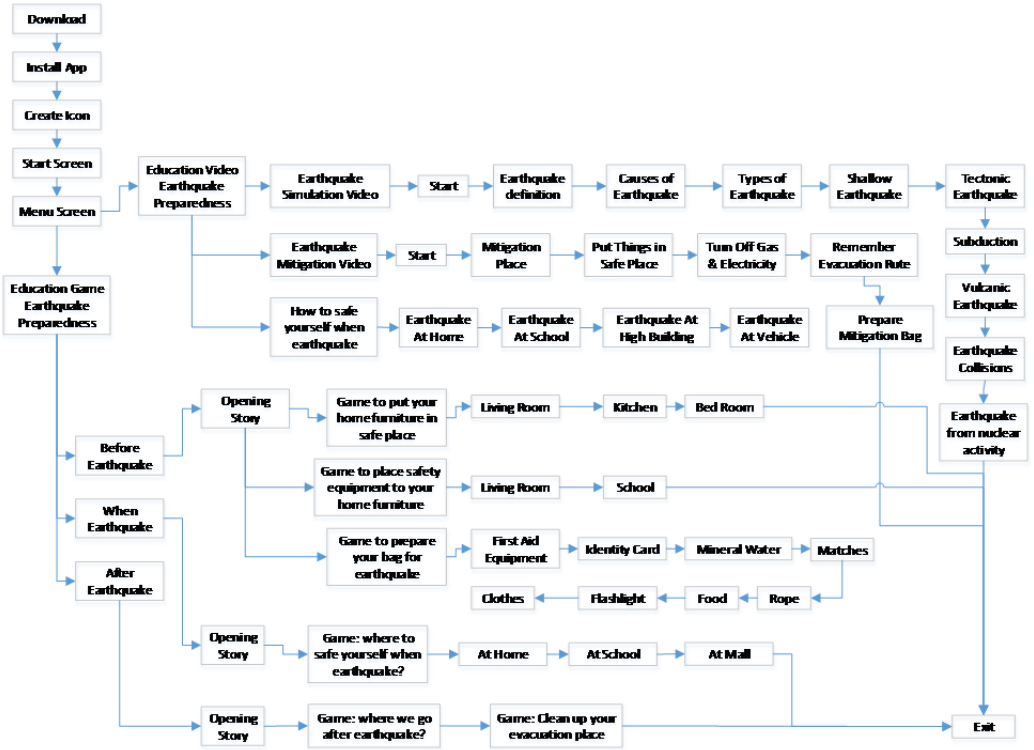

Figure 1. Mobile Application Process for Earthquake

There are two main scenes (Figure 2) as follows:

a. Video/simulation of earthquake: the player can choose to view earthquake material starting from definition, cause, type, tectonic, volcanic, and earthquake collision. The application gives the player information about the safest place to mitigate, how to put things in the right place, give the evacuation route, and prepare the mitigation bag. Also, the player can see the step of mitigation when an earthquake happens at home, at school, inside the building and on a vehicle. This scene is designed to be interactive and completed with earthquake lesson.

b. Earthquake education game: this scene is divided into three sub-scenes about the player activity before an earthquake happens, during an earthquake, and after an earthquake. The player is guided through the game from the opening story. Then, the player interactively plays the game with drag and drops the things that should be put on the right place in the living room, school, kitchen, and bedroom. Also, the player can choose the right place to hide when the an earthquake happens at school, and at home (Figure 3). The player needs to fulfill the bag with important things such as first aid equipment, identity card, mineral water, clothes, matches, flashlight, food, and rope (Figure 4). When an earthquake happens, the player should choose the safest place to hide from harmful things at home, at school, and at a department store (Figure 4). Finally, after the earthquake, the player should choose which positive activity that they can do in an evacuation place.

Figure 2. The Main Menu of Earthquake Learning Application

Figure 3. Simulation for Earthquake Preparedness in School

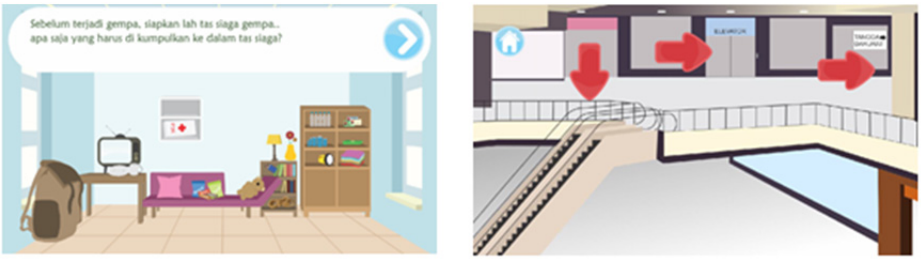

Figure 4. Game to Find the Right Item into Bag for Earthquake Preparedness and Game to Find the Right Route for Evacuation when Earthquake Happened in High Building

The independent variable was learning using mobile learning application. The dependent variable was students' understanding of earthquake disaster preparedness. The first data was the ability of students before being given treatment (pretest). Preliminary data before treatment was labelled X_1 variable. The next stage was treatment for the experimental class. The disaster preparedness treatments used mobile devices through educational application. After the treatment had been done, then a final test (posttest) called X_2 variable was performed. Based on the difference between posttest and pretest values, we determined whether there is a significant influence of using the application of natural disaster preparedness with t tests. Pretest and posttest data on disaster preparedness are presented in Table 1.

Table 1. *Pretest and Posttest Result*

Num	Pre-tes(X_1)	Post-tes(X_2)	D	D-$\bar{D}$	(D-$\bar{D}$)^2
1	60	100	-40	-14,34	205,63
2	70	100	-30	-4,34	18,83
3	100	100	0	25,66	658,44
4	50	90	-40	-14,34	205,63
5	90	100	-10	15,66	245,23
6	80	100	-20	5,66	32,03
7	90	100	-10	15,66	245,23
8	90	100	-10	15,66	245,23
9	80	100	-20	5,66	32,03
10	70	100	-30	-4,34	18,83
11	90	100	-10	15,66	245,23
12	60	100	-40	-14,34	205,63
13	70	100	-30	-4,34	18,83
14	50	90	-40	-14,34	205,63
15	80	100	-20	5,66	32,03
16	60	80	-20	5,66	32,03
17	90	100	-10	15,66	245,23
18	90	100	-10	15,66	245,23
19	70	100	-30	-4,34	18,83
20	40	100	-60	-34,34	1179,23
21	100	100	0	25,66	658,43
22	90	90	0	25,66	658,43
23	30	80	-50	-24,34	592,43
24	60	90	-30	-4,34	18,83
25	80	100	-20	5,66	32,03
26	60	100	-40	-14,34	205,63
27	70	100	-30	-4,34	18,83
28	90	100	-10	15,66	245,23
29	30	100	-70	-44,34	1966,03
30	50	90	-40	-14,34	205,63
Total	2140	2910	-770	-0,2	8936,67

$\sum D$= -770 , $\bar{D}$= $\frac{-770}{30}$ = -25.66

$\bar{X}_1 = \frac{2140}{30} = 71.33$, $\bar{X}_2 = \frac{2910}{30} = 97$

$S_D = \sqrt{\frac{\sum(D-\bar{D})^2}{n-1}}$

$S_D = \sqrt{\frac{8936,67}{29}} = \sqrt{308,16} = 17,55$

$S_{\bar{D}} = \frac{S_D}{\sqrt{n}} = \frac{17,55}{\sqrt{30}} = \frac{17,55}{5,47} = 3.20$

Then, t calculation

$t = \frac{\bar{D}}{S_{\bar{D}}}$

$t = \frac{-25,66}{3,20} = -8,02$

It is known that significance level α at 0.05 then $t_{(1-1/2\propto)} = t_{(0.975)}$ and $dk = n_1 + n_2 - 2$

Where:

n_1 = number of pre-test respondents

n_2 = number of post-test respondents

dk = 30 + 30 – 2 = 58

Based on the analysis of pretest data as X_1 variable, the highest value reached = 100 and the lowest value = 30 with 30 students 30. Statistics calculation shows that the average of pretest ($\bar{X}_1$) = 71.33 the average of posttest ($\bar{X}_2$) = 97 and standard deviation ($S_{\bar{D}}$) = 3.20.

The research hypothesis tested is that there is a significant difference in the understanding of

students about the earthquake disaster mitigation after following the learning with mobile application. After we obtained the dk value, then we found the t-value on the t distribution list for the two-sided test. The value of t (0.975) for two-tailed tests on the distribution of student (t) dk is 58 obtained t-table = 2,001 from the calculation of t = -8.02; this shows that the null hypothesis is rejected. It can be concluded that there is an influence of educational mobile application for the students for earthquake disaster mitigation. The analysis results show that learning with educational mobile application influences students' understanding about earthquake disaster preparedness.

The main purpose of learning is not to learn a large amount of new information, but rather to learn how to investigate important issues and how to become an independent student. Problems and questions investigated do not have an "absolute" answer, a complex or complex problem has many solutions and is often contradictory.

Learning using educational mobile application for this research is in accordance with learning paradigm in the 21st century, namely: (1) learning is directed to encourage students to find out (not to be notified) from various sources and focused on observation; (2) learning should be able to formulate problems (ask) not just solve problems, let alone answer questions; (3) learning should train analytical thinking (decision-making) instead of mechanistic thinking (routine), and (4) the importance of cooperation and collaboration in solving problems.

The knowledge developed and presented in mobile learning application is the thing that can be done in planning the earthquake disaster alert: (1) determining the escape route, making sure they know the safest way to leave home after an earthquake; (2) determining safe place where to meet; if friends or family members scattered, decide two places to meet. The first place should be a safe location near the house and the second place can be a building or park outside the village; and (3) conducting exercises to protect themselves from earthquakes, such as shelter under the table, away from the glass, running while protecting themselves, especially head (Winarni, 2016).

The research impact is in line with the Disaster Risk Reduction (DRR) framework, awareness and preparedness, preventive and curative attitudes that are grown and internalized so that it becomes the pattern and cultural values in community. The education world has a high degree of relevance to establishing disaster preparedness values within Disaster Risk Reduction (DRR) framework for some reasons, including (a) the substance of disaster material that can be integrated into various subjects in schools since the disaster phenomenon is a geological and social phenomenon; (b) the substance of preparedness is fundamentally based on attitudes and behaviors that socialization and internalization are possible in schools; (c) learners at elementary level are future generation, so that the cultivation of awareness and preparedness of disaster has a high sustainability value; and (d) school students psychologically are at a sensitive stage, easy to accept and develop knowledge and skills.

The improvement of students' understanding about earthquake disaster mitigation in this research is also accordance with the research of Winarni et al. (2015). The objectives of disaster management are: 1) to develop human values and attitudes; 2) to foster attitudes and awareness of disaster risks; 3) to develop an understanding of disaster risk, an understanding of social vulnerability, an understanding of physical vulnerability, behavior and motivation vulnerability; 4) to enhance knowledge and skills for disaster risk prevention and reduction, adaptation to disaster risk; 5) to develop efforts for disaster risk reduction, both individually and collectively; 6) to increase knowledge and skills of disaster preparedness; 7) to improve disaster response capabilities; 8) to develope readiness to support community rebuilding when disasters occur; and 9) to enhance the ability to adapt to major and sudden changes.

Children that benefit from educational innovations have a higher academic level. In other word, mobile application plays an important educational role and discovery because of the connection and close relation with motivation to discovery and fulfilling the personal curiosity. The experiment showed that educational mobile application influences the students' understanding.

5. Conclusion

Based on the findings of this study, it can be concluded that the implementation of learning that using the mobile application with educational games can give a real effect on students'

understanding of the earthquake disaster mitigation. The researchers suggest that when use the mobile devices as learning sources, teachers need to plan and arrange extra time for evaluating and setting up mobile phone. The students quickly understand how to operate the application. When working with students in elementary school, teachers should prepare to introduce the mobile application about 10-15 minutes. Observations taken throughout the implementation identified high motivation and engagement from students. To evaluate whether the application will increase mitigation knowledge, teacher must ensure that students are being challenged appropriately about the mitigation material. The application content matched with the standard of disaster risk reduction for earthquake. Nevertheless, it should support school facilities or user environment for high internet connectivity.

This study developed mobile game education for earthquake mitigation. Basically, students or teachers can access this application via mobile learning devices as smartphones, Personal Digital Assistants (PDAs), tablet PCs. This application makes the teacher easier to develop learning materials and help the achievements of student competence in the earthquake disaster mitigation. With mobile learning application can increase student confidence, self-learning knowledge, the motivation to practice, and remember the mitigation material.

Implementation of this research was conducted on a small class, thereby enabling further development to conduct a test on a wider scale with larger students as research participants. Furthermore, the use of educational games is suggested in the education of various sciences.

This study finding that mobile learning application can be effective tools in earthquake education, because its display the earthquake information in more interactive manner. But, the development of mobile application is an expensive and time consuming process. Some technical challenged are to build animation that realistically visualized students and earthquake illustration that easy to understand and easy to use by students in elementary school.

6. Acknowledgements

We would like to thank the Directorate of Higher Education, Ministry of Research, Technology, and Higher Education, Republic Indonesia for financial support throughout research grant in scheme National Strategic Research 2017.

References

Chizary, F., & Farhangi, A. (2017). Efficiency of Educational Games on Mathematics Learning of Students at Second Grade of Primary School. *Journal of History Culture and Art Research, 6(1), 232-240.* doi:http://dx.doi.org/10.7596/taksad.v6i1.738

Darmanto, Yulius Hari, Budi Hermawan. 2016. Mobile Learning Application to Support Mandarin Language Learning for High School Student. *Imperial Journal of Interdiciplinary Research (IJIR) Vol 2, Issue 4, 2016.* ISSN 2454-1362.

Diposaptotomo, Subandono, dkk. (2008). Hidup Akrab dengan Gempa dan Tsunami. *Buku Ilmiah Populer.* Bogor.

Dye, M. W. G., Green, C. S. & Bavelier, D. (2010). The Attention Skills in Action Video Game Players, *Neuropsychologia*. *47*(8-9): 1780-1789. http://dx.doi.org/10.1016/j.neuropsychologia.2009.02.002

Kucirkova, N. Messer, D., Sheehy K, & Fernandez Panadero, C. (2014). Children's engagement with educational iPad apps: Insights from a Spanish classroom. Computer & Education, 71, 175-184.

Mani, Lara, Paul D.Cole, Iain Stewart. (2016). Using Video Games for Volcanic Hazard Education and Communication: An Assessment of The Method and Preliminary Results. *Natural Hazards and Earth System Sciences*, Vol 16, ISSN 1673-1689.

Martono, Teguh Kurniawan, and Oky Dwi Nurhayati. 2014. Implementation of Android Based Mobile Learning Application As A Flexible Learning Media. *International Journal of Computer Sciences Issues, Vol. 11 Issue 3, No 1 May 2014 (IJCSI).* ISSN: 1694-0814.

Oldknow, A., Taylor, R. & Tetlow, L. (2005). *Teaching mathematics with ICT*. London: Continuum.

Paton, D., Smith, L., Daly, M.m and Johnston, D.: Risk perception and volcanic hazard mitigation: Individual and social perspectives, *J. Volcanol. Geotherm.* Res., 172, 179–188, doi:10.1016/j.jvolgeores.2007.12.026, 2008.

Reeves, J. L., Gunter, G. A., & Lacey, C. (2017). Mobile Learning in Pre-Kindergarten: Using Student Feedback to Inform Practice. *Educational Technology & Society, 20* (1), 37–44.

Shaw, R., Shiwaku, K., Kobayashi, H., and Kobayashi, M. (2004). Linking experience, education, perception and earthquake preparedness, *Disaster Prev. Manage*., 13, 39–49,

UNISDR (United Nations International Strategy for Disaster Reduction). (2015). The Sendai Framework for Disaster Risk Reduction 2015–2030, available at: http://www.preventionweb.net/files/43291_ sendaiframeworkfordrren.pdf (last access: 11 August 2017).

Winarni, E. W. (2011). Penelitian Pendidikan. *Bengkulu. FKIP UNIB*.

Winarni, E. W. (2012). Inovasi dalam pembelajaran IPA. *Bengkulu: FKIP UNIB*.

Winarni, E. W. (2015). Identifikasi Kompetensi Dasar Dan Indikator Program Pengurangan Risiko Bencana Gempa Bumi Terintegrasi Dalam Pembelajaran Tematik Terpadu Di Sekolah Dasar Kota Bengkulu. *proceedingpgsd*, *501*.

Winarni, E. W. (2016). Pengaruh Pelaksanaan Program Pengurangan Risiko Bencana Terintegrasi Menggunakan Model Problem Based Learning Berbasis ICT Bagi Siswa Kelas IV SD IT IQRA'1 di Kota Bengkulu. *JINoP (Jurnal Inovasi Pembelajaran)*, *2*(2), 351-359.