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Tests of Tsunami-Based Digital Map for Disaster Mitigation Course and Students Knowledge

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Abstract:
Understanding the Disaster Mitigation topic, like Tsunami can be easier with digital media. This research paper used the Tsunami-Based Digital Map for Teaching Media of Natural Disaster Course. A Qualitative Research Design was applied to collect the data of the use of digital map for mitigation knowledge. Some questionnaires were administered to Geography students in Universitas Samudra Langsa, Aceh of Indonesia. It took 39 geography students of the Disaster Mitigation Class, Lecturers and Head of Geography Department. After the application of Tsunami –Based Digital in University, the data analysis revealed tree significant effects of digital map; 1. an increase in lecturer's ability has improved students' learning outcome; 2. an increase in lecturers and students activities in the classroom with digital map, it improved students learning outcome; 3. the student's response has positive influence towards learning outcome. This study is a pioneer study in which researchers developed tsunami-based digital map as a medium to enhance student's understanding on disaster mitigation.

Keywords: *Tsunami, Digital Map, disaster, mitigation; students'knowledge.*

I. INTRODUCTION

Indonesia is prone to earthquake and tsunami. Indonesia is one of the World's most active earthquake zones because the country is subduction zone where three main active tectonic plates, Indo-Australian, Eurasian and Pacific Plates meet. A disaster refers to a situation in which an enterprise (or a group of enterprises) is confronted with sudden unpredictable and catastrophic changes over which it has little control (Rindrasih et al, 2019). The issue of disaster management becomes an important matter to note considering that lately there are often natural disasters that hit the territory of Indonesia. It is related to the geographical condition of Indonesia which is on the active plate of the world and is in the Pacific fire ring "the pacific ring of fire "So that it often poses a threat to natural disasters, especially earthquakes and volcanic eruptions (Putera et al, 2018).

Based on seismic activity map of Indonesia, about 290 cities (60% of Indonesian cities) are prone to earthquake and are located 11,000 kilometers away from the coast making these cities prone to tsunami. Tsunami occurs in Indonesia almost every year.Shallow earthquake (more than 6 Richter Scales) that occurs on the bed of the sea may cause tsunami. Indonesian tsunami is local tsunami that strikes very quickly as its epicentrum is located close to most of Indonesian beaches.

In recent years, Indonesia has been subject to numerous natural disasters, which are increasing in

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terms of both frequency and number of victims (Mei & Lavigne, 2012). Recently, an earthquake with a magnitude of 7.5, followed by a tsunami, hit the West Coast of Palu, Central Sulawesi on September 28, 2018. As reported by the Meteorology and Geophysics Agency (BMKG) report, the quake was not only felt in Palu — as the epicenter — but also in some surrounding regencies and cities, namely Donggala, ParigiMoutong, Sigi, Poso, Tolitoli, Mamuju, Samarinda, Balikpapan, Gorontalo, and Makassar. Although the strength of the earthquake was not big, however the disaster also caused severe damage to buildings and infrastructure. Two thousand people were killed and many people were injured (the number tended to increase). The damages were related to ground vibration, liquefaction direction, landslides and tsunamis. Indonesia is known for being an archipelagic country that is included in the ring of fire region which often experiences earthquakes and tsunamis. The disaster in Palu, Sulawesi, Indonesia occurred due to faults at shallow depths inside the Molucca micro-plate, which is part of Indonesia's tectonic plate (Wekke et al, 2019).

Indonesian earthquakes and tsunamis resulted in a lot of fatalities and material losses. Besides the 9.5-Mw tsunami taking place in Chili in 1960, the most severe tsunami in the last 100 years is Aceh tsunami (9 Mw) that took place on December 26, 2004. Not only did it damage millions of buildings, but the tsunami in Aceh also killed thousand people in seven countries in the Indian Ocean. The highest fatality occurred in Aceh and neighbouring provinces (150 thousand victims).

Having analysed the history of the tsunamis, tsunami casualties are generally caused by several factors. Besides the magnitude of the tsunami (including the epicenter, wave height, speed of propagation and height of inundation), the number of tsunami fatalities is also influenced by lack of knowledge about tsunami and poor disaster mitigation. The public have very little information about tsunami and regional government does not have adequate preparation should tsunami strikes. The literature on disaster management contends that the role of local governments is essential in delivering effective disaster management (Putra & Matsuyuki, 2019). In Indonesia by of Law No. 24 2007 concerning disaster management, at the moment the focus of disaster management is more directed at community preparedness in the face of danger with the meaning of disaster management not only in the emergency response but also in pre-disaster actions (mitigation) by means of socializing and educating the public about earthquake, building rules, determining disaster-prone areas so that they can minimize and minimize the possibility of victims that will be caused by disasters (Putera et al, 2015).

Mitigation refers to action that minimize casualty or fatality Enok (2007). Mitigation involves activities and preventive steps, namely preparation, analysis and evaluation (towards how severe natural disaster is and how much damage it costs) and disaster mitigation (rescue, rehabilitation and relocation). In 2003 Minister of Domestic Issues Decree number 131; in which mitigation is effort or activity of which objective is to minimize casualty a disaster may cause; it consists of preparation, awareness and prevention. Natural disasters are a series of natural events that threaten and disrupt the lives and livelihoods of people (Lassnigg, 2015). Natural disaster will result in casualties, environmental damage, property losses and psychological impacts, more particularly when people have very little knowledge of natural disasters. One method to improve student's understanding on natural disasters is through integration between topics discussing natural disaster and one of the subjects at school (Tilaar, 2008). Module helps students obtain information about discussed topics (Arief, 2012). Module fosters student's independence (Dahan Et al. 1996). Module helps students achieve learning objectives and targets. Wahyudi's study (in Enok, 2010) showed that integration between earthquake and mitigation techniques into wave symptom module got positive feedback; the integration developed students' understanding on geophysics and increased their

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average scores by 0.6 (average). Besides that, the integration enhanced students' understanding on disaster mitigation (Atwater, 1996). Good disaster mitigation will result in high disaster awareness. Disaster awareness refers to any action to prevent, deal with and overcome disaster.

Based on the background, it also aims to test the use of tsunami-based digital map for disaster mitigation learning. Digital tool has been popular in Indonesia and Matondang et al (2019) found the used of digital food marketing and delivery for culinary business has made the increase growth. So this research sought data of tests of tsunami-based digital map as a medium to enhance student's understanding on disaster mitigation, it is different from the previous related studies (Indriantoro et al, 1999; Arends, 1997; Arief, 2012).

II. LITERATURE REVIEW

Social Science Learning Model

Piaget argued that learning occurs continuously between individual and constantly changing environment. Yulaelawati (2008) defined learning as systematic combination between human, material, facility, media and procedures in order to achieve learning objective. Hasan (in Tilaar, 2008) postulated that learning model should meet the following principles, namely learning causes improvement, good learning occurs when teacher spends fewer times to engage students in learning, learning accommodates different learning styles and is facilitated by a teacher or lecturer, and there is not one perfect learning method.

Based on the Association of Education Communication Technology (AECT), media are various types and channels for spreading information. On the other hand, Miarso described media as any object that delivers message and at the same time, stimulates student's thought, feeling, attention and willingness to study. Media are classified into three categories, visual, audio, and audio-visual.

Social Education adopts the behaviour theory which makes direct consequence of learning (Erwin, 2013). Implementation of both reinforcer and punisher for behavioral change is called operant conditioning (Gredler, 1994). Early or immediate reinforcement and punishement have positive influence towards the upcoming behavior. Social learning theory discusses behavioral learning principles and emphasizes on internal mental processes. Bandura (in Slavin, 1994) suggested that most people learn through selective observation and remembering other's behaviors. There five possible outcomes of observational behavior, namely introduce new behavior or attitude, encourage existing behavior, change unwanted behavior, divert attention and foster emotion. Bandura (in Arief, 2012) suggested that human being observes his or her own behavior, analyze the behavior against his or her own criteria, and then give himself or herself reinforcement or punishment.

Disaster

Disaster as serious events that disrupt society and cause material, economic and environmental casualties to the society and therefore, the society is unable to use their resources to overcome the events **(**Kardi, 1997). Based on the UN International Strategy for Disaster Reduction (Kardi, 1997), there are two types of disaster, natural and technological disaster. Natural disaster consists of three categories, hydro-meteorological (flood, hurricane, drought and landslide), geophysical (earthquake, tsunami and volcanic activity) and biological (epidemics, plant and animal disease). Technological disaster also consists of three categories, namely industrial incident (chemical leaks, industrial infrastructure damage, gas leaks and radiation), transportation incident (land, rail and water transportation and airplane crash) and miscellaneous incident (domestic or non-industrial structure, explosion and fire).

Earthquake and Tsunami

Earthquake is vibration from within the Earth which then propagated to the Earth surface when the Earth is breaking and shifting violently (Adi ,2010).

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Earthquake may be caused by dynamics of the Earth (tectonics), volcanic activity, falling meteors, avalanches (below sea level) or nuclear explosion below the surface. Tsunami usually occurs if an earthquake with a large enough vertical movement takes place on the seabed. Tsunami can also occur due to volcanic eruption at sea or an avalanche occurs under the sea. Some information to take into account about earthquake and tsunami is that small earthquakes do not always lead to large earthquake; the seismic waves rock the Earth for days. This phenomenon is called earth free oscillation; weather does not induce earthquake; most earthquakes occur at less than 80 km below the Earth surface; and frequency of most earthquake waves is less than 20 Hz and thus, human can only listen to sound of shaken objects.Mitigation or activities to minimize earthquake and tsunami casualty consist of predicting earthquake, pre-, whilst- and post-earthquake or tsunami activities. There are 2 (two) earthquake prediction methods, namely short-range prediction and long-range prediction.

Digital Map

Digital map refers to representation of geographic phenomenon stored, shown and analyzed on computers. Every object in digital map is stored as one or a group of coordinate. Compared to the analog map, digital map has reliable quality, is easy to store and transferrable from one device to another, and can be updated. Digital map also has map attributes such as scale, geographic reference, projection system and map projection that can be use as teaching media. Indriantoro (1999) reported that West Java is very prone to natural disaster since natural disaster takes place once a year and epicentrum is relatively close. The area is densely populated and number of individuals at non-productive age is high. In other words, West Java has high dependency level. Quality of building and mobility are low. The locals have very few information about disaster mitigation. Survival rate is lower due to poverty, low education level and poor access to technology. Budiman (2012) reported that Indonesia is prone to earthquake, for example the ones taking place in Aceh and Yogyakarta a few years ago. This study developed a cellular phone application that consists of information about earthquake mitigation.Erwin (2013) argued the quality of learning equipments in integrated natural science classes can be used as one of the learning equipments for integrated natural science class in junior high school/Islamic junior high school.

III. RESEARCH METHOD

The study applied a Quantitative Design which used the questionnaire and observation forms as the instruments. It involved 39 geography students of Disaster Mitigation class of Geography Study Program of Universitas Samudra and few lecturers. A Multiple linear regression analysis was applied to count effects of two or more independent variables (Indriantoro, 1999). In Multiple Regression Analysis, an attempt is made to account for the variation of the independent variables in the dependent variable synchronically (Yuanik & Guler, 2013). In order to identify influence of lecturer's ability, lecturer's and student's activity in the classroom, student's responses and learning quality, multiple linear analysis method and SPSS program were used. The analysis formula was as follows:

$$\hat{y} = a + b1X1 + b2X2 + b3X3$$

Description:
$\hat{y}$: quality of learning outcome
a : constant
b1 : lecturer's ability regression coefficient
b2 : lecturer's and student's activity in the classroom regression coefficient
b3 : student's response regression coefficient
X1 : lecturer's ability
X2 : lecturer's and student's activity in the classroom
X3 : student's response
e : Standard error

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Coefficient of Determination Analysis

Coefficient of determination measured how much a model can explain dependence variable variance (Flew, 2007). Coefficient of determination with the following formula is used to identify percentage that represents how much influence lecturer's ability, lecturer's and student's activity in the classroom, and student's response towards quality of learning outcome.

$$R2 = (r)2 \times 100\%$$

Description:
R2 : coefficient of determination
r : coefficient of correlation

Coefficient of determination is between zero and one. Lower R2 means independent variables have very limited ability to explain dependent variable but when R2 is closer to one, independent variables can provide nearly all information to predict dependent variable.

IV. RESULT AND DISCUSSIONS

It found that t-test results as follows:

1. T_{value} of lecturer's ability was 3.121 (significant if t= 0.004). Since t was lower than 5% (0.004<0.05), lecturer's ability (X1) had significant influence towards student's learning outcome (Y). Standardized coefficient of regression (0.235) was positive, which means the independent variable has positive influence towards the dependent one. In other words, an increase in lecturer's ability improved students' learning outcome.
2. T_{value} of lecturer's and student's activity in the classroom was 2.116 (significant when t= 0.045). Since t was lower than 5% (0.045<0.05), lecturer's and student's activity in the classroom (X2) has significant influence towards student's learning outcome (Y). Standardized coefficient of regression (0.215) was positive, which means the independent variable has positive influence towards the dependent one. In other words, an increase in lecturer's and student's activity in the classroom improved student's learning outcome.
3. T_{value} of student's response was 5.244 (significant if t= 0.000). Since t was lower than 5% (0.000<0.05), student's response (X3) has significant influence towards student's learning outcome (Y). Standardized coefficient of regression (0.436) was positive, which means the independent variable has positive influence towards the dependent one. In other words, an increase in student's response improved student's learning outcome.

Standardized coefficient of regression (or beta) was an indicator that represented one independent variable that has the most dominant influence towards the dependent variable. The highest standardized coefficient of regression means the most dominant independent variable. Based on Table 1, student's response (X3) has the highest beta coefficient (0.436) which means it has the most dominant influence towards student's learning outcome.

Coefficient of Determination

Coefficient of determination showed how much the independent variables, namely lecturer's ability (X1), lecturer's and student's activity in the classroom (X2) and student's response (X3), can explain student's learning outcome. Table 2 showed coefficient of determination of the variables.

Table 1. Coefficient of Determination Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.854a	.732	.715	1.178

Based on Table 2, the Adjusted R Square was 0.715 or 71.5%. It means the lecturer's ability,

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lecturer's and student's activity in the classroom, and student's response can explain 71.5% of the learning outcome, while other variables outside the study explain the remaining 28.5%.

DISCUSSION

The Tests showed coefficient of regression of the lecturer's ability (X1) was 0.235 that means lecturer's ability has positive influence towards student's learning outcome. In other words, an increase in lecturer's ability will improve student's learning outcome. It is improve geography student's understanding on tsunami. The respondents had positive attitude towards the lecturer's ability because the teaching procedures were clearly stated and the lesson plans explained both teacher's and student's activities in the classroom clearly. It is in line with Piaget (in Kardi, 1997) that learners develop schemata based on their interaction with the environment and thus, teachers should provide an accommodating learning atmosphere for the learners. The finding of the study is in accordance to Erwin Prasetyo's (2013) study that the developed learning equipment can be used as one of the learning equipments for integrated natural science class in junior high school/Islamic junior high school.

The coefficient of regression of lecturer's and student's activity in the classroom (X2) was 0.215 which means lecturer's and student's activity in the classroom has positive influence towards student's learning outcome. Hence, an increase in lecturer's and student's activity in the classroom will improve student's learning outcome because the lecturers have prepared learning materials that match the model. It is in accordance to Arends (1997) that lecturer's analytical skills have positive influence towards students. Nur (1999) also argued that one of the factors affecting quality of learning is learning equipment. This study developed tsunami-based digital map as learning medium for disaster mitigation topic in order to enhance student's understanding on tsunami and its effects.

The coefficient of regression of student's response (X3) was 0.436 which means the student's response has positive influence towards learning outcome. Hence, an increase in student's response will improve student's learning outcome. Based on the students' questionnaire, student's response towards the implementation of tsunami-based digital map for disaster mitigation lesson has significant influence towards their learning outcome. Descriptive analysis towards student's attitude on the learning components revealed that students have positive attitude towards the learning components, the topic of discussion provides new information and is clearly elaborated, the students are interested in the developed learning medium and are motivated to participate in the following lesson having heard about the digital map. It is in line with Atwater (1996) that learning components should encourage students to engage in learning. The developed learning equipment can be used as one of the learning equipments for integrated natural science class in junior high school/Islamic junior high school. In 2007, Sarwosari (in Enok, 2010) developed m-learning application for student's organizer. Some of its features are time manager, course manager, and communication center.

The findings stated that, simultaneously, the independent variables, lecturer's ability, lecturer's and student's activity in the classroom, and student's response, has significant influence towards the dependent variable, student's learning outcome. It means simultaneous increase in the lecturer's ability, lecturer's and student's activity in the classroom, and student's response will improve the student's learning outcome and at the opposite, decreasing lecturer's ability, lecturer's and student's activity in the classroom, and student's response will decline the learning outcome. Therefore, the hypothesis, lecturer's ability, lecturer's and student's activity in the classroom, and student's response have significant influence towards student's learning outcome, was accepted.The Adjusted R Square was 0.715 or 71.5%. It means the lecturer's ability,

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lecturer's and student's activity in the classroom, and student's response can explain 71.5% of the learning outcome, while other variables outside the study explain the remaining 28.5%. Based on the percentage, learning outcome is influenced significantly based on the three independent variables, lecturer's ability, lecturer's and student's activity in the classroom, and student's response.

5. CONCLUSIONS

Based on the Testing Results and Discussion, it can be concluded that:

(1).Tsunami Based Digital Map for Teaching Media in Natural Disaster Course increased students' knowledge on Mitigation. The use of the Tsunami Digital Map had made the lecturers' ability improved and it has significant influence towards geography student's learning outcome ;

(2). Lecturers and students' activity in the classroom has significant influence towards geography student's ability in using tsunami-based digital map as learning medium for disaster mitigation class and student's response has significant influence towards geography student's ability in using tsunami-based digital map as learning medium for disaster mitigation class.

(3). Furthermore, the three independent variables, lecturer's ability, lecturer's and student's activity in the classroom and student's response have significant influence towards geography students ability in using tsunami-based digital map as learning medium for disaster mitigation.

Based on the conclusion, future researchers should involve wider population instead of one class of geography students. In addition to geography lecturers, it should have adequate preparation prior to using Tsunami-Based Digital Map as learning medium for disaster mitigation lesson.

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