Disaster Mitigation Snake and Ladder Game to Improve Earthquake Disaster Preparedness (A Case Study: Yogyakarta 5 Senior High School)

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Abstract. Tectonic earthquakes are natural disasters that are difficult to predict when they occur, therefore preparedness is needed to deal with them. This study aims to determine the improvement in student preparedness for tectonic earthquakes using Guncang Bumi snake and ladder learning media. This research is research and development using the ADDIE model (analysis, design, development, implementation, evaluation). The research subjects were 63 students of class XI of Science. Data collection techniques used were test questions. The data analysis technique used is descriptive analysis and independent t-test analysis. Based on the independent t-test analysis obtained sig <0.05, it can be concluded that there is a difference in preparedness between the experimental class and the control class. Based on the calculation of the improvement in preparedness score, the percentage of improvement in disaster preparedness for the experimental class is 67.65%. The improvement percentage in preparedness for the control class was 32.35%. Both classes have improved but the improvement over much experimental class. Therefore it can be concluded that the use of the Guncang Bumi snake and ladder can improve preparedness for a tectonic earthquake disaster.

Keywords: snakes and ladders, earthquakes, disaster preparedness

1. Introduction
The disaster laboratory is a term for the Indonesian state to illustrate that there are various natural hazards. The hazard can occur naturally or due to human activity and can be a disaster. An earthquake is an example of a natural disaster in Indonesia. Based on the cause, earthquakes can be divided into four types, namely tectonic earthquakes, volcanic earthquakes, ruins earthquakes, and meteoric earthquakes.

Earthquakes that often occur in Indonesia are tectonic. This is because geologically Indonesia is located at the confluence of three world plates. The Pacific Plate, the Eurasian Plate, and the Indo-Australian Plate continue to move. The consequence of tectonic plate movements is the existence of earthquake and volcanic pathways that are a hazard. According to [1] areas located around the Pacific Rim also have to compete with tsunamis, storms, typhoons, and floods.

Yogyakarta is one of the areas prone to tectonic earthquakes because it is located close to the Indo-Australian Plate and the Eurasian plate. This was evidenced by the earthquake on May 27, 2006, that caused casualties and damage to various facilities such as the education sector. The data in table 1 is data from the National Disaster Management Authority [2] about the number of fatalities caused by the 2006 Yogyakarta earthquake.
Table 1. Total of Yogyakarta Earthquake Victims in 2006

| Districts    | Death (people) | Injuries (people) |
|--------------|----------------|-------------------|
| Bantul       | 4141           | 12026             |
| Sleman       | 232            | 3789              |
| Yogyakarta   | 204            | 318               |
| Kulonprogo   | 22             | 2678              |
| Gunungkidul  | 81             | 1086              |
| **Total**    | **4,680**      | **19,896**        |

Sources: [9]

Based on data from the National Development Planning Agency [3], most area severely affected due to the earthquake in Yogyakarta in 2006 was Bantul. The total of casualties died is 4,141 inhabitants. Damage to facilities and infrastructure also occurred such as houses and schools. A total of 208,991 houses were light to severe damage [4]. The Education Sector is also not spared from the impact of the disaster with the amount of damage as many as 197 schools destroyed and 765 schools in mild to severe damage. To reduce its impact, it is important to understand the many factors that influence people's ability to effectively respond to evacuation warnings and orders [5].

The education sector affected by the earthquake indicates that schools are vulnerable to the impact of earthquake disasters. The various impacts that have been caused by the tectonic earthquake in Yogyakarta are a lesson that the importance of tectonic earthquake disaster preparedness education. As a follow up of the most severely affected areas, schools in the districts of Bantul got the attention of the government. Education mitigation of earthquake tectonic continues such form disaster prepared school being planned.

The disaster prepared school being planned is directed to the most severely affected areas, but did not rule out the possibility for other area are also getting attention as the city of Yogyakarta. Yogyakarta City Region ranks third after Bantul and Sleman Regencies with 204 fatalities and 318 minor injuries. Therefore, tectonic earthquake disaster mitigation education is needed for schools in the city of Yogyakarta. This is because students who attend school in the city of Yogyakarta do not only come from within the city of Yogyakarta.

Disaster mitigation education for high school students is aligned with the Geography material in the 2013 curriculum. Therefore, disaster mitigation education can be given when learning Geography. This is consistent with the research [6] which states that there is no better way to manage unforeseen disasters than recognizing the potential for the worst events and taking active and cooperative preventive actions to minimize losses. According to [5] when a person knows the dangers it can be used to decide the steps and how that should be taken when a person must be personally involved in disaster preparedness. Accordingly, the research is done to develop learning media mitigation of earthquakes based games using snakes and ladders to improve disaster preparedness earthquake. To facilitate the students to understand the material on disaster mitigation then is required a medium of learning.

The snake and ladder game model was chosen because the snake and ladder game is a popular and popular game from the age of children, teenagers, and even adults. The game of snakes and ladders is very effective in the learning process [7]. Besides, playing snakes and ladders involves peer-to-peer interactions following the theory put forward by [8] that children's cognitive can develop better through interactions with peers compared with interactions with adults. Therefore, the author tries to develop learning media with the snake ladder game of disaster mitigation to improve tectonic earthquake disaster preparedness with a case study in Yogyakarta 5 Senior High School.

2. Methodology

Earthquakes are vibrations that occur and are felt on the surface of the earth from within the earth's structure [4]. The shift occurred as a result of the event of the release of seismic wave energy suddenly due to the deformation of tectonic plates in the earth's crust. Based on the cause, earthquakes are
divided into four, namely tectonic earthquakes, volcanic earthquakes, earthquake earthquakes, and meteoric earthquakes. According to [10], earthquake is a devastating but common natural disaster that results in billions of dollars in property damage and significant loss of life. Preparedness is a series of activities carried out to anticipate disasters through organization and appropriate and efficient steps [11]. According to [6] Geohazards have increased globally. It is very important to manage natural hazards to minimize casualties and damage to various properties. Besides, there is a growing natural awareness that geological catastrophe events can adversely affect human groups. Enhancing natural disaster mitigation was identified as a priority issue by the island nation.

### Table 2. Indicators of Disaster Preparedness Assessment According to the Indonesian National Disaster Management Authority

| Preparedness                  | Indicator                      | Aspect                                           |
|-------------------------------|--------------------------------|-------------------------------------------------|
| Before a disaster             | Knowledge and Attitude         | Natural events and disasters                     |
|                               |                                | Physical environmental vulnerability             |
|                               |                                | Attitudes to disaster risk                      |
|                               |                                | Evacuation plan                                  |
| Disaster response             | Emergency                      | First aid, rescue, safety and security           |
| After a disaster              | Disaster Warning System        | Traditional (local) and modern technology        |
|                               | Resource Mobilization          | Human resources and funding                      |

Sources: [9]

According to [12] snakes and ladders games are a popular board game that has entrusted generations. This game is played on a grid board consisting of hundred squares in a ten by ten grid. It usually involves two or more players and they take turns to move by rolling a dice. On the way to the finishing line, the players meet some hurdles in the form of snakes and opportunities in the form of ladders. The player who reaches the finishing point (100th square) first wins the game. Snakes and ladders game is a famous board game that has captivated many generations. This game is played on a box in a game board consisting of a square box. Each grid can consist of ten squares. The game usually involves a minimum of two players. When traveling to the finish line, players will get obstacles depicted in the form of snakes and opportunities depicted in the form of stairs. The player who reaches the finish is first considered the winner of the game.

The research methodology is research and development (RnD). The development procedure used is adapted from the ADDIE model which consists of five stages [13]. The ADDIE model can be used to research the development of various learning media products, learning strategies, and learning methods [14]. The stages of the ADDIE model, namely analysis, design, development, implementation, and evaluation are presented in Figure 1:

![ADDIE model flow](image)

The ADDIE model is the framework most widely used by instructional designers [15]. The ADDIE research procedure begins with analysis. The analysis conducted is an analysis of the problems that occur regarding the importance of earthquake disaster preparedness. The next step is to make a design in the form of a media design. The development phase includes validation by material experts and media experts. The assessment of the material and media experts aims to determine the feasibility, criticism, and suggestions. If there are criticisms and suggestions, a revision process will be carried out, but if there is no implementation process will be carried out immediately. The implementation
process was carried out at Yogyakarta 5 Senior High School to find out the improvement for the earthquake disaster preparedness. Testing for increasing earthquake disaster preparedness is done by pre-test and post-test. Implementation involves the experimental class and the control class. The evaluation phase aims to find out the improvement in earthquake preparedness calculated using the independent t-test analysis.

3. Result and Discussions

Tectonic earthquakes are natural disasters whose timing is difficult to predict. This type of earthquake is more common than other earthquakes. The worst effects of an earthquake are fatalities. The school community is one that is vulnerable to the effects of the earthquake because there are activities that involve many people. Therefore, it is important to do an earthquake disaster preparedness education.

This tectonic earthquake disaster preparedness education is aligned with the Geography material in the 2013 curriculum. Following the 2013 curriculum, teachers are required to be creative and innovative in presenting learning in class. The form of a teacher's creativity can be reflected in efforts to develop learning media. The choice of media for snakes and ladders game is because the game is popular and is often played from the age of children, adolescents, and even adults.

The material in the snake and ladder game is tectonic earthquake disaster mitigation issued by the National Disaster Management Authority. The material is then arranged into a matter of pretest and posttest. Snakes and ladders that were develop were given the name Guncang Bumi snake and ladder. Components of the Guncang Bumi Snake and Ladder game that is: snakes and ladders board, cards, pawns, and dice. Snakes and ladders have the shape of a rectangle with a size of 42 x 29, 5 cm. This snake and ladder are packed using carton paper. Completeness in the Guncang Bumi snake ladder as follows:

- One snake and ladder board.
- Three pieces of different colors
- One dice
  - A set of 10 answer cards for questions in red
  - One set of motivation cards is 5 green cards
  - A set of knowledge cards totaling 11 cards are yellow
  - All cards have a size of 9 x 5 cm
  - One sheet of game rules with a size of 21 x 15 cm.
- Snakes and ladders packaging has a length of 24 cm, a width of 15.5 cm, and a height of 3cm.

The number of boxes contained in the Guncang Bumi snake and ladder is 50 boxes. The rules of the game snakes and ladders Rake Earth the same as the rules of snakes and ladders in general. Players run pawns following the numbers that appear when throwing dice. If a player has a box with a ladder in it, the player must move his pawns up on the box that the ladder shows. If the player gets a box with a snake's tail, the player's pawn must go down on the box shown by the snake's head and must open the motivation box. The player must roll the dice twice if the dice shows the number six then add them up to find out the number of boxes to go.

Players in the knowledge box must take the knowledge card according to the number in the box and read it to other players. The player who gets the question box must answer the question and must open the answer card according to the box number is in the question box but does not answer the question then your next turn will be skipped once by another player. If the player has answered a question but your answer is wrong, then the turn will not be jumped over by other players. The game is considered finished if there are players who are in the finish box. Here are the components of the Guncang Bumi snake and ladder.
Figure 2. Components of the Guncang Bumi snake and ladder game. (a) packaging (b) board game (c) game instructions (d) cards (d) pawns and dice

Implementation in the experimental class is a class XI science one. The number of students who participated was 20 students. Learning activities carried out following the learning plan. The activity starts with a greeting, attendance, apperception, and pre-test. After that, it is continued by explaining the material to be studied briefly accompanied by a question and answer session.
The next activity is to bring students into seven groups. Each group consists of 2-3 students. When students have completed play Guncang Bumi snakes and ladders, learning terminated with post-test. The learning activities in the control class were carried out at XI science two. The number of students who participated was 19 students. The activity starts with greeting, attendance, apperception, and carrying out pre-test. After that, continued learning activities by explaining tectonic earthquake mitigation material. Explanation of earthquake disaster mitigation is interspersed with question and answer sessions. When the material that is delivered finished the students were given about the post-test. The thing that distinguishes the learning activities in the experimental class and the control class is the use of the Guncang Bumi snakes and ladder game. The experimental class used the Guncang Bumi snake and ladder while the control class did not use the Guncang Bumi snake and ladder.

Based on the results of the average calculation of the pre-test and post-test scores of the experimental and control classes, it can be seen that the experimental class has a mean pre-test value of 57 and a post-test average value of 80. The control class has an average pre-test value of 60 and a post-test average value of 71. Each class experienced an improvement in tectonic disaster preparedness. The experimental class was 23 points and the control class was 11 points. The improvement in the average preparedness of the experimental group was higher than the control class.

| Class name | Average Pretest | Average Posttest | Gain Score | Percentage Enhancement |
|------------|----------------|-----------------|------------|------------------------|
| Experiment | 57             | 80              | 23         | 67.5%                  |
| Control    | 60             | 71              | 11         | 32.3%                  |

Sources: Analysis or Primary Data (2020)

|          | Levene’s Test for Equality of Variances | t-test for Equality of Means |
|----------|----------------------------------------|-------------------------------|
|          | f            | Sig | t    | df | Sig (2-tailed) | Main Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
| GAIN     | 1,752        | .194| 2,197| 37 | .034           | 11,43421        | 5,20469             | .88851 to 21,97991            |
|          | 2,215        | 34,631| .033| 11,43421 | 5,16213 | .95053 to 21,91789 |

Sources: Analysis or Primary Data (2020)
Based on the results of the independent t-test analysis it can be seen that the F value of 1.752 with a sig of 0.194. Therefore the sig value > 0.05 then the variance of the two groups is homogeneous. Therefore the interpretation that will be used is t which is at the top (equal variances assumed). T-test results found at a value of 2.197 with sig (2-tailed) 0.034. Therefore the value of sig <0.05 can be concluded that there is a difference in preparedness between the experimental class and the control class. Based on the calculation of improving preparedness score, an improvement in disaster preparedness score for the experimental class was 23 points with a percentage of 67.65% and an improvement in preparedness for the control class by 11 points with a percentage of 32.35%. The two classes have in common the improvement in preparedness but the increase is higher in the experimental class that uses Guncang Bumi snake and ladder. Therefore it can be concluded that the use of the Guncang Bumi snake and ladder can improve preparedness for a tectonic earthquake disaster.

4. Conclusion
Based on the independent t-test analysis obtained sig <0.05, it can be concluded that there is a difference in preparedness between the experimental class and the control class. Based on the calculation of the improvement in preparedness score, the percentage of improvement in disaster preparedness for the experimental class is 67.65 %. The percentage improvement in preparedness for the control class was 32.35%. Both classes have improved but the improvement over much experimental class. Therefore it can be concluded that the use of the Guncang Bumi snake and ladder can improve preparedness for a tectonic earthquake disaster.

5. Acknowledgments
This research was supported by the Geography Education Masters Program and Postgraduate of Yogyakarta State University.

6. References
[1] Paton, D. 2009. Living on the Ring of Fire: Perspectives on Managing Natural Hazard Risk in Pacific Rim Countries. Journal of Pacific Rim Psychology, 3 (01), 1–3. DOI: 10.1375 / prp.3.1.1.
[2] National Disaster Management Authority. 2010. Indonesia Information Data Disaster: Natural Disaster in Yogyakarta province in 2010. Retrieved from www.bnpb.dibi.go.id.
[3] National Planning and Development Agency. 2006. Public Disclosure Authorized: Initial Assessment of Damage and Disadvantage of Natural Disaster in Yogyakarta and Central Java. Jakarta: National Planning and Development Agency.
[4] National Planning and Development Agency. 2006. Earthquake Mitigation Action Plan in Central Java Province and Yogyakarta. Retrieved from http://bappenas.go.id.
[5] Bird, DK, Gisladottir, G., & Dominey-Howes, D. 2010. Volcanic risk and tourism in southern Iceland: Implications for hazard, risk and emergency response education and training. Journal of Volcanology and Geothermal Research, 189 (1-2), 33–48. DOI: 10.1016 / j.jvolgeores.2009.09.020.
[6] Bao, K., Wang, G., Lu, X., & McLaughlin, NB. 2011. A potential flood hazard is caused by Tianchi volcano eruption in Changbai Mountain, Northeast China. Journal of Mountain Science, 8 (5), 677–681. DOI: 10.1007 / s11629-011-2209-1.
[7] Mulyati, T. 2009. Snakes and Ladders Learning One Alternative to Increasing Results Studying History of Social Sciences Grade XI Students in SMA Negeri 1 Musuk Semester 2 Academic Year 2007-2008. DIDAKTIKA Journal Vol I No 1.
[8] Izzati, RE., Suardiman, SP., Ayriza, Y., et.al. 2013. Student Development. Yogyakarta: UNY Press.
[9] Christanto, J. (2011). Earthquakes, Environmental Damage, Management Policies and Strategies. Yogyakarta: Liberty.
[10] Xu, J., & Lu, Y. 2018. Towards an earthquake-resilient world: from post-disaster reconstruction
to pre-disaster prevention. *Environmental Hazards Journal, 17* (4), 269-275. DOI: 10.1080 / 17477891.2018.1500878.

[11] National Disaster Management Authority. 2012. Resilient Pocket Book Tough Facing Disasters. Retrieved from http://www.bnpb.go.id.

[12] Shree, GGK, Premalatha, MR, & Pushpa, J. 2016. Snake and Ladder Nutritional Game for Enhanced Health Status of Obese Children. *Journal of Advance Research and Review Vol.1, No.6, 196–207*. Available at https://ijjar.in/Admin/Pdf/103.pdf/.

[13] Molenda, M. 2003. In Search of the Elusive ADDIE Model. *Performance Improvement, 42* (5), 2003, 34-36

[14] Ampera, D. 2017. ADDIE Model Through The Task Learning Approach In Textile Knowledge Course In Dress-Making Education Study Program Of State University Of Medan. *International Journal of GEOMATE 30* (12), 109 – 114.

[15] Morrison, GR. 2010. *Designing Effective Instruction* (6th Edition.). John Wiley & Sons.