Level of earthquake disaster preparedness and its integrity in natural science learning: A literature review

V P S Latupeirisa¹ and Pujianto¹

¹Science Education, Universitas Negeri Yogyakarta, Sleman, Indonesia

Corresponding author: veronica0058pasca.2018@student.uny.ac.id

Abstract. Earthquake preparedness can be trained through a series of policies and strategies in formal and non-formal education. The characteristics of natural science as a study of nature are very strategic as a vehicle for learning mitigation. Earthquakes are one of the natural phenomena that have an impact on life. Earthquakes cause fatalities, property losses, and have an impact in education, this effect is because some people do not know about preparedness. This article uses a literature review. The purposes of writing this article are (1) literature review on earthquake preparedness attitudes (2) integrating earthquake preparedness in natural science learning (3) producing instruments for earthquake preparedness assessment instruments. The results obtained are (1) Earthquake alert attitude includes 4 aspects, 1): knowledge, attitudes and actions, 2): Early warning system, 3): Preparedness Planning, 4): Resource mobilization. (2) Integration of junior high school science subjects in the 2013 curriculum contained in the Basic Competency (Namely, KD) 3.10 which explains the layers of the earth, volcanoes, earthquakes, and risk reduction measures before, during and after disaster and KD 3.11 which analyzes the concept of vibration, waves and sounds. (3) Producing instruments with 27 statements that can be tested to determine the level of preparedness.

Keywords: earthquakes, disaster preparedness, sciences learning

1. Introduction

Earthquakes have a large impact on low and middle-income countries (LMIC), however, the academic evidence base to support disaster risk reduction activities in LMIC arrangements is limited [1]. The increased concern about disaster risk in all countries is evidenced by the increasing number of disasters and the amount of loss. Disasters include serious disruption to society that causes extensive damage to society [2]. According to the World Risk Index, six of the ten countries with the highest disaster risk in the world are in Asia and the Pacific. In the first decade of the 21st century, more than 200 million people were affected and more than 70,000 people were killed each year from disasters caused by natural hazards representing 90% and 65% of the total world, respectively [3]. Given that globalization makes countries increasingly interdependent, prominent disasters can produce global effects by increasing risk perceptions in other countries [4].

Some countries that are often affected by natural disasters, especially earthquakes are Japan, New Zealand, Indonesia and many countries that have experienced natural disasters. Indonesia is geographically located at the confluence of the world's tectonic plates. Indonesia is a disaster-prone country [5]. The country of Indonesia is a country that is on two continents and two oceans and Indonesia is geologically located on three tectonic plates namely the Indo-Australian plate, the
Eurasian Plate and the Pacific plate Indonesia is a country that has experienced natural damage and has experienced a severity. According to the 2010 Asia Pacific Disaster Report, Indonesia places a large number of positions \[6\] where disasters occur and to reduce their impact is very much needed preparedness[5]. Earthquakes cannot be prevented but there are steps to predict and take anticipatory steps. One alternative to increase risk awareness and risk assessment is the distribution and dissemination of communication tools and organizational involvement \[7\]. The action can be carried out with the support of several institutions, especially educational institutions. Educational institutions play an important role as a channel of knowledge to students who hope that knowledge can be applied in life.

Complete and detailed knowledge of earthquake history serves as an underlying factor for uncovering and installing sites of earthquake hazards. The relationship of seismotectonic structures of the area that emits earthquakes can make effective planning and preparedness in earthquake prone areas. Therefore, it is very important, considering the potential danger in the area around the residence \[8\]. Teenage involvement is also very necessary to deal with earthquake disasters. The contribution of young people to disaster response is very diverse and substantial; including involvement in rescue efforts, providing first aid and special disaster education \[9\].

Teenagers among students need to be trained as early as possible to know the importance of earthquake disaster preparedness so that it will foster anticipation, namely by including the topic of disaster in learning. One subject that can accommodate this material is the subject of Natural Sciences. A resilient country needs strong science for disaster risk reduction. At all levels of science education must prioritize the provision of disaster information so that it can be integrated into the implementation plan regarding disaster reduction \[10\]. Earth and space science for junior high school is given to science subjects with a portion of 6.94%, the total portion of Earth Science and space material is relatively small, so learning must be well prepared in order to create a community that is prepared for disasters. The relatively small proportion of Earth and space material shows that thinking towards understanding disaster risk is not yet a significant part of school learning materials \[11\]. Learning needs still need to reach the level of preparedness and effective expenditure management \[12\]. Disaster integration is expected to provide direct experience to students so that they are able to see the phenomenon as a whole and meaningfully. Studying integrated science helps students to understand and study the phenomenon of disaster in the review of earth science, the community and the environment, technology and physics so that students’ preparedness in facing disasters will be realized. The teacher has an important role when disaster strikes. The teacher has an important role when disaster strikes. The teacher accompanies students in emergencies such as giving directions to leave class, return to class or return to their homes. Students need to know about preparedness and preventive measures to reduce the impact of disasters because the preparedness training among students is still very limited. This training is very important because disaster preparedness training increases the knowledge and capability of disaster preparedness for students \[13\]. Students are expected to be partners in implementing schools that are safe from disasters. Before a disaster occurs, there needs to be an increase in human resources, including an increase in student resources \[14\]. Preparedness is very important to reduce the impact of earthquakes \[1\].

2. Discussion

2.1. Earthquake Disaster Preparedness Attitude

Disaster Preparedness is efforts that enable individuals, groups, organizations to overcome the danger of natural events, through the establishment of systematic emergency response structures and structures. The purpose of preparedness is to minimize casualties and damage to public service
facilities. Disaster Preparedness includes efforts to reduce the level of risk, formulation of disaster emergency plans, management of resources, training in disaster prone locations. Disaster preparedness is an action taken before an event that reduces or can help eliminate the severity of natural disasters by preparing students through the development of contingency plans for response, recovery and ongoing public awareness about the hazards and risks of disasters [15]. Another opinion states that disaster preparedness is the process of ensuring that an entity has complied with preventive measures; in estimating the effects of an event to minimize loss of life, injury and property damage; can provide rescue, relief, rehabilitation and other services after a disaster; and has the ability and resources to continue to maintain important functions without being overwhelmed with requests placed on them [16]. Careful planning forms the foundation of the disaster cycle. If planning is bad, not systematic or only at a single level, then it is likely that all other aspects of the cycle will also fail. The preparedness cycle applies to all levels of response from the community to the international for this reason disaster preparedness requires effective leadership and management so as to produce an appropriate response to the disaster [1].

Community behavioral responses to earthquakes vary, varying with social contexts, largely rational, adaptive and consistent with the norms and roles of performance [17]. Disaster management strategies can work effectively if the community has the knowledge and understanding of disaster management and mitigation [7]. Integrated disaster risk research involves various scales (local to global), stakeholders (experts, professionals, officials), Knowledge (scientific, local), scientific disciplines (physical, social, human science), methodological approaches, fields of application / implementation (planning, sustainable development, policy) and real-world experience [18]. Disaster Risk Reduction in 2015-2030 stipulates 'investment in disaster risk reduction for resilience'. This context includes both pre-disaster actions that seek to prevent damage and losses related to hazards and post-disaster strategies designed to overcome and minimize the impact of disasters. The concept of community resilience has gained wide acceptance in disaster management [19]. Community resilience is another aspect that is the focus of disaster preparedness. Although current preparedness practices do not emphasize the purification of community resilience in the aftermath of a disaster, it needs to be improved because the community is always the first to experience a disaster, they are the first to be affected. If the community is equipped, involved, and trained to deal with natural hazards during a disaster event thus, vulnerability is reduced [15]. Community resilience in facing disasters can improve techniques and knowledge. In addition, it is now generally recognized that integrating indigenous knowledge with scientific knowledge can lead to the success of a disaster preparedness strategy [3].

Communities have the power to activate the capacity of internal resilience to cope with and recover from natural disasters. Community responses to disasters illustrate the potential of communities to mobilize internal resources and capacity to deal with and recover from disasters [19]. Resource mobilization is the ability of an individual, group, organization or community to work together by having better social ties with the aim of growing awareness of preparedness [15]. Preparedness is needed to deal with mental health and rehabilitation needs in the medium to long term. The main preparedness actions include proper identification, planning, and training [1]. Individual preparedness plays an important role in reducing deaths and morbidity caused by disasters and there are many things individuals and communities can do to prevent or reduce the consequences of disasters, even with small scale investment [20].

The problems associated with increasing losses due to disaster more lie in the interpretation and understanding of risk [22]. Disaster awareness is an important factor for carrying out disaster preparedness. Key dimensions for assessing disaster vulnerability include employment, income level, housing, cultural background, education level, age, gender, and disability [23],[20]. Factors that can be considered as obstacles in disaster preparedness are the level of disaster experience, the lack of motivation for the possibility of a disaster occurring, not thinking about a disaster, not having enough information, not having enough space, socio-economic status and budget for disaster preparation [15]. Understanding how people interpret risks and choose actions based on interpretation is essential for
any disaster reduction strategy emphasizing that risks in the context of natural hazards always involve interactions between natural (physical) and human (behavioral) factors [22],[17],[27].

Students’ preparedness in facing an earthquake can be realized if all aspects of competency both in terms of cognitive, affective and psychomotor can be fulfilled. Preparedness can be done in several ways, namely: (1) Training and outreach ;(2) Providing information through simulation exercises or techniques such as virtual reality, providing information through brochures or other traditional methods [26]; (3) Individual curation [27]; (4)Through education at school [16].Earthquake disaster preparedness can be realized by making efforts to reduce disaster risk. There are 3 stages of earthquake risk reduction namely efforts before an earthquake occurs, efforts when an earthquake occurs, and efforts after an earthquake occur. There are 10 steps to realizing disaster safe education units [27] can be seen in figure 1.

![Figure 1. Steps to realize disaster-safe education units.](image)

The ten steps in Figure 1 are steps that can be applied to disaster-prone schools so that students will have a picture of disaster safe actions and have been trained when a disaster occurs. The teacher must use all steps in sequence. Training is a very important element in systematically increasing preparedness efforts. There are three stages of training, namely the training stage, the simulation stage, and the system test stage. The three of them have plot [28] namely:

- A phased understanding in preparedness exercises is carried out starting from the initial stages of needs analysis, planning, preparation and implementation, as well as monitoring and evaluation.
- Tiered, it means that training is carried out starting from the most basic level of complexity, namely socialization, to the highest complexity, namely integrated training / field rehearsal. All types of preparedness exercises are intended to increase the capacity of stakeholders, ranging from increasing knowledge, to attitudes and skills in carrying out functions and responsibilities during an emergency situation.
- Preparedness training activities can be carried out routinely, especially in cities/regencies with a high risk of disasters, and are conducted at least once a year to reduce the number of disaster victims.

The purpose of the preparedness exercise is to increase the capacity of human resources in implementing Standard Operating Procedures (SOP) that have been made, to assess the capability of
supporting communication equipment for early warning systems, supporting evacuation, and supporting emergency response and reviewing cooperation between local institutions / organizations. Disaster preparedness parameters include first: knowledge, attitudes and actions; second: school policy; third: Preparedness planning; fourth: resource mobilization [14]. Efforts must be made before an earthquake occurs namely: (1) Prepare a rescue plan when an earthquake suddenly occurs; (2) Make simple exercises to deal with falling objects during an earthquake: ducking, protecting your head and hiding under a table; (3) Prepare fire extinguishers, standard safety equipment and medical supplies; (4) Building earthquake-resistant housing reconstruction and renovating parts of houses and buildings that look cracked; (5) Paying attention to zoning in earthquake prone areas and land use regulations issued by the government; (6) Form a disaster rescue action group by conducting training and first aid in the community.

Efforts to reduce disaster risk in the event of an earthquake in terms of location and actions to be taken [28] can be seen in figure 2. Figure 2 explains the anticipatory steps that can be taken when an earthquake occurs in certain situations. Like when we are indoors, outdoors, driving, on the beach, in the mountains or when we are trapped in the rubble of a building.

Figure 2. Actions are taken when an earthquake occurs.
2.2. Integration of Earthquake Alert Attitudes in Natural Science Learning

The topic of earthquakes in junior high school science learning is contained in KD 3.10 which explains the layers of the earth, volcanoes, earthquakes, and risk reduction measures before, during and after disasters in accordance with the threat of disasters in their area and there is also a material connection to KD 3.11 which analyzes concepts vibrations, waves and sounds, in everyday life including the human hearing system and the sonar system in animals. The whole basic competency is prepared to equip students to be prepared in the event of an earthquake because they have a good understanding of the concepts of earth structure, vibration and waves. Briefly can be seen in figure 3.

The concept map on the topic of earthquakes is very specific which only discusses the movement of plates, earthquake measuring devices and earthquake impacts. Combining these 2 basic competencies will be very useful for students to make it easier to understand material about earthquakes. The integration lies in the aspects of earth, society, and the environment, technology and physics. The integration of earthquake disaster preparedness is still very minimal applied in learning, especially relating to certain topics.

![Concept Map Earthquake Material for Junior High School](image)

Figure 3. Concept map earthquake material for Junior High School.

Some applications for integrating preparedness in learning can be seen in table 1.

| No. | Article Title, Author, & Journal | Year | Substance |
|-----|---------------------------------|------|-----------|
| 1   | Evaluation of disaster preparedness training and disaster drill for nursing students.. Alim, S., Kawabata, M., & Nakazawa, M (Nurse Education Today) [13] | 2016 | Research on "Evaluation of disaster preparedness training and disaster training for nursing students" This study evaluates fully the effectiveness of disaster preparedness training and disaster training: Training and training increases knowledge and ability for disaster preparedness for both undergraduate and diploma students. |
| 2   | A critical discussion on the earthquake risk mitigation of urban | | The Science Review is concerned with earthquake risk mitigation as a basis for |
cultural heritage assets. International Journal of Disaster Risk Reduction Maio, R., Ferreira, T. M., & Vicente, R [7] understanding the current situation and for identifying new research gaps and opportunities to increase the level of knowledge in the field of mitigation

3 Effects of Disaster Nursing Education on Nursing Students’ Knowledge and Preparedness for Disasters. Kalanlar, B (International Journal of Disaster Risk Reduction) [21]. The purpose of this study was to determine the effect of the application of the scenario-based training module on 'Nursing and Disaster Management' on the awareness, knowledge, and readiness of students for disasters, to prepare nurses to face the challenges of unexpected events and enable them to take a more active role in disasters

4 Tailoring disaster risk reduction for adolescents: Qualitative perspectives from China and Nepal. Newnham, E. A., Tearne, J., Gao, X., Guragain, B., Jiao, F., Ghimire, L., Balsari, S., Chan, E., & Leaning, J. (International Journal of Disaster Risk Reduction) [9]. Sixty teenagers (51% women, ages 13-19) participated in informant interviews and focus group discussions in disaster-affected areas in China and Nepal. The results state that the contribution of adolescents in disaster response is very diverse and substantial.

This special article has not explained about disaster preparedness among students, but has not specifically discussed earthquake preparedness in the topic of learning in the classroom

2.3. Earthquake preparedness measurement instrument
Based on a review of several articles, the researcher summarizes the main aspects that form the basis of earthquake disaster preparedness, namely (1) knowledge, attitudes and actions [22],[3],[18],[14],[8], (2) early warning systems [25],[34], (3) preparedness planning [18],[1],[14] and (4) resource mobilization[14],[16],[19]. So the researchers made an earthquake alert measurement instrument as set out in table 2.
No. | Aspect                  | Indicator                          | Statements                                                                 |
---- |------------------------|------------------------------------|----------------------------------------------------------------------------|
     | with disasters and procedures | 11. Techniques and procedures when dealing with earthquakes  
     |                         | 12. Techniques and procedures for after-earthquake simulation | 13. Earthquake preparedness exercise  
     |                         | 14. Earthquake preparedness simulation |  
     | Exercise and simulation |  
     |                         | 15. Evacuation route map | 16. Determine the evacuation lane |
     | Preparedness planning | 17. Providing first aid to earthquake victims | 18. Determine a safe place for temporary shelter |
     |                         | 19. Disaster evacuation planning | 20. Give priority to victims who are seriously injured, children and the elderly |
     | 3                     | Determine evacuation routes |  
     |                         | First aid rescue and security |  
     | Resource mobilization | 21. Form a team to facilitate evacuation | 22. The team helps the process of channeling assistance |
     | Institutional arrangement |  
     | Command system | 23. Listen to the instructions of the officer | 24. Manage the process of channeling assistance |
     | Availability of resources both human resources and funding, facilities and infrastructure | 25. Provision of food and necessities that are very necessary | 26. Readiness of medical personnel and drugs |
     |                         | 27. Provision of temporary accommodation |  

The level of preparedness of students cannot only be measured by one of the aspects in table 2. All aspects make the same contribution in preparedness. This measurement instrument can be used to measure the level of preparedness among students. So that it will continue to be improved policies on how to grow the level of preparedness of students in dealing with natural phenomena.

### 3. Conclusion

Preparedness is an activity carried out by individuals, groups of organizations and even communities to anticipate disasters through organizing and through appropriate steps with the aim of minimizing casualties and damage to facilities. Disaster preparedness is very important to know from an early age so it needs to be applied in learning at all levels of the school so that students have the knowledge of what must be prepared before, during and after a disaster. This literature review involved 36 reference sources consisting of several international and national articles and ebooks. Through some literature reviews, preparedness is connected with several topics in junior high schools to integrate some knowledge in science learning so that it becomes a unity that can be implemented in life. This implementation process can be monitored by measuring how prepared the students are in facing disasters through the available measures.

### References

[1] C Cartwright M and Hall A C K Lee 2017 *Public health*. 150 60-6 [http://dx.doi.org/10.1016/j.puhe.2017.04.024](http://dx.doi.org/10.1016/j.puhe.2017.04.024)

[2] Wand M Z, Ayuba I G U and Asika B G 2015 *IOSR Journal of Environmental Science, Toxicology and Food Technology*. 9 43-5 [http://doi.org/10.9790/2402-09134347](http://doi.org/10.9790/2402-09134347)

[3] Hiwasaki L, Luna L, Syamsidik and Shaw R 2014 *International Journal of Disaster Risk Reduction*. 10 15-23 [http://dx.doi.org/10.1016/j.ijdrr.2014.07.007](http://dx.doi.org/10.1016/j.ijdrr.2014.07.007)

[4] Hu H, Lei T, Hu J, Zhang, S and Kavan P 2018 *International Journal of Disaster Risk Reduction*. 28 664-73 [https://doi.org/10.1016/j.ijdrr.2018.01.022](https://doi.org/10.1016/j.ijdrr.2018.01.022)
[5] Prihatiningsih T S, Widyandana, Hapsari E D, Helmiyati S and Ananda A J N 2017 Journal of Interprofessional Education & Practice. 9 125 https://doi.org/10.1016/j.i jeep.2017.10.001
[6] McClean D, editor 2010 World Disasters Report 2010: Focus On Urban Risk (Geneva, Switzerland: International Federation of Red Cross and Red Crescent Societies ) pp 35-202
[7] Maio R., Ferreira T M. and Vicente R 2018 International Journal of Disaster Risk Reduction, 27 239–47 https://doi.org/10.1016/j.ijdrr.2017.10.010
[8] Mavroulis S, Stanoja E S and Lekkas E 2019 Quaternary International https://doi.org/10.1016/j.quaint.2019.09.006
[9] Newnham E A, Tearne J, Gao X, Guragain B, Jiao F, Ghimire L, Balsari S, Chan E, and Leaning J 2018 International Journal of Disaster Risk Reduction. 34 337-45 https://doi.org/10.1016/j.ijdrr.2018.12.020
[10] R Southgate, V Murray, C Roth, J Schneider, P Shi, Tishiishi, Wenger D, Ammann, Ogallo a nd Beddington S J 2013 Using Science For Disaster Risk Reduction Report of the UNISDR Scientific and Technical Advisory Group–2013 (Swiss : The United Nations Office for Disaster Risk Reduction) pp 2-8
[11] Pujianto, Prabowo and Wasis 2018 Proc. Intl. Conf. on Science Education (Surabaya) vol 1006 (Bristol: IOP Publishing) p 1-11 http://dx.doi.org/10.1016/j.ijdrr.2017.11.002
[12] Alim S, Kawabata M. and Nakazawa M 2015 Nurse Education Today 35 25 http://dx.doi.org/10.1016/j.nedt.2014.04.016
[13] BNPB 2012 Peraturan kepala badan nasional penanggulangan bencana No 04 tahun 2012 tentang pedoman penerapan sekolah/madrasah aman dari bencana (Jakarta: Badan Nasional Penanggulangan Bencana)
[14] Rañeses M K, Richards A C, Richards J and Bubb J 2017 Proc. Int. Conf. on Building Resilience (Bangkok) vol 212 (Amsterdam: Elsevier) p 419–26 http://doi.org/10.1016/j.j.proeng.2018.01.054
[15] Buor J K, Menachof D A and Talas R 2016 Accident Analysis and Prevention 123 433-47 http://dx.doi.org/10.1016/j.aap.2016.07.013
[16] Goltz J D and Bourque L B 2016 International Journal of Disaster Risk Reduction. 21 251-65 http://dx.doi.org/10.1016/j.ijdrr.2016.12.002
[17] Gall M, Nguyen K H and Cutter S L 2015 International Journal of Disaster Risk Reduction. 12, 255–67 http://dx.doi.org/10.1016/j.ijdrr.2015.01.010
[18] Moreno J 2017 Procedia Engineering. 212 1040–45 http://doi.org/10.1016/j.proeng.2018.01.134
[19] Yesil S T, Tanner M. and Kara M 2018 International Journal of Disaster Risk Reduction. 33 284-89 https://doi.org/10.1016/j.ijdrr.2018.10.014
[20] Teo M., Goonetilleke A., Ahankoo A., Delami K and Lawie M 2018 International Journal of Disaster Risk Reduction. 31 37 https://doi.org/10.1016/j.ijdrr.2017.12.008
[21] Spiekermann R., Kienberger S, Norton, J, Briones F and Weichselgartner J 2015 International Journal of Disaster Risk Reduction 13 96–7 http://dx.doi.org/10.1016/j.ijdrr.2015.05.002
[22] Teo M., Goonetilleke A., Ahankoo A., Delami K and Lawie M 2018 International Journal of Disaster Risk Reduction https://doi.org/10.1016/j.ijdrr.2018.09.008
[23] Cook A B D, Shrestha M and Htet Z B 2018 International Journal of Disaster Risk Reduction, 31, 535-47 https://doi.org/10.1016/j.ijdrr.2018.05.014
[24] Arnold S A, Brockdorff F, Jakovljev I and Zdravković S 2018 International Journal of Disaster Risk Reduction, 31 37 https://doi.org/10.1016/j.ijdrr.2018.04.015
[25] Lai C H and Tang T 2018 Computers in Human Behavior. 88 37-46 http://doi.org/10.1016/j.chb.2018.06.023
[26] Amri A 2017 Pendidikan tangguh bencana (Jakarta: Sekretariat Nasional Satuan Pendidikan Aman Bencana, Direktorat Pembinaan Pendidikan Khusus Dan Layanan Khusus, Direktorat
Jenderal Pendidikan Dasar Dan Menengah, Kementerian Pendidikan Dan Kebudayaan)

[28] Supatini E, Kumalasari N, Andry D, Susilastuti., Fitrianasari I., Taringan J, Haryanta A A, and Nugi R 2017 Buku pedoman latihan kesiapsiagaan bencana membangun kesadaran, Kewaspadaan dan kesiapsiagaan dalam menghadapi bencana (Jakarta: Badan Nasional Penanggulangan Bencana) pp 14-6

[29] Tarek S A 2014 Procedia Economics and Finance 18 287-95 http://doi.org/10.1016/S2212-5671(14)00942-3