

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

V P S Latupeirisa<sup>1</sup> and Pujiyanto<sup>1</sup>

<sup>1</sup>Science 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 often 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]. To find out the level of disaster preparedness among students it is necessary to have a review in the form of literature developed as an information center that is constantly updated. The literature can be supported by learning instruments, especially measurement instruments to determine the level of readiness of junior high school students in preparing themselves when before, during and after a disaster..

## 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].

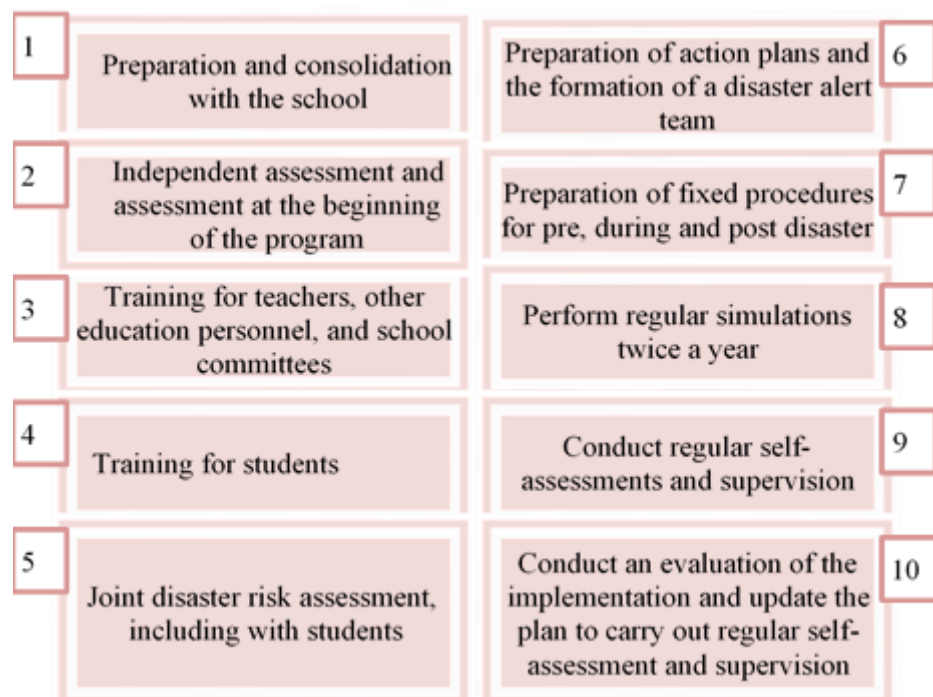
Community behavioral responses to earthquakes vary, varying with social contexts, largely rational, adaptive and consistent with the norms and roles of performance [17]. Disaster management strategies can work effectively if the community has the knowledge and understanding of disaster management and 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.

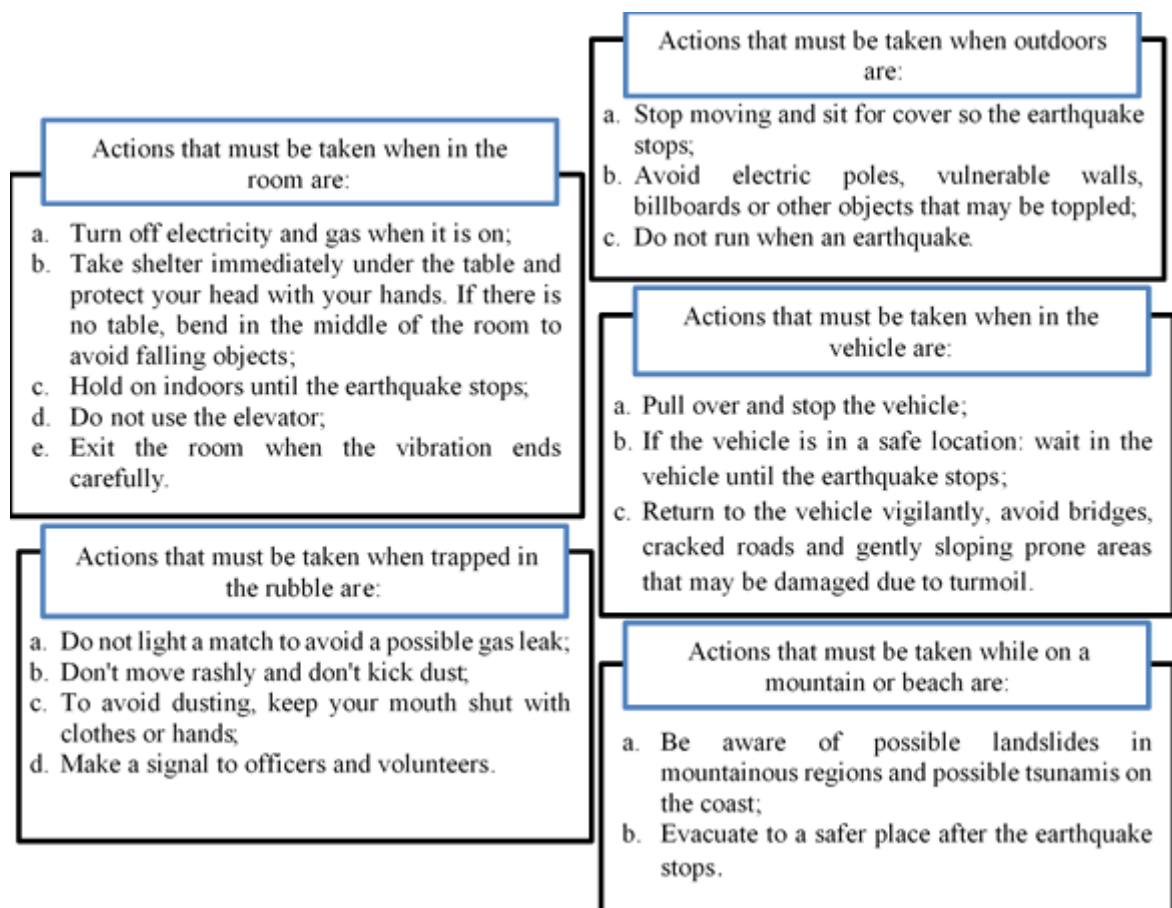
The ten steps in Figure 1 are steps that can be applied to disaster-prone schools so that students will have a picture of disaster safe actions and have been trained when a disaster occurs. The teacher must use all steps in sequence. Training is a very important element in systematically increasing preparedness 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.

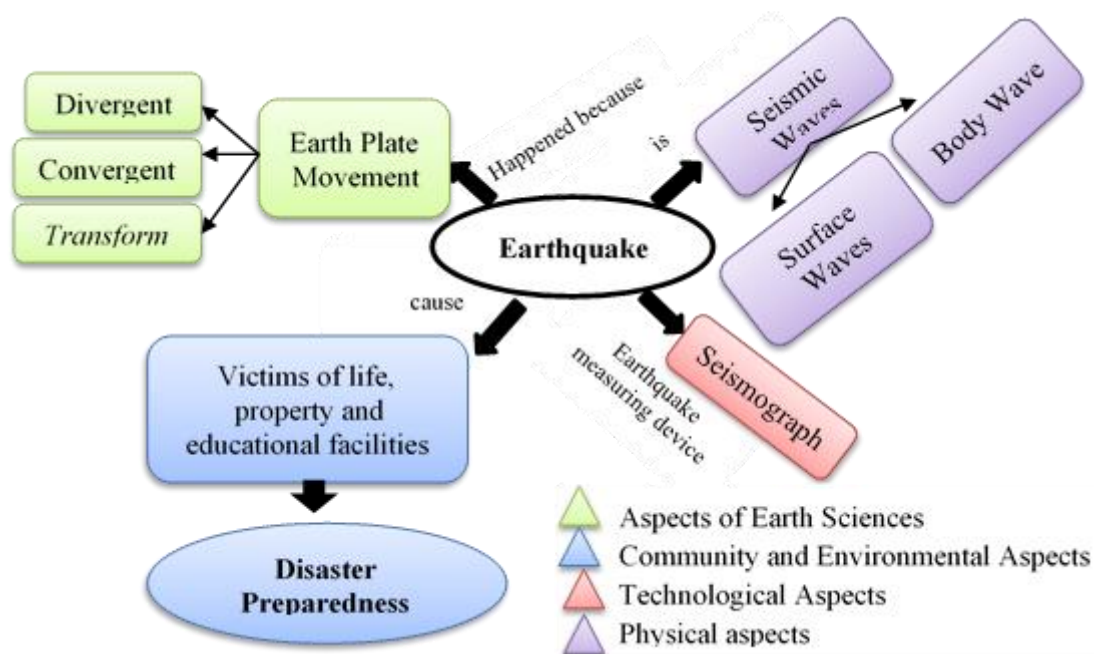


**Figure 2.** Actions are taken when an earthquake occurs.

## 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.



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

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

**Table 1.** Application of disaster preparednes in learning.

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 ( <i>Nurse Education Today</i> ) [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

No.	Article Title, Author, & Journal	Year	Substance
	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 ( <i>International Journal of Disaster Risk Reduction</i> ) [21].	2017	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. ( <i>International Journal of Disaster Risk Reduction</i> ) [9].	2018	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.

**Table 2.** Measuring instruments for earthquake preparedness.

No	Aspect	Indicator	Statements
1	Knowledge, attitudes and actions	Knowledge about earthquakes	1. Knowledge of earthquakes in the area of residence 2. Knowledge of the impact of disasters on living things and the environment
		Knowledge of before, during and after earthquake disasters	3. Knowledge of actions before an earthquake occurs 4. knowledge of actions during an earthquake 5. Knowledge of actions that must be taken after an earthquake occurs
		Attitude to respond to the earthquake disaster	6. Attitude in responding to earthquake in the area of residence 7. Attitudes towards others who experience the effects of disasters
2	Early warning systems	Disaster dissemination warning	8. Disaster risk reduction information 9. Measures to reduce the risk of impacts
		Mechanism for dealing	10. Pre earthquake earthquake techniques and



No	Aspect	Indicator	Statements	
3	Preparedness planning	with disasters	procedures 11.Techniques and procedures when dealing with earthquakes 12.Techniques and procedures for after-earthquake	
		Exercise and simulation	13.Earthquake preparedness exercise 14.Earthquake preparedness simulation	
		Determine evacuation routes	15.Evacuation route map 16.Determine the evacuation lane	
		First aid rescue and security	17.Providing first aid to earthquake victims 18.Determine a safe place for temporary shelter	
		Evacuation Plan	19.Disaster evacuation planning 20.Give priority to victims who are seriously injured, children and the elderly	
		Resource mobilization	Institutional arrangement	21.Form a team to facilitate evacuation 22.The team helps the process of channeling assistance
			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.

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