Investigating the response of students with disabilities to earthquakes: Preliminary results

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Abstract. This research aims to investigate the responses of students with disabilities to earthquakes. To achieve the goal, this study investigated the perception of evacuation plans for earthquakes among students with visual impairments (n=32, junior and senior high schools) and their teachers (n=12) using in-depth interviews. The questions asked to the respondents encompassed the knowledge and experience of earthquakes, safe school buildings and designs, evacuation plans, and assistance during emergencies. An evacuation simulation for earthquakes was also performed to understand the ability of students to protect and evacuate themselves from earthquakes. Testimonials were also noted from students and teachers after the simulation to understand interventions needed to improve the students’ response in facing earthquakes. The interviews and simulation processes were recorded using voice and video cameras, respectively. A qualitative content analysis was used to scrutinize the responses obtained from the interviews and evacuation simulation for earthquakes. The results of interviews showed that the majority of SWDs show poor (n=22) responses to earthquakes. Only a small number of students show moderate (n=4) and good (n=1 people) responses to earthquakes. The interviews revealed aspects need improvements, including the knowledge about earthquakes, reaction time to earthquakes, self-protection and evacuation procedures, safety of school buildings, and design of school building to support swift evacuation. Furthermore, the simulation for earthquakes exposed that the students are vulnerable to earthquake disasters. In addition to the lack of ability to protect and evacuate themselves during earthquakes, the students are not prepared mentally to face earthquakes. Capacity building through regular evacuation simulation for earthquakes, knowledge improvements in earthquakes, and self-protection training is likely to reduce the risk of being adversely affected by earthquakes.

1. Introduction
Among the people with disabilities (~15% of the global population, including children), students with disabilities (SWDs) are one of the groups that are extremely vulnerable to disasters, with higher mortality rate compared to that of students without disabilities [1-3]. The vulnerability may be exacerbated by other factors, including a poor understanding of disability-specific needs, negative societal views [4], lack of participation in disaster risk management processes, or unequal access to resources and information to manage catastrophic events [5]. The challenges are potentially related to the lack of data associated with SWDs [6-8] or the stigma that disability courses are complex issues and relatively beyond the institutional capacity of organisations [9]. These unfavorable conditions are likely to cause SWDs unable to adapt, withstand, or rapidly recover from disaster events [10]. Scholars have
argued that raising awareness, combating negative attitudes, and addressing discrimination are needed to convert the vulnerability into capability to not only improve survival rates, reduce rehabilitation cost, counter poverty and disadvantages [5], but also addressing social vulnerability and enhancing the resilience society as a whole [7].

In line with the Sendai Framework 2030 and the national mid-term development goal in disaster management, the Government of Indonesia through Indonesian National Board for Disaster Management commits to reducing the present disaster risk index by 30% until 2019 through the increase of disaster management capacity at the regency level [11]. Seventy-one indicators are used to measure the endeavour, and one of the indicators is the implementation of the safe school initiative. Supporting the national disaster management plan, the Indonesian Ministry of Education and Culture reported that about 26,000 schools had conducted efforts to reduce disaster risks [11]. However, many schools for students with disabilities do not have disaster risk reduction plan. The limitations may be due to various reasons, ranging from insufficient guidelines, technical difficulties, the lack of capable human resources, to the inadequate data on behaviors of students with disabilities, preparedness needs, and integration of the needs into community emergency plans [10]. Therefore, an urgent need exists to fill the gaps in the availability of data and resources to reduce damages and losses potentially suffered by students with disabilities in case of earthquake events.

Studies have shown that evacuation plans - one of the disaster preparedness tools - are essential in preparing population at risk in reducing potential damages and losses from disaster events [12]. It is argued that many aspects need to be considered to generate evacuation plans suitable for student with disabilities, including the risk perception, evacuation behaviour, and specific needs of SWDs [13, 14]. First, risk perception provides information related to not only to the awareness but also how people respond to risk. It is crucial that SWDs have an accurate perception of the hazards and unsafe conditions threaten their well-being. Otherwise, SWDs may not respond accordingly during an emergency event. Second, unsafe evacuation behaviour may jeopardize the safety of SWDs during emergency events. Golshani, Shabanpour [15] stated that the evacuation decisions, such as ignoring situations, or evacuating to safer places, are influenced by several factors, including individuals’ socio-economic conditions, disaster characteristics, and built-environment factors. Finally, SWDs may require an access to resources and specific mechanisms to enable them to reach safe places promptly during emergency events and to support their normal functioning in the aftermath of disasters (e.g., in the evacuation shelter) until they can be reunited with their family members [12].

Surabaya is at risk of earthquakes because two active faults, namely Waru and Surabaya, pass through the city [16]. Both faults shifted at a speed of 0.5 mm/year and potentially generate land earthquakes around ML6.5. Surabaya needs to prepare to face the earthquake risk, including the school for student with disabilities. It is essential for the schools to ensure that the students with disabilities (SWDs) are safe during earthquake emergencies. To respond to earthquake emergencies effectively and efficiently, the schools require not only disability friendly building design but also emergency evacuation plans and basic self-protection skills [11]. Despite the risk and urgent need for preparation to face earthquakes, studies investigating the responses of SWDs and teachers to earthquakes are lacking.

The present study aims to investigate the students with disabilities and teachers’ responses to earthquakes. In doing so, this research performs in-depth interviews and evacuation simulations of earthquake in one of the schools for students with visual impairments in Surabaya. The results of this investigation is likely useful for reducing impacts from potential earthquakes to SWDs in Surabaya.

2. Methods

2.1 A. In-depth interview
In-depth interviews were performed to investigate the responses of SWDs and teachers to earthquakes. The sampling method for collecting the data from the students is stratified random sampling. It is worth mentioned also that not all students were attending school during the data collection period due to the post-examination school holiday or sickness. Students from Grade XII were not included in as the
respondents will graduate before the present study is completed. Table 1 shows the participants of this research.

Table 2 describes questions asked during in-depth interviews. Questions related to knowledge and experience of earthquakes (K1-K10), safe school buildings and designs (S1-S2), evacuation plans (E1-E9), and assistance during emergencies (A1-A6) were asked to the SWDs and teachers. Furthermore, Table 3 explains the criteria used to score responses provided by interviewees.

### Table 1. Participants of the interviews

| No | Participants | #respondents | No | Participants | #respondents |
|----|--------------|--------------|----|--------------|--------------|
| 1  | Teachers     | 12           | 4  | Grade IX    | 10 (1-7-2)  |
|    | Students:    |              | 5  | Grade X     | 4 (0-4-0)   |
| 2  | Grade VII    | 8 (1-6-1)*   | 6  | Grade XI    | 3 (0-2-1)   |
| 3  | Grade VIII   | 7 (0-7-0)    |    | Grade XII   |             |

* Example 1-6-1 in sequence (1 student with low vision, 6 student with total blind, 1 student with difficulties in perceiving light)

The responses of SWDs and teachers to earthquakes are divided into three levels, that is Low, Moderate, and High. The formula to determine the class interval is as followed:

$$\text{interval} = \frac{\text{maximum} - \text{minimum}}{\text{#class}} \quad \ldots \ldots \ldots \ldots \ldots (1)$$

The minimum and maximum values are obtained from the multiplication of the number questions with the lowest and highest scores, respectively. For examples, for the present study, the range of values is Low 27-44; Moderate 45-62; and High 63-81. The formula is also used to classified the cumulative experience of respondents on each question to understand aspects that require special attentions.

### Table 2. Questions to understand the responses of student to earthquakes.

| No | Variables                          | Code | Questions                                                                 |
|----|-----------------------------------|------|--------------------------------------------------------------------------|
| 1  | Knowledge and experience          | K1   | Have you ever experienced an earthquake?                                 |
| 2  |                                   | K2   | Do you get a lesson about earthquakes?                                  |
| 3  |                                   | K3   | If an earthquake occurs, what will your first reaction be?              |
| 4  |                                   | K4   | After experiencing panic due to earthquakes, what is the first reaction can be done? |
| 5  |                                   | K5   | If an earthquake happens, where will you run to?                       |
| 6  |                                   | K6   | What will happen if an earthquake occurs?                               |
| 7  |                                   | K7   | How can you avoid the adverse effects of the earthquake?               |
| 8  |                                   | K8   | Are you familiar with the building layout in this school?              |
| 9  |                                   | K9   | Have you ever received training on earthquake responses?               |
| 10 |                                   | K10  | What will you do (your reaction) if the earthquakes stop?              |
| 11 | Safe school buildings and designs | S1   | Is this school strong enough to withstand an earthquake?                |
|    |                                   | S2   | Does the layout of this school support the evacuation process during earthquake? |
| 13 | Evacuation plans                   | E1   | Does this school have Standard Operating Procedures for earthquake evacuation? |
| 14 |                                   | E2   | What is the sign (audio or else) for dangers (early warning)?           |
| 15 |                                   | E3   | Are there policies in your school that about earthquake risk reduction? |
| No | Variables | Code | Questions |
|----|-----------|------|-----------|
| 16 |          | E4   | Is there an evacuation map? |
| 17 |          | E5   | Is there a gathering point for evacuation? |
| 18 |          | E6   | Is there a temporary shelter? |
| 19 |          | E7   | Do you have a school disaster alert group? * |
| 20 |          | E8   | Do you know the signs for earthquakes? (tremors, etc.) |
| 21 |          | E9   | Are there special supplies (first aid kit, medicine) during emergencies? |
| 22 | Assistance during emergencies | A1   | Do you need assistance in doing daily activities? |
| 23 |          | A2   | Do you use any tools to support your daily activities? |
| 24 |          | A3   | Do you need help to save yourself? |
| 25 |          | A4   | How do people provide you help? |
| 26 |          | A5   | What tools are needed to help save yourself when evacuating for earthquakes? |
| 27 |          | A6   | Who do you contact during emergencies? |

2.2 Evacuation simulation for earthquakes

An evacuation simulation for earthquakes was performed to investigate the actual student responses to earthquakes. The simulation was performed in the beginning of the academic year 2019/2020 (at the fifth day). While the in-depth interview was performed in 27 May 2019, the simulation was performed in July 26, 2019. The delay between each pre-test was due to the school holiday. It is worth mentioning that SWDs were unaware that the simulation will be performed on the day. However, although the evacuation simulation was informed only to three teachers (including headmaster and vice headmaster), it was found that all teachers were aware of the event.

The setup of the simulation is as following. Around 9 a.m., all students were directed to the music room where students are free to play musical instruments and watch musical performances of their classmates. After approximately 30 minutes, one of the teachers broadcasted a warning using siren followed by announcement of an earthquake event three times using a microphone. The announcement sounded “Earthquake, earthquake, evacuate, evacuate”. It is worth mentioning that the broadcast was delivered while the students were listening to the musical performances. The whole evacuation simulation processes were recorded using video cameras.

2.3 Focus Group Discussions

Focus Group Discussions (FGDs) were performed with SWDs and teachers in the aftermath of the evacuation simulation. For the SWDs, the group was formed according to the students’ respective classes. Figure 1 shows one of the discussion sessions with teachers. Similar questions to those in Table 2 were asked during the FGDs. The qualitative content analysis was used to analyzed responses obtained from the FGDs.

Table 3. Category for scoring interview responses

| Quest. (Code) | Scores |
|---------------|--------|
|               | 1      | 2      | 3      |
| K1 Never      | Ever, but was not able to say where and when | Ever and was able to mention the earthquake where and when it happened |
| K2 Never      | Ever, but forget | Ever and can explain the form of learning |
| Quest. (Code) | Scores |
|---------------|--------|
| **1**        |        |
| **2**        |        |
| **3**        |        |
| **K3**       | panicked, resigned, and did not know what to respond to | panic, know what to respond, can explain the possibility of chaos that will occur | calm, know what to respond to, can explain the possibility of chaos that will occur |
| **K4**       | don't know what to do, resign, just pray without trying to save themselves, don't know how | can mention at least 1 way to save themselves such as protecting the head, shelter under the table, running into an open space, asking for help, phoning emergency numbers, avoiding objects that are likely to fall | can mention at least 3 ways to save themselves such as protecting the head, shelter under the table, running into an open space, asking for help, phoning emergency numbers, avoiding objects that are likely to fall |
| **K5**       | do not know | to an open place but can't mention its location | to the gathering point or open space, was able to mention the its location |
| **K6**       | not mentioning at all about the intensity of the earthquake and can only mention “chaos” or the like | can only explain the estimated impact that might be experienced, but not based on the intensity of the earthquake | can explain the impact that might be experienced based on its intensity. For example MMI scale II: objects that are hanging rocking |
| **K7**       | do not know | can explain one of the actions that need to be taken before, during, after an earthquake | can explain the actions that need to be taken before, during and after an earthquake |
| **K8**       | don't know / haven't memorized it | memorized only part of the area | Well memorized |
| **K9**       | Never | ever, but forgot | ever and can explain the form of training |
| **K10**      | resigned, pray without effort | Can mention at least 1 method of evacuation (exiting the building, checking if anyone is injured, calling an emergency number, helping a friend, turning off electricity, monitoring aftershock information, etc.) | Can mention at least 2 methods of evacuation (exiting the building, checking if anyone is injured, calling an emergency number, helping a friend, turning off electricity, monitoring aftershock information, etc.) |
| **S1**       | do not know | mention strong / not strong, but based on reasons that are not in accordance with the conditions of the school | mention strong / not strong based on reasons that are in accordance with the conditions of the school |
| **S2**       | do not know | mention strong / not strong, but based on reasons that are not in accordance with the conditions of the school | mention strong / not strong based on reasons that are in accordance with the conditions of the school |
| **E1**       | don't know and nothing | do not know | Know, if any |
| Quest. (Code) | Scores                                      |
|--------------|---------------------------------------------|
| 1            | 2                                           |
| E2           | don't know and nothing                      |
|              | do not know                                 |
|              | Know, if any                                |
| E3           | There is no                                 |
|              | There is                                    |
|              | There is and taught regularly               |
| E4           | don't know and nothing                      |
|              | do not know                                 |
|              | Know, if any                                |
| E5           | don't know and nothing                      |
|              | do not know                                 |
|              | Know, if any                                |
| E6           | don't know and nothing                      |
|              | do not know                                 |
|              | Know, if any                                |
| E7           | don't know and nothing                      |
|              | do not know                                 |
|              | Know, if any                                |
| E8           | cannot explain                              |
|              | Can mention 1 sign such as earth shaking / vibration, things in the room rocking, windows / doors rattling and walls sound, chaotic situations, buildings collapse |
|              | Can mention 2 signs such as earth shaking / vibration, things in the room rocking, windows / doors rattling and walls sound, chaotic situations, buildings collapse |
| E9           | don't know and nothing                      |
|              | do not know                                 |
|              | Know, if any                                |
| A1           | Necessary, especially for activities related to disaster evacuation, for example walking, recognizing rooms, etc. |
|              | necessary, for some conditions not related to the disaster evacuation process, for example eating, drinking, etc. |
|              | no need at all                              |
| A2           | Not at all                                  |
|              | Yes, but seldom                             |
|              | Yes and regularly used                      |
| A3           | need assistance but no companion at school  |
|              | need assistance and there are assistants at school |
|              | does not require assistance and there is no assistant at school |
| A4           | Supports related to help with accessibility of the blind |
|              | Supports not related to help with accessibility of the blind |
|              | no help                                     |
| A5           | cannot mention the tools needed             |
|              | can mention the tools needed but not related to their limitations |
|              | can name the tools needed to overcome their limitations |
| A6           | Don’t know                                  |
|              | Calling closet family members/relatives     |
|              | Calling emergency numbers, such as 112      |
3. Results and Discussion

3.3.1 In-depth interviews

Figure 1 shows the level of SWDs’ and teachers’ responses to earthquakes. It can be seen that the majority of SWDs (n=30 or 93.75%) have low response to earthquakes. Only 2 students have moderate (6.25%) and none and high responses to earthquakes, respectively. Furthermore, the majority of teachers (n=8, 66.67%) shows moderate responses to earthquakes and 33.33% teachers displays low responses to earthquakes. The results indicate that the capacity of SWDs and teachers to face the earthquake risk needs to be improved.

Figure 2 exhibits the average scores per question item for the SWDs and teachers, indicating the potential interventions for improving the SWDs and teachers’ responses to earthquakes. For example, students mentioned that the assembly points in the aftermath of earthquakes are non-existent, as mentioned by several students:

“None. We wait for directions. for example, we gather near the entrance during fires; we stay inside classrooms during strong winds.”

“Most likely in the hall”

“None. We never have any emergencies.”

Some students mentioned that they obtain notifications about earthquakes from cellphones:

“We get information about earthquakes from phones”

Some students also stated that they never have any training in evacuation for earthquakes. However, they are aware that the training exists in the audio format.

“Never have any training related to earthquakes. We have information on the earthquake evacuation in the audio format.”

For the SWDs, it can be observed that only one item shows high score, that is the familiarity with the school environment (K8, $\bar{x}=2.38$, s=0.75). The reason is that SWDs get school orientation at the beginning of semesters, as mentioned by a student:

“We memorized the location of the school for 2-3 weeks during the orientation.”

On the other hand, several question items answered by teachers have high scores, including the familiarity with the school environment (K8, $\bar{x}=2.75$, s=0.62), the confidence in building structure strength in withstanding earthquakes (S1, $\bar{x}=2.50$, s=0.90), independency in performing daily activities (A1, $\bar{x}=2.50$, s=0.90), and supports from others (A4, $\bar{x}=2.42$, s=0.81). Nevertheless, several aspects need
 attentions to improve the responses of teachers to earthquakes. For example, the teacher reported that they never have performed any training related to earthquake simulations (K9, $\bar{x}=1.00$, $s=0$) and procedures during earthquake emergencies are unavailable (E1, $\bar{x}=1.00$, $s=0$).

Furthermore, Figure 2 shows that majority of questions answered by SWDs have low scores, indicating the SWDs are highly vulnerable to the impacts of potential earthquakes. Interestingly, the questions answered by teachers in the category of safe school building and designs have high scores ($\bar{x}=12.38$, $s=0.89$); knowledge and experience ($\bar{x}=1.77$, $s=0.65$) and assistance during emergencies have moderate scores ($\bar{x}=1.88$, $s=0.76$); and evacuation plans have low scores ($\bar{x}=1.23$, $s=0.16$). It is worth mentioning that despite the high score for the safe school building and designs, teachers are unsure about the quality of the school buildings.

“Depends on the strength of the earthquake, it probably not strong enough to withstand because it’s an old building.”

“I don’t really know the standard for building’s strength, but since this is an old building and based on several incidences, like recently when the ceiling at the computer room fell down, so most likely it is high risk.”

Furthermore, each question in the evacuation plan category shows low scores for both SWDs and teachers, suggesting the urgent need for designing evacuation plans for the school.

Figure 2. (Left) SWDs’ (n=32) and (Right) teachers’ (n=12) responses to earthquakes (interviews)

Figure 3. Scores (average) per question item for (top) SWDs (n=32) and (bottom) teachers (n=12).
3.3.2 Evacuation simulation

a. Observation

Several issues that are likely to hinder the evacuation process were revealed during the simulation, including issues related to the audibility of emergency announcements, interpretation of SWDs on the emergency messages, responses of SWDs to the chaotic situations, and methods for SWDs to protect and evacuate themselves. Firstly, it seems that not all students hear the warning signals. Two reasons are observed. While it is likely that the sound of warnings and musical instruments collided, it is also revealed that the school is not completely supported by an adequate sound system that can serve as emergency broadcasting equipment. Secondly, some students seem to hear unusual sound. However, it looked like they did not understand the meaning of the siren. The warning signals were followed by a loud announcement about earthquakes, and it seems that most students recognized the word “earthquakes” and “evacuate”. Most students were panicked, resigned, and cried after understanding that they were in emergency situations. Nevertheless, some students did not consider the sirens to be real and attempt to convince their classmates of their views. Although the responses of the students were varied, no actions related to self-protection procedures, such as drop-cover-hold or evacuate to the nearest exit, were observed. It was observed that the interactions among students influenced the developments and outcomes of simulations. Thirdly, it seems that the distressed students affected other classmates. It was observed that the panicking students are prevailing conditions during the simulation. Although some students attempted to pacify their friends, the situations quickly became uncontrollable for the student themselves. Fourthly, it was revealed that most students did not know how to protect and evacuate themselves during emergency events.

Teachers play an essential role in evacuating SWDs during earthquake events. Unfortunately, the teachers stayed in their room, act normal as if no warnings are announced, and were not showing any self-protection procedures during the evacuation simulation. The teachers were aware that the siren is a fake warning. Finally, the situation started to become manageable after two teachers in the room took initiatives to control of the class conditions and directed students to evacuate out of the room. Students with complete visual loss relied on anyone close to them to evacuate, and students with partial visual impairments mimicked the teachers and aided other students to evacuate from the class. Such interactions are likely to happen due to bond among students. This result supports findings mentioning that teachers play a pivotal role during emergency situations in the school for students with disabilities [17]. Also, this finding suggests the potential of students with partial visual impairment in aiding teachers in directing students with complete visual impairments during evacuation processes provided capacity development (i.e., appropriate knowledge and evacuation techniques).

b. Focus Group Discussions

Teachers

FGDs were performed in the aftermath of the evacuation simulation to obtain an overview of the conditions from the perspective of the students and teachers. FGDs with the teachers were started with open questions about their perspectives on the simulation and aspects need to be improved. Issues related the accuracy of the simulation, reasons for teachers’ inactiveness, and rooms for improvements were raised. Firstly, most teachers mentioned that the simulation did not represent the actual condition of earthquakes. They argue that more stimulants (e.g., compared to smoke in fire evacuation) are needed to create situations that trigger the students to act (e.g., shaking tables, loud sounds, or trembling body). Secondly, teachers mentioned that they were aware of the nature of earthquake warnings and felt there are no real threats. This condition should not only be attributed to pre-knowledge of teachers on the nature of simulations but also the knowledge of teachers on actions needed during earthquake emergencies. As previously mentioned, the school does not have evacuation plans and the majority of teachers never have any experiences on performing earthquake evacuations. Finally, teachers articulated about their awareness and needs for a unique warning signal to signify the earthquakes, evacuation plans for earthquakes, and self-protection mechanisms. Discussions related to the form of warnings, selection of assembly points, and appropriate methods
Students

Students were actively conveyed their opinion about the evacuation simulation processes, including their confusion about, inability to act on, distrust to the earthquake warnings. Some students admitted that they hear unusual sound. However, the students acknowledged that they did not understand the meaning of the siren. Recognizing the announcement “earthquakes” and “evacuate”, a small number of students perceived that the announcement was not real. However, most students showed uncomfortable gestures after hearing the warnings. Influenced by prevailing conditions, the situations became uncontrollable. One of the students mentioned, “… I know earthquakes, but I cannot do anything due to my conditions. So, I reconcile to whatever will happen…”. The result of the FGDs shows potentials for improving the evacuation plans in the school for SWDs.

4. Conclusions

The present study has successfully investigated the responses of students with disabilities (SWDs) and teachers to earthquakes. Using in-depth interviews, questions related to the knowledge and experience to earthquakes, safe buildings and designs, evacuation plans, and assistance during emergency categories were asked to the respondents. It was found that most SWDs showed low responses to earthquakes, and teachers have low to moderate responses to earthquakes. Furthermore, it was found that most question items answered by SWDs showed low scores. On the other hand, the teacher showed low scores to questions on the evacuation plan category. The results indicated the urgent need for designing the evacuation plans to improve the SWDs’ and teachers’ responses to earthquakes. Furthermore, the evacuation simulation of earthquakes revealed several issues that likely to hamper the evacuation processes, including the audibility of emergency announcements, understanding of SWDs to the emergency messages, responses of SWDs to the chaotic situations, and methods for SWDs to protect and evacuate themselves. Findings of this study are likely beneficial to reduce the impacts of potential earthquakes in the school with disabilities.

Further studies are proposed. Another similar post-test in the forms of in-depth interviews and evacuation simulations after performing interventions on earthquake-related knowledge and self-protection skills is highly recommended.

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