

# Earthquake Disaster Prevention Learning Approach in Japan Combining Fieldwork Survey Learning and Evacuation Drill Training

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**Abstract:** There has been increasing awareness on disaster prevention in Japan. The aim of this research is to ascertain whether learning activities on earthquake disasters consisting of pre-incident fieldwork survey learning and evacuation drill training, can be converted to disaster preparedness awareness. Learners study the situation and danger in a particular region through fieldwork. Subsequently, they review the findings and conduct retrospective learning assuming a disaster has occurred. Based on this assumption, they execute evacuation drills simulating a disaster outdoors. We designed a series of similar learning activities and developed learning support systems for tablet devices. Conducting classes at a high school, we analyzed changes in learners' consciousness. Learners participated with interest and studied disaster prevention while simulating disasters with the support of the system. Results of the subjective survey revealed that certain effects were recognized during disaster preparedness, developing learners' self-efficacy in protecting themselves in the event of a disaster.

**Keywords:** Disaster prevention, mobile learning, scenario-based learning, system development

## 1. Introduction

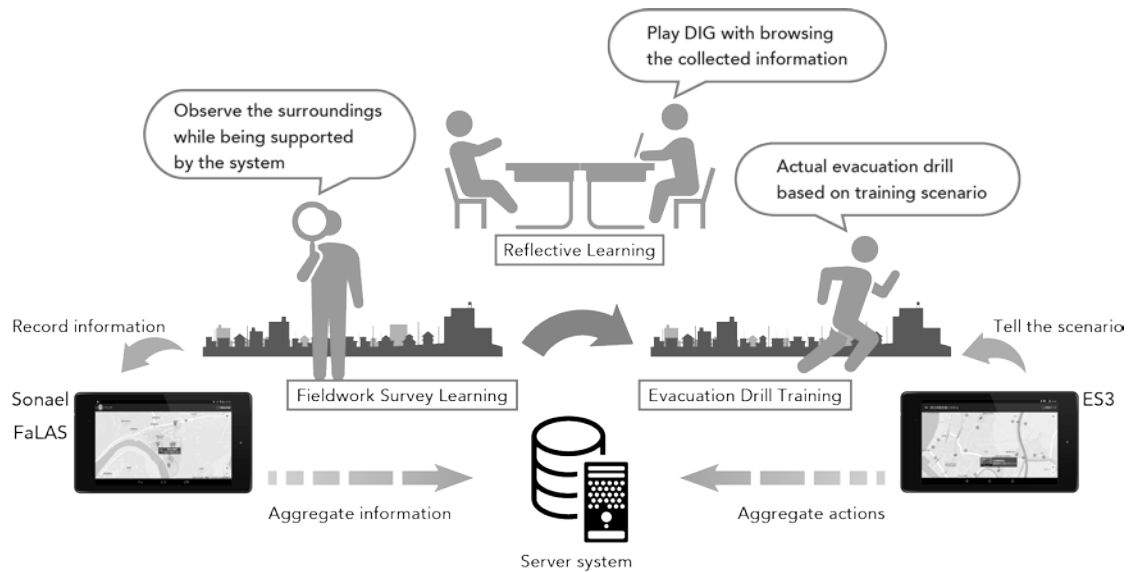
After massive earthquake disasters such as the Great East Japan Earthquake and the Kumamoto earthquake in 2016, there has been increasing awareness for the need for disaster prevention in Japan. Following the Great East Japan Earthquake, the Ministry of Education, Culture, Sports, Science and Technology Japan (MEXT) experts' conference—called the “Council on Disaster Prevention Education and Disaster Management”—was aimed at children and students to 'encourage positive protective behavior' in the future (Ministry of Education, Culture, Sports, Science and Technology, 2012b). It also indicated that guidance on fundamental knowledge as a foundation of disaster prevention education, such as acquiring basic disaster prevention knowledge and understanding past and possible disasters based on an area, improved. The importance of learning subjectively to improve behavior and increase awareness through experiential activities was indicated. MEXT formulated a plan on school safety promotion in the same year. This plan required acquisition of basic knowledge at school and possession of appropriate ability to take decisions and perform actions based on it; this necessitated securing teaching time and establish an educational method (Ministry of Education, Culture, Sports, Science and Technology, 2012a).

In disaster prevention education in Japan, many cases using Information and Communication Technology (ICT) are reported. Most are based on a game-based learning method that is an extension of knowledge learning in classrooms. In recent years, however, some case studies incorporating real world situations in experimental learning are being studied. Activities that study a region through fieldwork and compile the information on disaster prevention maps have been reported. A case on developing a system that performs evacuation drills in the real world also exists.

## 2. Objectives

The aim of this research is to ascertain whether learning activities on earthquake disasters consisting of pre-incident fieldwork survey learning and evacuation drill training can be converted to disaster preparedness awareness.

Learners study the situation and danger in a particular region through fieldwork. Subsequently, they review the findings and conduct retrospective learning assuming a disaster has occurred. Based on this assumption, they execute evacuation drills simulating a disaster outdoors. We designed a series of similar learning activities and developed learning support systems for tablet devices. Conducting classes at a high school, we analyzed changes in learners' consciousness.



**Figure 1.** Overview of the Earthquake Disaster Prevention Learning Activity.

## 3. Learning Support System

### 3.1. Support System for Fieldwork Survey Learning

Natural disasters depend on the characteristics of a region. If it is a mountainous area, landslides can occur and if it is a coastline, a tsunami can occur. Based on general knowledge on disasters, observing geographical and topographical features, considering all the dangers, and placing them on a disaster prevention map is effective in understanding local hazards.

To proceed with learning, a system was required to record the disaster assumptions that emerged as a result of learners' fieldwork. We developed a disaster prevention learning support system called "Sonael" that facilitated the task of recording information at a real location and aggregating it for presentation on a disaster prevention map. The basic concept of Sonael is based on the prototype "FaLAS" (Hatakeyama, Nagai, & Murota, 2015). Sonael consists of a client system that operates with an Android tablet computer and a server-side system that stores client data. The client application is implemented as an Android application installed on the Android tablet device the learner carries while conducting fieldwork. To ensure outdoor learning proceeds regardless of network, the client application includes a mechanism that enables recording information on a local database so that it can be operated separately. The server application aggregates data asynchronously and shares it among the client applications. The client application communicates via the application programming interface (API). Additionally, it has a screen that can be viewed from some web browsers. For functions not required by client applications, such as teachers' ability to view information, the server application has a screen that can be used from a browser.

As fieldwork activities, learners gather information on local features and hazards separately. They carry the tablet device outdoors and the application provides instructions on how to take pictures, record classifications indicating safety or danger, and input comments explaining the basis for the classifications. This record is stored in a local database together with the GPS coordinates for that area. These records are transmitted to the server in the classroom and aggregated when communication is established. The aggregated data is redistributed to the devices from which learners can share information and view the merged records on maps. If there is aggregated information, even in an area s/he never visited, s/he can obtain information based on the records and make assumptions during disasters. With limited fieldwork time, activities can be conducted to understand an area and consider disaster mitigation measures.

### *3.2. Support System for Evacuation Drill Training*

When encountering a disaster, one has to act immediately to protect oneself based on one's own judgment. Various scenarios for disaster evacuation education have been developed in similar research. Alexander (2000) reports that scenario methods are useful in developing decision-making skills under stress. However, such scenarios have certain limitations such as divergent narratives based on given choices. Hence, we propose outdoor evacuation drill training with flexible scenarios based on assumptions made during disasters in the area.

We developed a flexible scenario-based learning support system called the "Evacuation Scenario Simulator System" (ES3), based on an improvised situation at a real location (Hatakeyama, Nagai, Shibayama, & Murota, 2016). The scenario consists of location-based elements of the disaster situation and shelters, with certain sections of the area damaged by the disaster. The scenario includes no set route or order of events and actions, having only two types of points namely disaster encounter points and shelters as goal points. The disaster encounter points include the first point encounter, namely the beginning of the training and various secondary disaster points encountered during the evacuation. Since it is not a pre-defined scenario with a prepared narrative, the learner experiences the situation flexibly, diverging in terms of the hypothetical disaster.

The ES3 system consists of a server and a client application operating on an Android tablet connected bidirectionally to the server. The primary features of the application are its presentation of a hypothetical disaster scenario based on a real location, and its recording of learners' activity logs, such as locations and input values. The scenario is pre-set on any device on which the client application is installed. Learners bring their devices outdoors for the evacuation training. When the disaster encounter point approaches, the system displays the hypothetical disaster situation through an image on the device and a message indicating the commencement of the training. The learner executes actions using his/her own judgment to navigate routes and shelters throughout the disaster evacuation. During the evacuation, dangers are revealed at certain points along the route, directing the learner to select an appropriate action with a reason. The evacuation is complete when the learner reaches a shelter that is the goal point. The server collects the activity logs recorded on each device in which the client application is installed. The collected data are stored and arranged to be displayed on a map of the scenario. Learners can view the data using a web browser to study their actions after the experiential learning.

## **4. Classroom Practice**

### *4.1. Outline*

We conducted experimental hands-on lessons at a high school to help students learn about the types of hazards that can occur in a specific area based on its features. These lessons were conducted on first-year high school students during the Integrated Study period. The school is located near Tokyo Bay in the western region of Chiba Prefecture, inland from the sea. A river flows beside the school. There is extensive topographic relief here, including a small hill near the school. For this learning activity, the study area was set at about 1 km between the school and the coast.

The complete schedule is displayed in Table 1. Four teachers from four classes conducted four lessons altogether from October 2016 to January 2017. Learners formed groups of four, and each group was provided an Android tablet device each day.

Table 1: Schedule of lessons.

	Lesson Time	Learning Content
Day 1	100 min	Review the basic knowledge Practice operating the system
Day 2	100 min	Conduct fieldwork survey learning
Day 3	60 min	Reflective learning
Day 4	100 min	Conduct evacuation drill training

#### 4.2. *Fieldwork Survey Learning*

On Day 2, they conducted the field research component of the study. The students surveyed and recorded various aspects of the area outside the school using the Sonael system. In the area, we prepared six places that we wanted the learners to focus on as “Mission Areas.” Each mission area contained typical examples of hazards and geographical features. We assigned three mission areas to each group to ensure they walked around the entire area. Students were asked to record anything that was not limited to the mission areas on the system.

#### 4.3. *Reflective Learning*

On Day 3, they studied aggregated information on disasters. Assuming that a large earthquake had occurred while they were outdoors, by referring to the recorded information on the Sonael system and their acquired knowledge, under the guidance of their classroom teacher, the students devised evacuation measures using paper simulations such as Disaster Imagination Game (DIG) (Komura & Hirano, 1997). These paper simulations created two scenarios: one involved experiencing an earthquake on a school road regularly used by students, and another involved an earthquake near the coast, in an area that was less familiar to students. The purpose of the exercise was to identify an appropriate evacuation site and consider possible escape routes and eventualities that might occur along the way. Students first considered each scenario independently after which group discussions were held. This was followed by a summary discussion and final analysis that involved the entire class.

#### 4.4. *Evacuation Drill Training*

On Day 4, the actual evacuation drill training activities were conducted outside the school. Four training scenarios simulating the occurrence of a major earthquake, each including approximately 50 events and reflecting the geological features of the area, were used. The scenarios were prepared identifying particular areas of safety or danger around the school, based on the students’ postulations during their reflective learning paper simulations. Each group conducted an outdoor activity using the ES3 system configured for one of the four scenarios.

## 5. **Results**

After each class from Day 2 to Day 4, learners were asked to complete a questionnaire on the lesson content. Each item being evaluated was phrased as a question, allowing responses on a five-point Likert scale (from “very little” to “completely”). Table 2 displays the results.

**Table 2: Summary of the responses to lesson evaluations.**

	After Day 2			After Day 3			After Day 4		
	N	M	SD	N	M	SD	N	M	SD
1. Was the learning activity interesting?	109	3.44	1.182	109	4.03	0.937	105	3.91	0.962
2. Did you imagine the situation during a disaster?	109	3.53	1.127	108	3.84	1.025	106	3.86	0.910

Before and after learning, we conducted a subjective survey of the students' awareness of disaster preparedness. Each item being evaluated was phrased as a question, allowing responses on a five-point Likert scale. Table 3 summarizes the responses to the questions relating to awareness and self-efficacy. Using a t-test, we found significant changes in scores on some questions. These results indicate that there was a certain effect on learners' consciousness regarding disaster prevention.

**Table 3: Summary of the responses to disaster awareness and self-efficacy questions.**

	N	Before		After		t-test
		M	SD	M	SD	
1. Have you decided where to evacuate in the event of a disaster?	97	3.40	1.320	3.41	1.375	<i>ns</i>
2. Do you always take preventive action during earthquakes and floods?	101	2.83	1.059	3.15	1.152	*
3. Do you always check for a shelter outside school in the event of a major earthquake?	100	2.95	1.132	3.06	1.196	<i>ns</i>
4. Can you assess if a place is dangerous outside school when an earthquake occurs?	99	3.22	1.139	3.47	1.172	<i>ns</i>
5. Can you protect yourself should an earthquake occur outside school?	95	3.59	1.067	3.68	1.024	<i>ns</i>
6. Can you explain in detail how to respond after the earthquake has settled if you feel a strong tremor outside school?	97	2.98	1.000	3.34	1.009	**

\*:  $p < 0.05$ , \*\*:  $p < 0.05$ , *ns*: non-significant.

## 6. Discussion

Based on the results displayed in Table 2, learners gave each lesson a good evaluation. They were able to participate in the lessons with interest and could visualize the disaster situation by using the system. However, before and after the learning activities, there was only a partial change in disaster preparedness consciousness.

In order to investigate this factor, we added the questionnaire result on Day 3 and conducted a one-way ANOVA on the questions regarding self-efficacy (questions 4 - 6). The result displayed in Figure 2 indicates a significant difference before and after reflective learning in each question. Fieldwork survey learning and reflective learning confirmed that learners' self-efficacy such as assessing danger and protecting themselves improved. However, evacuation training experiences seem to have suppressed excessive self-efficacy. The following description by a learner in the questionnaire feedback conducted after learning substantiates this deduction: "The last lesson taught me how to respond when an earthquake occurs. I believe I can understand it better by actually putting it into practice." Thus, learning to study and respond in an emergency when encountering a disaster

was realized by experiential learning primarily through evacuation drills rather than understanding the area through fieldwork.

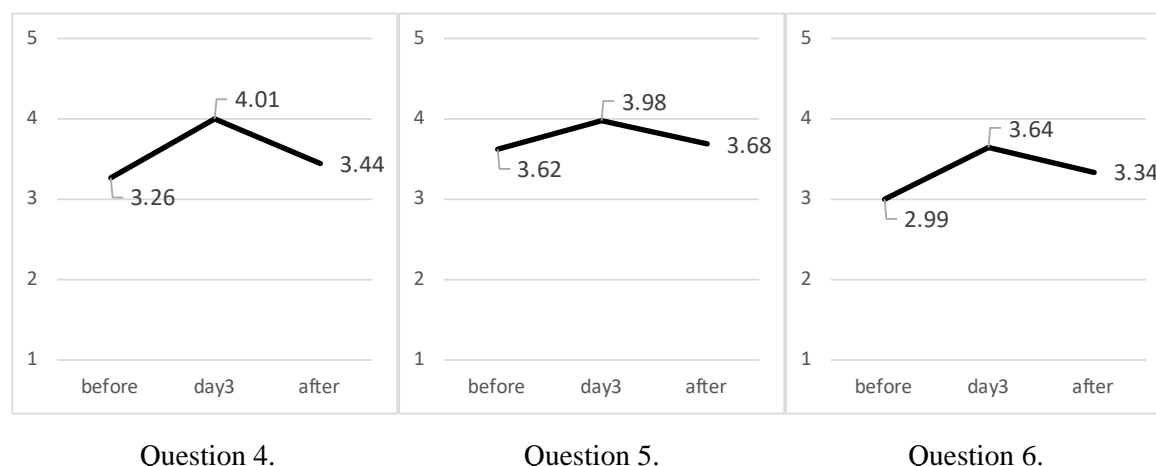


Figure 2. Result of one-way ANOVA.

## 7. Conclusion

In this study, learning activities consisting of pre-incident fieldwork and evacuation training learning were conducted, and changes in learners' disaster prevention awareness were examined. Learners participated with interest and studied disaster prevention while simulating disasters with the support of the system. Results of the subjective survey revealed that certain effects were recognized during disaster preparedness, developing learners' self-efficacy in protecting themselves in the event of a disaster. Future studies can investigate how to make learning more effective.

## Acknowledgements

We would like to thank Amaha High School for supporting the training exercises described here. This work was supported by JSPS Grant-in-Aid for Scientific Research Grant Numbers 15H02933, 16K21262.

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