

Acquiring Disaster Prevention Knowledge from Fieldwork Activities in a Region

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Abstract. There has been increasing awareness of the need for disaster prevention in Japan. The aim of this research is to ascertain whether a basic knowledge of disaster prevention can be acquired through fieldwork learning activities for purposes of creating a disaster prevention map. We developed a disaster prevention learning support system that facilitated the task of recording information at real locations, and then aggregated it. Using this system, we conducted a classroom exercise at a high school to help students identify the kinds of hazards that are likely to develop in specific areas—based on their features—in the event of a large earthquake. After conducting fieldwork, they returned to the classroom. Under the guidance of their teachers, they referred to the information they had recorded and the knowledge they had acquired to postulate a scenario in which a large earthquake occurred. They further assumed that this earthquake had occurred while they were outdoors. The students then devised evacuation measures using paper simulations. The results of this exercise revealed that the knowledge of disaster prevention acquired through this exercise had practical applications.

Keywords: Disaster management · Disaster prevention · Mobile learning · System development

1 Introduction

Damage caused by natural disasters is reported from around the world every year. Japan is no exception. This country has suffered extensive damage from disasters such as earthquakes, typhoons, and heavy rains. In the Great East Japan Earthquake that occurred in 2011, the earthquake and tsunami inflicted enormous damage mainly on the Pacific coast of the Japanese archipelago, and resulted in more than 15,000 victims. The Kumamoto earthquake that occurred in 2016 and wreaked havoc on many houses is still a fresh memory. The occurrence of multiple class 7 seismic intensities exceeds

our conventional assumptions. Since these events have occurred recently, there has been an increasing awareness of the need for disaster prevention in Japan.

Especially at educational sites, students' safety and possible evacuation routes have been examined. Following the earthquake, the Ministry of Education, Culture, Sports, Science and Technology Japan organized a meeting of experts—called the “Council on Disaster Prevention Education and Disaster Management”—to have them present their recommendations on this aspect of disaster prevention. According to a proposal in which their recommendations were summarized, “disaster prevention learning” is not only necessary for protecting oneself in the case of a natural disaster, but also for acquiring a systematic understanding of the regional disasters that are likely to occur in the future [1]. However, in school education, disaster prevention learning programs—in the form of general lectures and repetitive training for viable evacuation procedures—have been largely implemented. We believe that there is a need to devise programs and activities that will interest learners in developing a better understanding of disaster prevention. However, we also believe that not much practical training has been offered, in the context of situations in which a disaster might strike students on their way to and from school [2].

Learning about local disaster prevention requires the development of a disaster prevention map, in which learners gather information about an area by walking through the area, or examining information on a hazard map. They then assume that a disaster has stricken the area, and organize information according to whether specific areas are safe or in danger. Disaster prevention maps display this information. These types of activities are frequently conducted as part of children's elementary and secondary school education, and are positioned as part of regional study. Disaster prevention maps are typically drawn on paper, but there are also some examples in which computers have been used for this purpose [3, 4].

The disaster prevention map and the hazard map are used in a method called DIG (Disaster Imagination Game), which imagines a disaster and depicts it on paper [5]. Desirable characteristics of DIG are its simplicity and interactive nature. Assuming a disaster, learners will work in the cause of the presented targets, such as disaster relief, think about solutions, and summarizing their analyses on a map. This paper training method is arranged variously, and is widely practiced as part of disaster prevention activities in local community.

The aim of this research is to ascertain whether basic knowledge of disaster prevention acquired through fieldwork learning activities can be applied to disaster prevention for mitigate the harm done by the disaster such as using to create a disaster prevention map. Learners observe normal situations, and consider a possible disaster occurrence using disaster prevention knowledge. They record the risks that have been depicted on a disaster prevention map, and collaboratively reflect on each viewpoint. We expect that their participation in the outdoor activities and group reflections will inspire students' further interest in disaster prevention learning at school. To conduct this learning, we developed a mobile system that supports learning outdoors.

2 System Development

2.1 System Concept

Basic Design. To proceed with learning, a system is needed to record the disaster assumptions that emerged as a result of learners' outdoor activities. We developed a disaster prevention learning support system called "Sonael" that facilitates 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" [6]. 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 and learning outdoors. Tablet devices generally support network connections with Wi-Fi, but there are not many models that can be connected to a cellular phone network alone. Even devices that permit data communication may lose speed or be disconnected, depending on outdoor radio wave conditions. For this reason, to allow outdoor learning to proceed without relying on a network, the client application included a mechanism that would enable recording information in a local database (SQLite) in such a way that it could even operate stand-alone.

The server application aggregates data asynchronously and shares it among the client applications. It is implemented by Ruby on Rails and uses MySQL as a data store. The client application communicates via the API corresponding to the JSON format. There is also a screen that can be viewed from some web browsers. For functions not required by client applications, such as the ability of teachers to view information, the server application has a screen that can be used from a browser.

Utilization. The learner carries the tablet device outdoors, and the application provides instructions for the learners on how to take pictures at a point, record classifications indicating safety or danger, and input comments that explain the basis for the classifications. This record is stored in a local database, together with the GPS coordinates for that point. Using this system outdoors engenders learners' interest in conducting surveys outdoors, and focuses their interest on disaster prevention learning.

These records are transmitted to the server in the classroom over the network 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. Once the photos and comments have been consolidated, learners can consider the relative safety of areas without conducting fieldwork. Also, they can expect to evaluate their judgments objectively, by comparing them with those of other learners (Fig. 1).

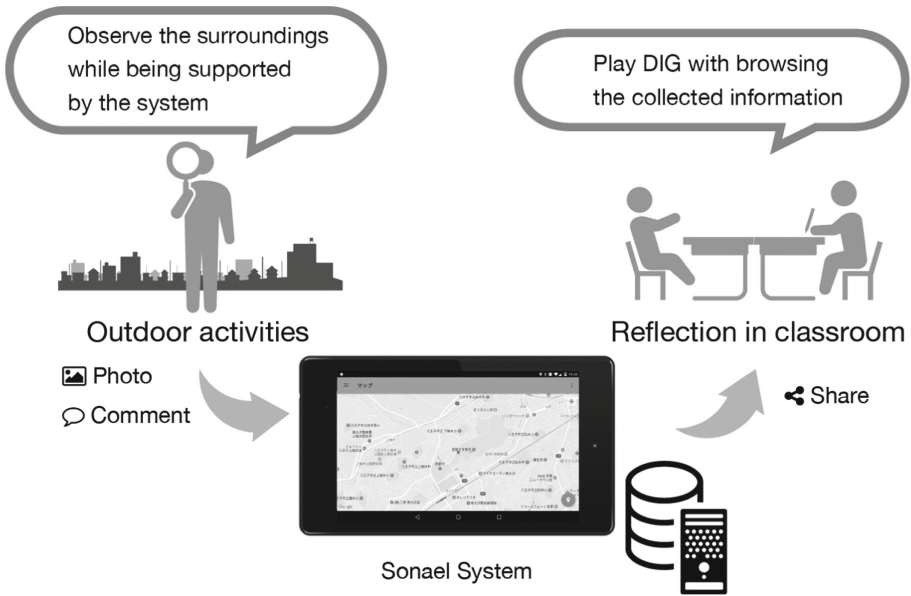


Fig. 1. Image of Sonael system

2.2 Helping Learners Use the System

Quiz for Applying Knowledge. Even if a learner is encouraged to investigate the outdoors at his/her own discretion, there is a possibility that he/she may not know where to go. To mitigate this possibility, we adapted a technique from the sport of Orienteering. The teacher preliminarily set a plurality of “mission areas” in the area where the field study was being conducted. A circle with a radius of about 100 m represented this mission area. The data was stored in the client application’s local database, and presented to the learner as a circle on the map. Multiple checkpoints can be set inside the mission area. A checkpoint is like a quiz. It provides an example of how the teacher would respond to a question, according to the learning goal, and describes the event the student wants to discover or record, by applying his/her disaster prevention knowledge. The data consists of locational information that has not previously been presented to the learner—including the type of location, the assumed situation, and a hint for the learner—that is stored in the client application’s local database. In addition to the positional information of latitude and longitude, a hint can be provided for each checkpoint. Hints have content that will help remind students of their disaster prevention knowledge when searching for checkpoints. By demarcating mission areas that include these checkpoints in the area to be analyzed, it is expected that the learner will move over the whole area by going around the points and answering the questions in each quiz. Once the learners’ responses to a quiz have been recorded for the mission area, whether or not they correspond to a checkpoint is verified, and if they do, the learner receives feedback.

Position Tracking. In learning activities outside of the classroom, teachers must secure the learners’ safety. Under one method the teacher always leads, but doing so is difficult when there are many learners. To address this limitation, we developed a mechanism that would identify the learners’ positions in real time, based on the current position of the device.

For the client application, we always acquired locational information using a GPS to verify the mission area. Although the network on the learner’s device was not always valid, its current location was sent periodically as communication was possible. A screen displaying the current position of the device on the map was included in the server application. Using Web Socket, it was possible to update current locations in real time, without reloading the browser. The environment in which the teachers’ devices was being operated functioned in general modern browsers, including those of smartphones.

User Management for Data Sharing. In order to safeguard the learners’ data, we implemented a mechanism that could manage users’ authentication and users’ data. Before commencing learning activities, the teachers inputted the master data necessary for learning—such as the mission area and the learners’ information—into the server. At the same time, the teachers linked a learner’s information with the mission area that would be presented to that learner. User authentication was required prior to using the client application. Once the user’s authentication had been confirmed, the client application received the master data associated with the user from the server via API. Throughout the learning process, the device’s locational information and survey records were sent to the server, along with the user’s information. To save the transmitted information without duplication, a universally unique identifier (UUID) was applied to all data exchanged between the client application and the server application. This facilitated the detection of duplicate records, and enabled updating the differences safely (Fig. 2).

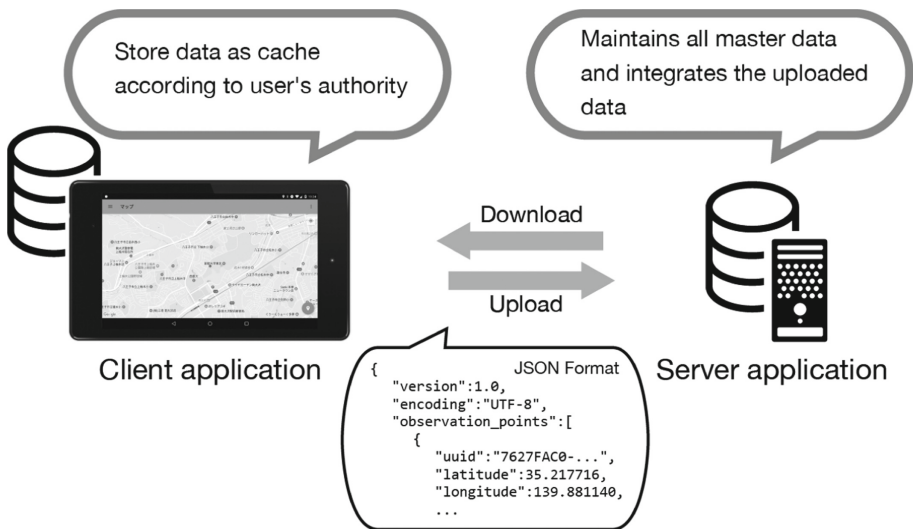


Fig. 2. The roles of client and server system

Since the review of field survey results might be conducted on a class-by-class basis, it was necessary to have controls for each group. Therefore, the “user” was the group’s class. Only the records pertinent to the user group to which the user belonged were acquired from the server.

3 Classroom Practice

3.1 Outline

Using this system, we conducted hands-on lessons at a high school to help students learn about the types of hazards that can be expected in a specific area, based on its features, when a large earthquake occurs. These lessons were conducted for first-year high school students during the Integrated Study period. The school is near Tokyo Bay in the western part of Chiba Prefecture, inland from the sea. A river flows next to the school. There is extensive topographic relief here, which includes a small hill close to the school. For purposes of this learning activity, the study area was set as being a range of about 1 km between the school and the coast.

3.2 Learning Contents

Four teachers in four classes conducted a total of three lessons from October 2016 to November. The complete schedule is shown in Table 1. On the first day the students confirmed that they were responsible for securing their own safety, depending on the situation present in the area when a disaster occurred, which was the overall learning objective. With the help of their teacher, they reviewed their basic knowledge. To help students familiarize themselves with the operation of the system, they practiced recording information for the mission area for practice in the school premises.

Table 1. Schedule of lessons

Day	Date	Lesson time	Learning content
1	10/11/16	100 min	Review the basic knowledge Practice operating the system
2	10/17/16	100 min	Conduct fieldwork survey
3	11/28/16	60 min	Depict the information on paper

On the second day they conducted the field research component of the study. First they formed groups of four, after which they surveyed and recorded various aspects of the area outside the school. Teachers did not lead the student groups. Instead, the students acted as independent groups. The teachers patrolled the students’ movements using the position tracking function to ensure their safety. Each group was assigned three of the six mission areas, which they could visit in any order. Students were told to record anything that was not limited to the mission areas and the checkpoints on the system.

On the last lesson day the students assumed that a large earthquake had occurred. Assuming that the large earthquake had occurred while they were outdoors, by referring to the recorded information and their learned knowledge, under the guidance of their classroom teacher, the students worked out evacuation measures using paper simulations such as DIG. These paper simulations created two scenarios: One scenario involved encountering an earthquake in the middle of a school road typically used by students, and another involved encountering 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 to that place. 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 class as a whole.

To facilitate the use of this system, we lent one Android tablet device to each group on each lesson day. The device used was either a ASUS Nexus7 (2013) or a Lenovo YOGA2. Since YOGA has a SIM card slot, it was set so that each user could communicate data independently. In addition, because Nexus is not compatible with the SIM card, we installed portable Wi-Fi router on each device, in preparation for pairing and communication. Consequently, we created an environment in which communication could be carried out in the field from all devices. We also installed a Sonael client application on each device, so that we could view the records.

4 Results

4.1 Questionnaire Survey

Following the investigative learning completed in the field on day 2, we conducted a subjective survey of the students on their use of the system. The results are shown in Table 2. Each item was phrased as a question, allowing responses on a five-point Likert scale (from “very little” to “completely”). Items that received scores of 3 or more were considered to be high scores.

Table 2. Summary of the responses to self-efficacy questions

	N	M	SD
Was the tablet device easy to operate?	109	3.35	1.158
Was the system easy to operate?	109	3.37	1.086
Was the map displayed on the system easy to see?	109	3.47	1.167
Was the hint of the mission displayed on the system easy to understand?	109	3.07	1.176
Was it easy to understand how to record the investigation results on the system?	109	3.29	1.165
Was it easy to see how to check the information recorded on the system?	109	3.31	1.136

Before and after learning, we investigated students’ self-efficacy with regard to disaster prevention. Each item being evaluated was phrased as a question, allowing responses on a five-point Likert scale (from “very little” to “completely”). Table 3 summarizes the responses to the questions relating to self-efficacy. These results showed improvements in the average scores for all of the items surveyed. Using a t-test, changes in the scores were found to be significant for all questions. These results show that the students’ self-efficacy in terms of disaster prevention had been developed through the practice.

Table 3. Summary of the responses to questions evaluating the system

	Before			After	
	N	M	SD	M	SD
Can you judge a dangerous place outside the school when an earthquake occurs?***	99	3.22	1.121	4.06	0.890
Could you protect yourself should an earthquake occur outside the school?***	97	3.58	1.029	4.02	0.924
Can you explain in detail how you should act after the earthquake has settled, if you feel a strong tremor outside the school?***	98	2.99	0.947	3.71	0.952
Can you explain in concrete terms how I should act to protect my own safety when I feel a strong tremor outside the school?***	97	2.89	0.967	3.60	1.047

***Significant at $p < 0.01$

4.2 Record of Learning

The GPS traces acquired in these outdoor field activities shows how the learner group in class moved. When examining the GPS traces, many groups moved around the area to visit specific mission areas. The number of records differed from 1 to 15, depending on the group, and many gathered information on places that would be dangerous in the event of a disaster.

5 Discussion

According to the results of the subjective survey, the learners’ summary evaluation of the system’s operation was positive. In the comments’ section of the questionnaire completed after investigative learning in the field on day 2, multiple opinions were as follows: “I felt that there were quite a few dangerous places on the way walking to school,” and “I was able to confirm dangerous places and safe places.” From these comments, it is evident that a new awareness can be created by conducting field surveys in the areas where students live. It is thought that the system was able to support the students’ learning in the field. In addition, from comparisons made before and after learning, it was confirmed that students’ self-efficacy in terms of being able to protect themselves in the event of a disaster had improved through learning achieved using this system.

In the paper simulations there were many instances in which students' chose nearby evacuation sites, and some in which they chose evacuation sites with the highest altitude, even at some distance. However, after some of these students had learned about specific evacuation sites, they selected different evacuation destinations, considering events that might occur on that route. A learner initially thought, when confronted by an evacuation scenario on the coast, that it would be best to evacuate to the station. However, because the preferred evacuation route passed through a narrow alley, we introduced the possibility that a house had collapsed and it would be difficult to go around it, so after a discussion with group members, we then chose to evacuate to the hill. Routes were also revised, to enable passage on relatively wide roads. Although this is only one example, in the lesson on retrospective learning, activities were conducted that necessitated considering and judging various possibilities based on the appearance of a locality—something that is hard to decipher from a map. A learning method that uses a system that shares its records and outdoor activities is thought to have had a positive effect on the application of knowledge to disaster prevention learning.

The function of tracking the learner's position received a positive evaluation from the teachers. Since there is a range of learning and there are differences in elevation, it was difficult to confirm all the learners' actions at specific sites. We were also moving around the field by car. Sometimes we could not locate them, when a learner was passing through a narrow alley for example. However, using the system, teachers could check the current positions of the students with their own smartphones. We received one comment that this support was carried out smoothly, because it was possible to remind learners of the time available to collect data by looking at their positions, so that all groups conducting the field survey could return to school by the end of the class.

6 Conclusion

We aimed to ascertain whether basic knowledge about disaster prevention could be acquired through outdoor learning activities. We developed a disaster prevention learning support system called Sonael that enables recording information from a real location and aggregating it. We conducted a classroom exercise at a high school using this system to help students learn what kinds of hazards can be expected when a large earthquake occurs, based on the features of a specific area.

As reported above, it was confirmed that students' self-efficacy for protecting themselves at the time of a disaster improved, along with the effectiveness of the system. We received a positive evaluation of the operation and functioning of the system. This learning method, which allows records and data summarizing outdoor movements to be shared, is thought to have had a positive effect on disaster prevention learning, and so the application of knowledge. It remains a challenge for future research to objectively evaluate what learners learned as adaptable knowledge.

Acknowledgements. We would like to thank Amaha High School for its support of 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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