A Flexible Scenario-Based Mobile Learning System for Disaster Evacuation

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Abstract. Disaster prevention awareness has been growing in Japan since the Great East Japan Earthquake in 2011. This research aimed to improve high school students' judgments in emergency situations by training through a scenario-based learning support system called "ES3." Groups of four to five students were presented with a hypothetical earthquake disaster scenario on Android tablets and used their own judgment to navigate routes and shelters throughout the evacuation process. Faced with certain dangers and sites of damage, the students were required to select appropriate responsive actions. During the exercise, learning logs of locations and input values were stored in the server system. Following the exercise, the students discussed their decisions and actions, completing a questionnaire on safety consciousness. The data analysis suggested that the students selected actions, shelter, and evacuation routes using their own subjective judgment, and that the evacuation training increased their consciousness of their own safety.

Keywords: Disaster management · Disaster evacuation · Mobile learning · Scenario-based learning

1 Introduction

Japan is a country frequently affected by disasters like earthquakes and typhoons. In 2011, more than 15,000 people were killed in the Great East Japan Earthquake and the accompanying tsunami, including 617 school children, with many more injured while at school. Some students avoided the danger by using their own judgment to evacuate to a safe place, rather than risking a shelter assumed by others to be safe. On the other hand, many people became victims because of delayed decisions on evacuation in areas where the tsunami was assumed not to pose a threat. Since these events, disaster prevention awareness has been growing in schools and communities.

Many schools in Japan have adopted evacuation training, such as "ShakeOut" [1], as a form of education for disaster management. Such training aims to have students memorize particular actions to ensure smooth evacuation of buildings and areas,

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including schools, in the event of an emergency. However, it is difficult for such students to judge life preserving actions when encountering an emergency situation outside of school, because they have never pictured such a scenario.

The research reported here aimed to improve students' judgment in emergency situations. This paper presents a learning system prototype that supports student judgment training for emergency situations.

2 Training Development

Various scenarios for disaster evacuation education have been developed in similar research. Alexander reports that scenario methods are useful in developing decision making skills under stress [2]. However, such scenarios have certain limitations, such as divergent narratives based on given choices. Because of such limitations, it is difficult to train emergency judgment for situations beyond the scenario creator's assumptions.

For the purposes of this research, 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. The scenario consists of location-based elements of the disaster situation and shelters, with certain parts 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 start of the training, and various secondary points of disaster encountered during the evacuation. Because it is not a pre-defined scenario with a prepared narrative, the trainee is able to experience the situation with flexibility, diverging in terms of the hypothetical disaster.

The ES3 system consists of a server and a client application run on an Android tablet connected bidirectionally to the server. Figure 1 shows a conceptual overview of the system. The main features of the application are its presentation of a hypothetical disaster scenario based on a real location, and its recording of trainees' activity logs, such as locations and input values. The scenario is pre-set on any device on which the client application is installed. Trainees bring their devices outdoors for the evacuation training. When the disaster encounter point is approached, the system shows the hypothetical disaster situation through an image on the device, and a message indicating the training is about to start. The trainee takes action using his or her own judgment to navigate routes and shelters throughout the disaster evacuation. During the evacuation, dangers are revealed at certain points along the way, upon which the trainee selects an appropriate action with a reason. The evacuation is completed when the trainee reaches a shelter as a goal point.

The server collects the activity logs recorded in each device in which the client application is installed. The collected data are stored and arranged to display as an overlay on a map of the scenario. Trainees can browse these data using a web browser to reflect on their actions after the experiential learning.

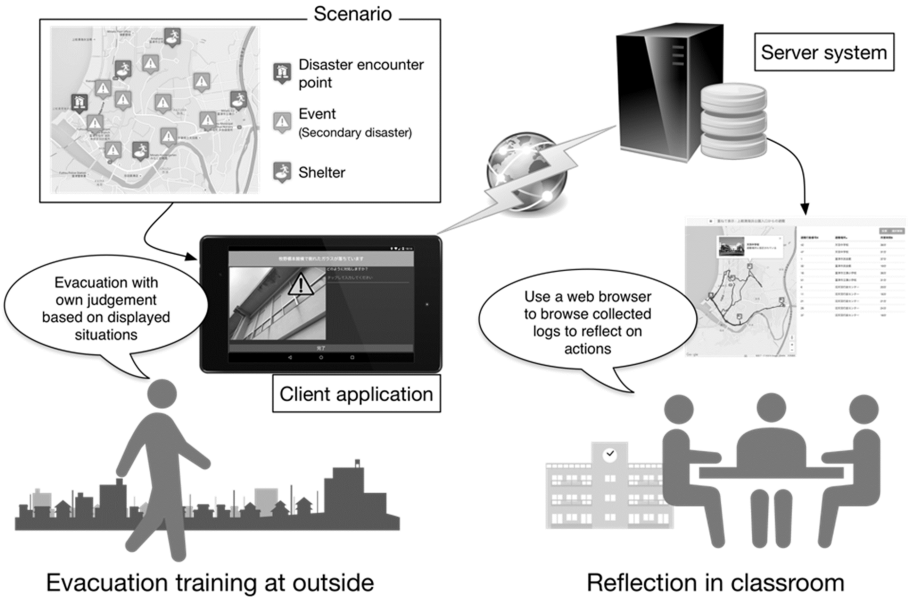

Fig. 1. Conceptual overview of ES3

3 Training Exercise

We conducted a training exercise with 111 first grade high school students in order to validate the utility of the ES3 system. The training comprised the school's integrated studies course, which aimed to allow students to learn and reflect on their actions in the event of a major earthquake. The training was carried out over four lessons conducted between September and November 2015. Each lesson was carried out at the same time for each class. The students were divided into groups of approximately four, and each group was lent an Android device.

Five training scenarios assuming the occurrence of a major earthquake, each including 50 events and reflecting the geological features of the area, were used. The scenarios were prepared with recognition of particular points and areas of safety or danger around the school, based on previous research [3].

Each of the four classes received the same four lessons. In the first lesson, the students were taught area information and basic disaster knowledge through a video, and how to operate the system through a tutorial in the schoolyard. The second and third lessons comprised the actual outdoor activities for the evacuation training outside the school. Each group conducted two outdoor activities with their devices configured for one of the five scenarios. Thus, the training was carried out twice, with a different scenario each time. Each training session took approximately 85 min, including the time taken to move from the classroom to the starting point and from the shelter at the goal point back to the classroom. Following the training, the students reflected on their results with the help of the system in the fourth lesson. They reviewed their own behaviors by browsing their trace and activity logs, which were stored in the system. They discussed standards

for judgments in emergency situations following an earthquake. After this, they reviewed the training behaviors of all the groups, voting for the training route that was the closest match to the standard in order to learn optimally from the training, over and above their own experience.

4 Results and Discussion

4.1 Training Records

For each scenario, the evacuation starting point was the same. However, the final evacuation shelter and the route to it differed for each group. The time taken for evacuation also varied according to the scenario and the selected route, with many of the groups evacuating in approximately 20 min. The groups encountered an average of 4.1 events during their evacuations. Many, although not all, of the routes consisted of wide roads.

It seems that the judgments by which the students selected their evacuation routes were promoted by use of the system. After reflecting on their results in order to construct a judgment standard, their review-based votes were concentrated on a specific route. By means of this learning process, we believe that the students' judgment skills for emergency situations were improved, leading to more appropriate judgment.

4.2 Questionnaire Results

The students were required to complete survey questionnaires before and after the training in order to determine any changes in their disaster judgments skills and the learning effects of the training. The questionnaire, which contained five-point scaled items relating to awareness of disaster risk management and a sense of disaster values,

Table 1. Results for self-efficacy questions.

	N	Before		After	
		M	SD	M	SD
Can you judge which places outside the school are dangerous in the event of a major earthquake? *	107	3.20	1.120	3.54	0.984
Do you always check a shelter outside the school in the event of a major earthquake? *	107	2.57	1.150	3.21	1.172
Can you protect yourself if you feel an extremely strong vibration?	107	3.53	1.102	3.60	1.054
Can you evacuate to a shelter after the tremors of the earthquake stop?	107	3.58	1.010	3.74	0.894
Can you describe specifically where there is danger when an earthquake occurs? *	107	2.68	1.024	3.08	1.011
Can you describe specifically to where you should evacuate when an earthquake occurs? *	107	2.60	1.050	3.01	0.895

* significant at $p < 0.01$

was developed by Motoyoshi et al. [4]. The questionnaire also contained additional questions relating to self-efficacy against disaster.

The questionnaire results showed improvements in average scores for most of the items, with the exception of those targeting a sense of disaster values. The change in scores was found by t-test to be significant for 11 of the 21 questions. For example, Table 1 shows the results for the questions relating to self-efficacy against disaster. The self-efficacy results show that the students' disaster consciousness was developed through the training exercise. However, no significant change in terms of a sense of disaster values was observed.

5 Conclusions

As reported above, we developed the ES3 scenario-based learning support system based on an improvised situation at a real location. The analysis of the students' actions revealed that they selected routes and shelters using their own subjective judgment. The questionnaire results showed that evacuation training in the field increased the students' consciousness of their own safety.

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