

## Article

# Assessment of Educational Methods for Improving Children's Awareness of Tsunamis and Other Natural Disasters: Focusing on Changes in Awareness and Regional Characteristics in Japan

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Received: 31 October 2017; Accepted: 24 January 2018; Published: 30 January 2018

**Abstract:** In this research, a visiting class on disaster preparedness education for higher-grade elementary school students (10–11 years old) was conducted in Wakayama prefecture, which is exposed to Nankai Trough earthquakes, and in different parts of the three prefectures whose coasts were most affected by the 2011 Great East Japan Earthquake: Fukushima (Western inland), Miyagi (North side out of the tsunami inundation area and Northern inland), and Iwate (Medium inland). Group activities with game-like elements were conducted. To examine whether this initiative improves schoolchildren's awareness of disaster-prevention, surveys were conducted before, immediately after, and one month after the classes. Results indicate differences in awareness depending on regional characteristics of the schoolchildren's residential area. The data obtained at each school varied according to whether the school was in a region that had experienced disaster in the recent past, or if the school was in a region where there is a recognized risk of disaster in the future. Classes in regions with recent disaster experience showed increased awareness of threats and prevention after the disaster-prevention class; however, this effect was short-lived. Increased awareness lasted longer in those schools located in regions that had not suffered from disasters in the recent past, but that are predicted to experience a major disaster in the future. We therefore infer that the "previous history of disasters" defines the key difference between regions, even when the particular school concerned was located outside the afflicted area (the coastal zone in the 2011 Great East Japan earthquake and tsunami) and so not directly affected. The afflicted area was limited to the 2011 Great East Japan Earthquake; regions experiencing no direct damage, even if they were near damaged regions, saw an increased awareness of the threat of disasters as a result of disaster-prevention classes. Students also saw a decrease in their own confidence regarding evacuation behavior, while their expressed dependence on their families for help in evacuation situations strengthened. However, such effects were temporary. In the future, it would be desirable to develop disaster-prevention programs that consider such regional characteristics.

**Keywords:** tsunami disaster education; disaster-preparedness education; awareness of disaster reduction; regional characteristics

## 1. Introduction

Tsunami waves are generated from changes in the sea floor caused by earthquakes and landslides [1–3]. Precursory phenomena are relatively easy to detect compared to direct earthquakes. Thus, tsunami waves should be natural disasters that are reasonably simple to plan for in enough time to evacuate [4,5]. However, tsunami disasters occur less frequently than earthquakes and typhoons,

making the knowledge of going through a tsunami less likely to be passed from one generation to another over many generations. The consequences of this have been examined by a number of studies following the 2011 Great East Japan earthquake and tsunami.

Comparative studies of different regions affected by the 2011 tsunami disaster by Suppasri et al. (2016) [6] and Latcharote et al. (2017) [7] show that fatality ratios for given tsunami intensities in the 2011 tsunami disaster were lower on the Sanriku Ria coast than on the Sendai coast. These authors show that awareness of tsunamis on the Sanriku coast was higher because it had been impacted by recent tsunami (in 1896 and 1933) whereas the Sendai coast had not, and infer that this elevated awareness led in most places to more effective evacuation behaviors. A similar conclusion was reached in earlier investigations within the Sanriku region by Ando et al. (2013) [8], and in the analysis by Day and Fearnley (2015) [9], who emphasized that prior learning about hazards and evacuation behaviors is essential for effective human evacuation behavior in response to warnings from even the most advanced alarm and defense systems.

Other studies of post-2011 Japan have revealed differences in post-disaster risk perceptions between disaster regions and regions outside the impact area of the disaster. Gyoba's (2014) research revealed a difference in risk perception, depending on place of residence at the time of disaster. Risk perception of disasters among people who had experienced the 2011 disaster first hand was found to be high, but risk perception of disasters by people elsewhere in Japan who had not was found to be low [10]. Oki et al. (2012) investigated evacuation awareness focusing on perceptions of the significance of tsunami inundation height reports. They found that residents in areas potentially affected by Nankai Trough earthquake tsunamis placed importance on the height of the tsunami, but underestimated the hazards due to even low-height tsunamis because of a misplaced belief that only tsunamis as big as the 2011 Great East Japan tsunami were dangerous [11]. Again, the evidence from these studies is that misinterpretation of tsunami warning messages due to a lack of prior experience or awareness education can raise the risk of damage, and conversely, that learning about a tsunami is key to minimizing its damage [12–14]. Similarly, it has been shown with weather-related disasters that have occurred frequently in recent years that knowing about the properties of the disaster leads to proper evacuation behavior, ultimately decreasing the human toll [15–17].

These various studies do, however, raise an important question: while it is evident from them that awareness and understanding of both hazards and the means to mitigate their effects is critical to ensuring risk-reducing behaviors such as prompt and efficient evacuations of tsunami inundation zones, it is not clear what methods of education are most effective in doing this. In this study, we investigate the effectiveness of different education methods used in disaster education lessons in elementary schools, and in particular address the question of whether these methods have the same effects in regions recently affected by disaster and in regions not so recently affected. If this is not the case, then education methods will have to be adapted to reflect the characteristics of these different regions.

### 1.1. Background

After the Great East Japan Earthquake of 2011, it was pointed out that it is not sufficient to focus solely on tangible aspects (e.g., physical measures such as coastal defense system, alarm system) in order to reduce human damage during large-scale disasters [18–20]. Intangible measures, such as disaster education that correctly communicates the meaning of the tsunami inundation area installed on roads and evacuation route signs, are necessary for telling people how to behave in the case of a tsunami. Education in schools is a particularly important venue for such education, not only for the children but potentially also as a conduit to get messages to their families via the children, through parent-child discussions after the school day.

### 1.2. Previous Studies of Natural Disaster Education

Irasawa and Tagaya (2013) conducted research using a questionnaire for elementary school children who participated in a disaster-prevention seminar focusing on regional natural disasters (flood damage, landslide disasters, and volcanic disasters). Schoolchildren who responded as “started to discuss more” about disasters also responded as “remembering” the class content and were likely to actively research subjects related to the class content [21].

Katada and Kanai (2016) conducted a questionnaire for elementary school children and junior high school children who participated in a disaster-prevention seminar focusing on regional natural disasters (Tsunami). They conducted a survey about changes in execution of evacuation drills and practical activities from 2010 through 2013. In addition, they investigated what students learned from the Great East Japan Earthquake [22]. Katada and Kanai (2008) [23] taught evacuation behaviors and saved many students and local residents during the Great East Japan Earthquake.

### 1.3. Previous Studies of Threat Education

Toyosawa et al. (2010) focused on the significance of emphasizing fear. This study conducted a disaster-prevention seminar, during which higher-grade elementary school children watched videos of natural disasters that were likely to instill fear. The results showed that an increase in the emotion of fear heightened the children’s desire to inform their family members of the content they had learned, and that this, in turn, heightened the family’s cooperation level with disaster-prevention measures [24]. On the other hand, Lopes (1992) showed that threatening emotions from natural disasters remained in memory, but that they did not lead to disaster-prevention measures [25]. Jones (2012) asserts that by eliminating fear and threat-based messages, new messengers can share readiness as an accessible, empowering, and valued pursuit for all communities distinct from the disasters and threats that people face [26].

### 1.4. Previous Studies of Disaster-Prevention Education Using Active Learning Tools

Nouchi et al. (2015) conducted disaster-prevention education for elementary school students. The group that used a learning tool known as a self-made pocket book, in which situations and behaviors during disasters are displayed with illustrations in an easily comprehensible manner, was reported to have greater awareness for handling disasters compared to the group that learned through video [27]. Furthermore, Nouchi and Sugiura (2014) confirmed that, during disaster-prevention classes for middle school students, groups that learned disaster prevention using the disaster simulation game book they had developed had higher confidence in being able to handle natural disasters and adopt necessary safety behaviors than the group that learned from a video, leading to an improvement in disaster-handling ability [28]. Clerveaux and Spence are developing games that raise children’s disaster awareness. These studies all show that, instead of simply giving students a scientific explanation of natural disasters, it is important, in order for disaster-prevention education to be successful, to make participants feel the threat of disasters and incorporate tools that encourage participants to engage in learning [29].

Regarding the effect of active learning, Vandiver and Wals (2010) verified that students are actively involved [30]. Similarly, Sunaga (2010) says students will be involved in playing a more involved role in the learning process when using active learning techniques [31].

Other studies have shown that the effect of disaster-prevention education may depend on the characteristics of the region in which it is conducted. Depending on the geographic characteristics of each region, the types of disasters that are likely to occur will differ, as will the experience of past disasters by the regional residents. It has been reported that such regional changes appear in the residents’ disaster-prevention awareness or measures, as well in the importance level assigned to disaster-prevention education at each school [32].

### 1.5. Objective

Based on the above, this research aimed at developing and practicing a more effective disaster-prevention education program geared toward higher-grade elementary school students and validating their effects. To be specific, this study involved informing students about the mechanism, the state of occurrence, and the threat of disasters through classroom learning first. It then conducted a disaster preparedness education program with experiment-based group activities developed independently that included game-like elements. Changes in the children's awareness toward disaster were revealed through surveys. To investigate regional differences in the effects of the disaster-prevention education program, education and surveys were conducted at five elementary schools in Japan with different regional characteristics.

Regional characteristics defined in this study refer to the characteristics of the surveyed school district. Although this is a characteristic of one school, schools in Japan are designated as evacuation centers [33–37]. The community and the school have strong ties. Collaboration and cooperation between the region and the school has been proposed [38]. In other words, from the viewpoint that we should think about disaster consciousness as a characteristic of the area where the school is located, we want to include the school features in regional characteristics.

## 2. Materials and Methods

### 2.1. Participants

The research period was between July 2016 and February 2017, with the questionnaires used to evaluate the longer-term impact of the disaster education classes being collected at the beginning of April 2017. The classes, described below, were conducted by the authors, while all the questionnaire surveys were conducted by the classroom teacher in each school. The student participants were all 5th grade students aged 10 to 11 years. There were 285 participants distributed as follows: 92 students from Elementary School A in Sendai City, Miyagi prefecture; 52 students from Elementary School B in Miyagi prefecture; 32 students from Elementary School C in Wakayama prefecture; 54 students from Elementary School D in Fukushima prefecture; and 55 students from Elementary School E in Iwate prefecture.

The questionnaire surveys for children used in this study were approved after having been examined by the Ethics Committee of the Institute for Disaster Science of Tohoku University (2015-001).

### 2.2. Schools' Regional Characteristics

Elementary School A in Sendai City is located farther inland than Sendai Harbor. During the Great Tohoku Earthquake, it did not experience any direct damage from the tsunami. However, since the school was a designated refugee shelter, approximately 3850 evacuees stayed at the school during the peak of the crisis [39,40]. The displaced people were mainly families of students who attended another neighboring elementary school that had been completely destroyed. Elementary school students in our study were very young at the time of the 2011 disaster, which occurred before they entered the elementary school. Therefore, they did not have a chance to directly see the situation in the evacuation shelter. However, the principal told the children that the school had become a shelter and that many people had evacuated there.

Elementary School B in Miyagi prefecture is located in a flat inland section near the Naruse River and is a region in which major damage from disasters has not been reported so far; however, its adjacent region experienced a flood from torrential rain in 2015.

Elementary School C in Wakayama Prefecture is located on relatively low land facing an entrance to the bay. There is a river in front of the school's main entrance, and a street along the river is a school route. It is a region that can expect tsunami damage should a Nankai Earthquake tsunami occur [41,42]. Both the children and their parents or guardians are engaged in various advocacy activities believing that a major disaster will strike in the future for certain. In this region, garbage collection bags have



a message reading “Getting Away From Tsunami!” This was taken to indicate that it is a region in which the entire area is prepared for a Nankai Earthquake tsunami. The regional and local government carries out every year regular tsunami evacuation drills with the children.

Elementary School D in Fukushima is close to the prefectural border with Tochigi prefecture, located in a mountainous region, and did not suffer much damage during the Great Tohoku Earthquake. The region this school is located in the 80 km out of range of the first nuclear power plant in Fukushima [43]. However, there are many valleys around this school and it is inferred that there are many dangerous areas of sediment-related disasters.

Elementary School E in Iwate prefecture is located in the central region of Iwate prefecture and is a region that did not suffer much damage from the Great Tohoku Earthquake. This region in which major damage from disasters has not been reported so far. The locations of the schools are shown in Figure 1.

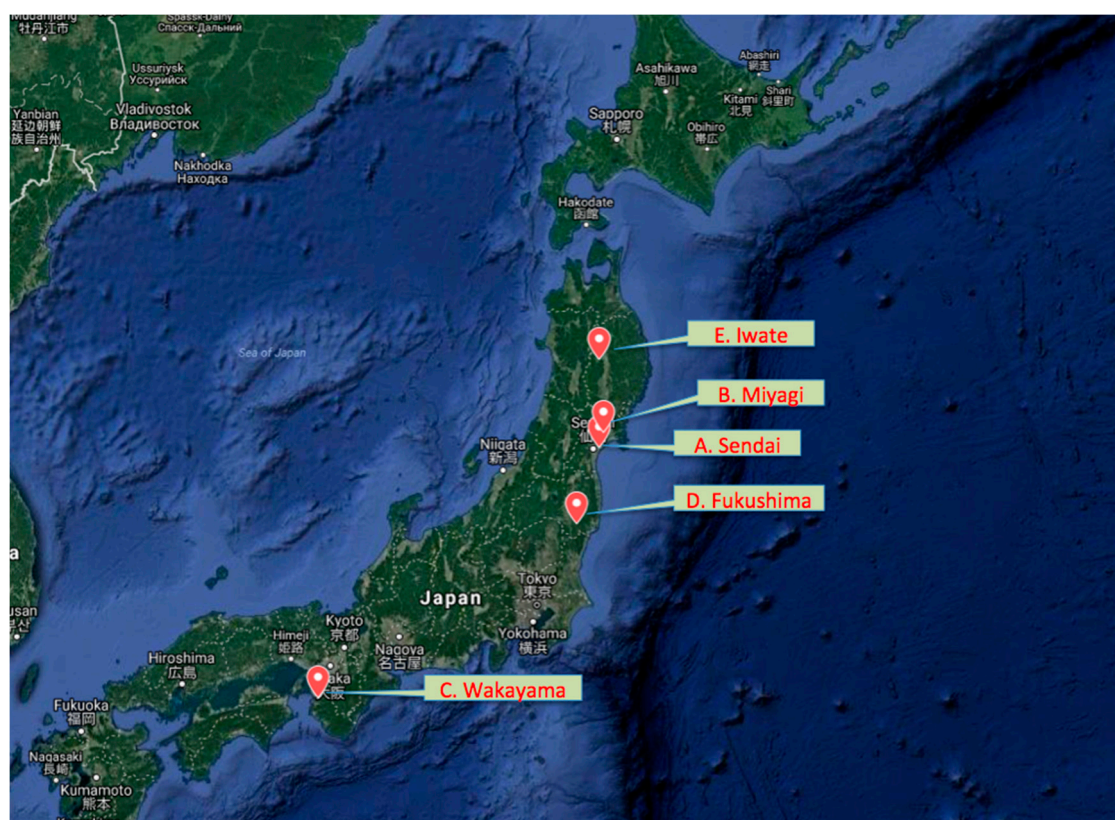


Figure 1. Schools' locations targeted for this survey.

### 2.3. Class Content

The disaster education classes carried out at each school consisted of three parts: a normal school-format class; a group activity game; and a subsequent group discussion and presentation exercise.

#### 2.3.1. Part 1

In Part 1, the first author held a class on the topic of “learning about the mechanisms of natural disasters and the damage they cause.” This class aimed to transmit lessons learned from previous disasters without using anecdotes, pictures of past damage, or reports. Instead, it used computer-generated graphics and videos of experiments related to natural disasters that could happen in the future. Looking to future disasters, we must deepen learning to prepare each person to think

about how to respond to the disasters that are likely to happen in their region or across the whole country. Thus, it is important for people to know the mechanism of the Great East Japan Earthquake as an example of an event that may affect any part of the country in future. Additionally, depending on the geographical conditions of schools, people should be aware of the risks of sediment-related disasters due to earthquakes and heavy rain, of tsunamis by earthquake, of flooding due to heavy rain, or of liquefaction of ground due to earthquake. To that end, the schoolchildren took school-format classes in which they listened to the teacher or asked questions after looking at PowerPoint slides projected onto the screen at the front of the class. In this way, schoolchildren learn that preparation means thinking about the impacts of disasters on their lives when they occur, and what they need to do minimize these impacts.

### 2.3.2. Part 2

In Part 2, a group activity game was conducted. Groups of 5–8 students were formed, with groups participating in one of two games: a game of finding dangerous spots when a disaster strikes from a picture (hereafter, “FD game”), or a stamp rally in which the players think of actions to take during six different situations spanning from when the disaster takes place to living within the evacuation shelter. The explanation of the two games is displayed in Figures 2 and 3.

(a) Find dangerous spots!



(b) Find dangerous spots!



(c) FD games by children



(d) FD games by children



**Figure 2.** Example of a game for finding dangerous spots (FD game).

The FD game confirms dangers in the home in the case of natural disasters, in preparation for the next disaster. Children spend half of the day at home, underscoring its familiarity. In the event of an earthquake, falling objects, among other things, become dangerous. Sometimes we must escape from a house in the dark at night, for example. In the event of a typhoon, meanwhile, it is necessary to prepare for strong winds. Children should relate their homes to disasters and imagine possible dangers



around them. To that end, the FD game asks students to imagine a situation in which they have to evacuate after a disaster occurs, and then point out the dangerous spots within the illustrated settings. These include a common Japanese household's entrance area, dining and living rooms, and children's rooms. Then the children were asked to write down the reasoning behind their selections and solutions. In a stamp rally, a stamp board was distributed for each student. Each group went through six stamp points and read the six questions relating to a time period ranging from the occurrence of a disaster to living at the evacuation center. Out of five stamps, students selected the response stamp with the response closest to their thinking and stamped it onto their stamp board, collecting six stamps.

(a) Stamp rally by children



(b) Stamp rally by children



**Figure 3.** Example of the stamp rally.

The stamp rally game was invented for this study and so was unfamiliar to the children. Furthermore, before implementing the stamp rally, the practitioner told the children that all stamps are correct and so they should select stamps according to their own thoughts. Each stamp had been given one of three colors in accordance with the category of thinking: red for self-assisting thoughts, green for mutual-assistance thoughts, and blue for public-assistance thoughts. Group activities were assigned in accordance with the number of attendees for each lesson. Since FD game sessions could be conducted concurrently, regardless of the number of groups, they were conducted when the number of attendees was 60 or more. On the other hand, if the number of groups for the stamp rally exceeded six, the children would have to wait their turn to press the stamp onto their stamp board, causing time to be wasted. For this reason, this activity was conducted when the number of children was less than 60. The FD game was conducted at School A and the stamp rally was conducted at the other schools.

### 2.3.3. Part 3

The objective of Part 3 was to formulate a vision of actions the children could take to handle natural disasters and have these images stay with the students. Sharing the results of group work and discussing each other's way of thinking makes it possible for each person to imagine disaster situations more concretely. Children can experience more realism by speaking and listening to what another child imagines is different, and think about concrete preparation (arranging and fixing furniture, necessary goods, family communication, etc.). To clarify what kind of actions should be taken in situations that change moment by moment after a disaster has occurred, as well as for children to have a clear image of actions to take at each moment and have those images stay with them, in Part 3, a group activity was conducted in which they shared, discussed, and summarized the actions they selected in the group. Afterward, each group presented their results. The photos of the presentation are shown in Figure 4. Questions and answers for the stamp rally are shown in Figure 5.

## 2.4. Questionnaire Survey Forms

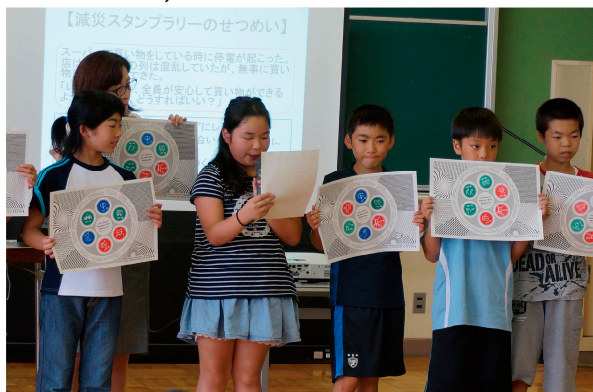
The questionnaire survey form comprises eleven question items. Each question is answered using a 5-point scale of 1 for Strongly Disagree, 2 for Disagree, 3 for Undecided, 4 for Agree, and 5 for Strongly Agree. Similar questionnaires, also using a Likert scale, have been used in previous studies on the views of children aged about 9 [27,44] and we therefore have confidence in the ability of children of this age to understand such questions.

Q1 asked about the sense of fear of natural disasters, Q2 the possibilities of becoming injured during disasters, Q3 about estimates of the risk of natural disaster occurrence in one's residential area, and Q4 about the willingness to acquire knowledge of the disaster occurrence mechanisms. Q5 asked about confidence in the ability to evacuate safely during disasters, Q6 about the necessity of having rules within the family for during a disaster, Q7 about the possibility of one's family members becoming injured during disasters, and Q8 about awareness of the need to share the content of the disaster-prevention class with family member. Q9 asked about the necessity for disaster-prevention measures among family members, Q10 about the prediction of appropriate evacuation behavior of family members during disasters, and Q11 about confidence of being able to protect one's life during disasters.

For the questionnaire given a month after the classes, three questions (Q12, Q13, and Q14) were added to these eleven question items. With Q12, the respondents were asked to indicate the matters they discussed with family members after the disaster-prevention class, by selecting everything that was applicable within the 10 items listed (evacuation site, evacuation route, contact method, house safety or lack thereof, evacuation materials, essential items, stock pile, responsibilities, local hazard map, your pets' whereabouts). In Q13, the respondents were asked to select all applicable options from the ten possible disaster-prevention measures that they actually conducted with their family (check the evacuation site, check the evacuation route, decide contact method, check whether your house is safe or not, check evacuation material, check essential items, check stock pile, check each person's responsibilities, check local hazard map, check your pets' whereabouts). In Q14, the respondents were asked to respond using a 5-point scale whether they would like to do the group activity game they did in Part 2 again. The reason that Q12 and Q13 were added was to examine whether the classes lead to disaster-reduction behavior. The reason that Q14 was added was to examine whether there was a difference in the evaluation by children regarding the two types of group activities.

The questionnaire survey forms for before (pre-class) and immediately after (post-class) conducting the disaster-prevention education program are displayed in Figure 6. The survey form conducted approximately a month later is presented in Figure 7.

(a) Presentation by children



(b) Presentation by children



Figure 4. Example of the group presentation.































<p><b>#01 Beach and coastal place</b></p> <p>What should be done to escape as quickly as possible from the shore when an earthquake strikes?</p> <p><b>#01 Actions</b></p> <div> <div>  <p>A01-1 Keep your body fit to be able to escape quickly.</p> </div> <div>  <p>A01-2 Call out to all persons nearby and escape together.</p> </div> </div> <div> <div>  <p>A01-3 Use a mobile phone to gather latest information in case of a disaster.</p> </div> <div>  <p>A01-4 Take part in local disaster drills as often as possible.</p> </div> </div> <div> <div>  <p>A01-5 Prepare a signboard that indicate the escape route.</p> </div> </div>	<p><b>#02 Contact within family members</b></p> <p>What should be done by separate family members in order to rejoin after an earthquake ?</p> <p><b>#02 Actions</b></p> <div> <div>  <p>A02-1 Try to reach them by all ways: phone, mail or Line.</p> </div> <div>  <p>A02-2 Build a bulletin board to locate the family in the refuge.</p> </div> </div> <div> <div>  <p>A02-3 Decide to gather where in case of a big earthquake.</p> </div> <div>  <p>A02-4 Share information actively among people in the district.</p> </div> </div> <div> <div>  <p>A02-5 Provide an internet system that can be used even during a disaster.</p> </div> </div>
<p><b>#03 At home</b></p> <p>What should be done for the family to be able to get out of the house safely ?</p> <p><b>#03 Actions</b></p> <div> <div>  <p>A03-1 Fix the shelves firmly so that they can't collapse.</p> </div> <div>  <p>A03-2 Just in case organize a drill with neighboring people.</p> </div> </div> <div> <div>  <p>A03-3 Don't put any furniture on the way to the entrance.</p> </div> <div>  <p>A03-4 Provide information about the risk of furniture collapse.</p> </div> </div> <div> <div>  <p>A03-5 Provide financial support to improve housing standards.</p> </div> </div>	<p><b>#04 The way to the refuge</b></p> <p>What should be done to get easily and safely to the refuge at night time ?</p> <p><b>#04 Actions</b></p> <div> <div>  <p>A04-1 Prepare a flashlight for each member of the family.</p> </div> <div>  <p>A04-2 Call out to neighboring people while evacuating.</p> </div> </div> <div> <div>  <p>A04-3 Listen to the latest information even during evacuation.</p> </div> <div>  <p>A04-4 Join the local "night disaster drill" for prevention.</p> </div> </div> <div> <div>  <p>A04-5 Arrange streetlights that can be used at night evacuation.</p> </div> </div>
<p><b>#05 First moment at the refuge</b></p> <p>What should be done regarding water and food distribution in the refuge ?</p> <p><b>#05 Actions</b></p> <div> <div>  <p>A05-1 Bring your own water and food from home to the refuge.</p> </div> <div>  <p>A05-2 Receive water and food in consideration of others.</p> </div> </div> <div> <div>  <p>A05-3 Go shopping immediately after the disaster hits.</p> </div> <div>  <p>A05-4 Distribute water and food from children and elder persons.</p> </div> </div> <div> <div>  <p>A05-5 Gather as much food as possible in advance in the refuge.</p> </div> </div>	<p><b>#06 Life in the refuge</b></p> <p>What should be done for everybody to spend a comfortable time at the refuge ?</p> <p><b>#06 Actions</b></p> <div> <div>  <p>A06-1 Bring some games, books or comics to not be bored.</p> </div> <div>  <p>A06-2 Cook and do some exercises with your new fellows.</p> </div> </div> <div> <div>  <p>A06-3 Talk to other people to get along well with them.</p> </div> <div>  <p>A06-4 Gather the youngest children and play with them.</p> </div> </div> <div> <div>  <p>A06-5 Organize a concert or a live performance in the refuge.</p> </div> </div>

Figure 5. Questions and answers for the stamp rally.



Visiting Class Pre-Questionnaire 1	School Name
Class	No.
1. <u>Are you scared of natural disasters, like earthquakes, tsunamis, typhoons, heavy rain, and volcanic eruptions?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
2. <u>Do you think you may get injured if a natural disaster were to occur?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
3. <u>Do you think natural disasters will occur in your area?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
4. <u>Is it good for you to know the reason why natural disasters, like earthquakes, tsunamis, typhoons/ cyclones, heavy rain, and volcanic eruptions happen?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
5. <u>Do you think you could evacuate safely if an earthquake, tsunami, typhoons, heavy rain or volcanic eruption were to occur?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
6. <u>Do you think you need to talk with your family to decide what to do in the event of a natural disaster?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
7. <u>Do you think your family would get injured if a natural disaster occurs?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
8. <u>Do you want to tell your family about how to protect each other's lives based on what you've learned from studying disasters?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
9. <u>Do you think your family would become safer if you talked and made promises to improve preparedness?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
10. <u>Do you think your family could evacuate safely if an earthquake, tsunami, typhoons, heavy rain or volcanic eruption were to occur?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	
11. <u>Do you think you can save your life with what you learned today if a disaster happens?</u>	
<input type="checkbox"/> a. Strongly Disagree <input type="checkbox"/> b. Disagree <input type="checkbox"/> c. Undecided <input type="checkbox"/> d. Agree <input type="checkbox"/> e. Strongly Agree	

**Figure 6.** Questionnaire survey forms given before and after disaster preparedness education class.

12. Have you talked with your family about disasters? Please select what you've discussed below


☐evacuation site ☐evacuation route ☐contact method ☐check your house is safe or not  
☐evacuation materials ☐essential items ☐stock pile ☐responsibilities  
☐local hazard map ☐your pet's whereabouts

13. What disaster preparations have you done with your family?  
Please select from the choices below.

☐check the evacuation site ☐check the evacuation route ☐decide contact method  
☐check whether your house is safe or not ☐check evacuation material  
☐check essential items ☐check stock pile ☐check each person's responsibilities  
☐check local hazard map ☐check your pet's whereabouts

14. Would you like to try the group work game again?

☐a. Strongly Disagree ☐b. Disagree ☐c. Undecided ☐d. Agree ☐e. Strongly Agree

  
 See you again !!

**Figure 7.** Questions added in the follow up survey. In the follow-up questionnaire, questions 1–11 were the same as those shown in Figure 6.

## 2.5. Procedure

The disaster preparedness education program conducted in this study was part of “Yui Project, a project that aims to spread awareness of disaster preparedness” by the Tohoku University Disaster Reduction Advocacy Visiting Class [45]. This project involved going to elementary schools that wished to take a class and holding disaster reduction classes. The detailed timetable is presented in Table 1. A questionnaire survey was conducted before and after the class was held and approximately a month after the class. All questionnaire surveys were conducted by the classroom teacher in each school.

**Table 1.** Class Timetable and Implementation Program.

Order	Contents	The Purpose	Time
	Questionnaire on disaster awareness before the class	Measure current disaster prevention consciousness	5 min
Part 1	Lecture on natural disasters and hazard based on lessons from the 2011 Great Tohoku Earthquake	Make the mechanism and damage of disasters recognized as scientific knowledge	30 min
	Break	Break	5 min
Part 2	Group activity game using FD game or Stamp rally	Make children anticipate the situation at the time of disaster	25 min
Part 3	Presentation	Identify disaster mitigation measures that can be implemented by individuals	20 min
	Questionnaire on disaster awareness after the class	Measure changes in disaster prevention awareness of children after class	5 min

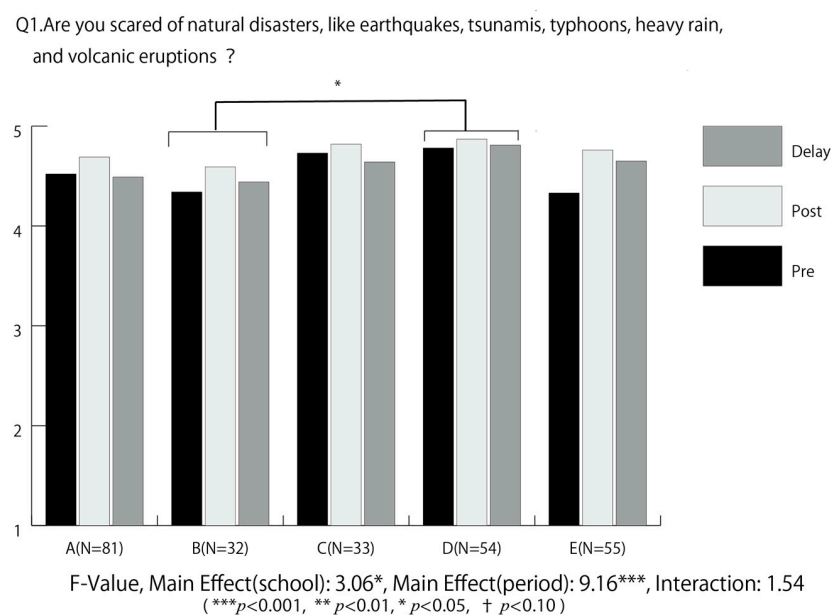
The time it took to complete the questionnaire was approximately five minutes. There were 255 respondents, with the retrieval rate being 89.5%.

### 3. Results

The responses for question items Q1 to Q11 were aggregated by awarding a score of 1 for “Strongly Disagree”, 2 for “Disagree”, 3 for “Undecided”, 4 for “Agree”, and 5 for “Strongly Agree”. The mean value for each question by school and period are displayed in Figures 8–18. A 5 (school) times 3 (period) analysis of variance (ANOVA) was conducted for each question. Furthermore, Bonferroni’s method was used for multiple comparison tests. We set the adjusted  $p$  value by dividing the  $p$  value (0.05) by the number of tests. Then, we considered individual tests with  $p < 0.005$  to be significant at school because the number of tests for the school was 10 (e.g., school A vs. school B, school A vs. school C). We also considered individual tests with  $p < 0.0167$  to be significant at period because the number of tests for the period was 3 (Pre vs. Post, Pre vs. Delay, and Post vs. Delay). SPSS ver. 22 was used for analysis.

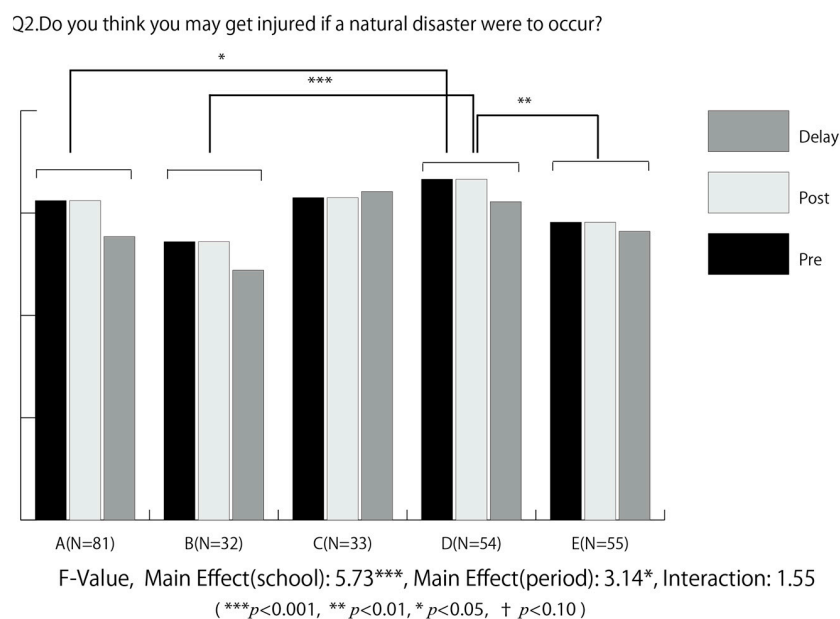
#### 3.1. Q1–Q3

Figure 8 shows the mean values for fear of natural disasters (Q1), the main effect of school ( $F(4, 250) = 3.06, p < 0.05$ ) and the main effect of period ( $F(2, 500) = 9.17, p < 0.001$ ) were found to be significant. The interaction effect was not significant. The results of multiple comparison showed that in terms of schools, a significant difference was found between Schools B and D ( $p < 0.05$ ), with the rating scale value being higher for School D than School B. Concerning the period, a significant difference was found between pre-class and post-class ( $p < 0.001$ ), as well as between post-class and one month later ( $p < 0.05$ ). It was revealed that the scores increased from the pre-class to post-class, and decreased from post-class to a month later.



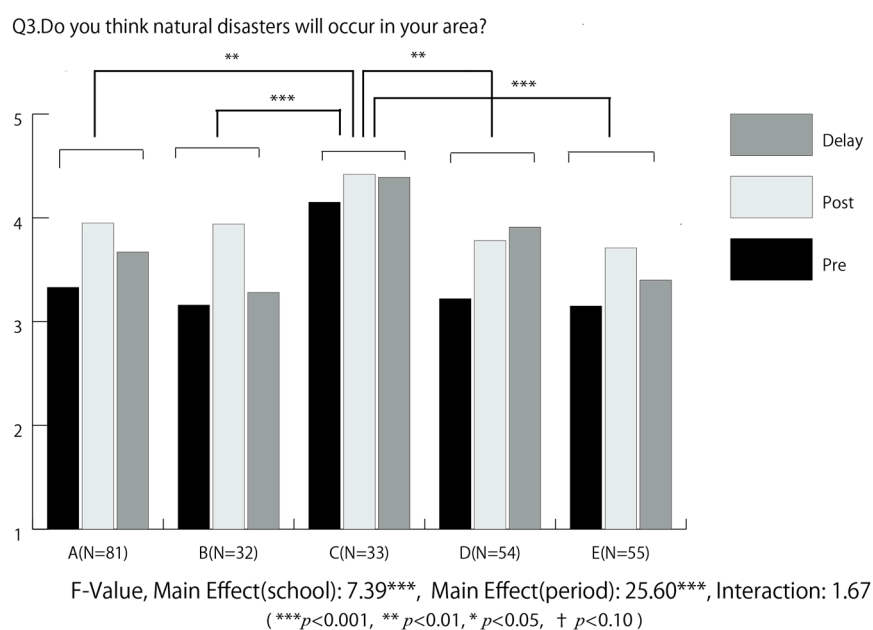
**Figure 8.** Mean values for fear of natural disasters (Q1).

Figure 9 shows the mean values for the possibility of becoming injured during a disaster (Q2), the main effect of the school ( $F(4, 250) = 5.73, p < 0.001$ ) and the main effect of the period ( $F(2, 500) = 3.14, p < 0.05$ ) were found to be significant. The interaction effect was not significant. The results of multiple comparison showed that for schools, a significant difference was found between Schools D and E ( $p < 0.01$ ), Schools B and D ( $p < 0.001$ ), and Schools A and D ( $p < 0.05$ ), with School D having the highest rating scale value. Concerning the period, a significant difference between post-class and one month later was found ( $p < 0.05$ ), and it was revealed that the value decreased from post-class and a month later.



**Figure 9.** Mean values for possibility of becoming injured during a disaster (Q2).

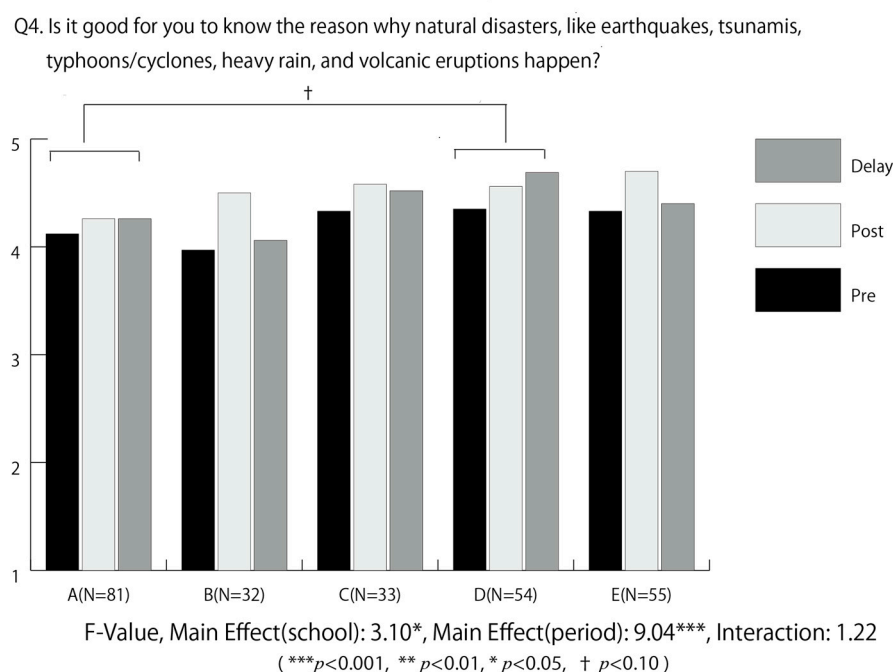
Figure 10 shows the mean values for the estimation of disaster occurrence risk in residential areas (Q3), the main effect of the school ( $F(4, 250) = 7.39, p < 0.001$ ) and the main effect of the period ( $F(2, 500) = 25.60, p < 0.001$ ) were significant. The interaction effect was not significant. The results of multiple comparison showed that in terms of schools, School C had a significantly higher rating scale value compared to other schools (Schools A and D:  $p < 0.01$ ; Schools B and E:  $p < 0.001$ ). Concerning the period, a significant difference was seen in all combinations of periods (pre-class and post-class:  $p < 0.001$ , pre-class and one month later:  $p < 0.01$ , post-class and one month later:  $p < 0.01$ ), with the score increasing from pre-class to post-class and decreasing from post-class to one month later; however, the scores were higher for one month later than for pre-class.



**Figure 10.** Mean values for estimation of disaster occurrence risk in residential areas (Q3).

### 3.2. Q4–Q6

Figure 11 shows the mean values for the desire to acquire knowledge of the mechanisms that cause disasters (Q4), the main effect of the school ( $F(4, 250) = 3.10, p < 0.05$ ) and the main effect of the period ( $F(2, 500) = 9.04, p < 0.001$ ) were found to be significant. The interaction effect was not significant. The results of multiple comparison showed that in terms of schools, the difference between School A and D was marginally significant ( $p < 0.10$ ), with School D tending to be higher than School A. Concerning the period, a significant difference was found between pre-class and post-class ( $p < 0.001$ ), with pre-class and a month later showing a marginally significant effect ( $p < 0.10$ ). The value increased from pre-class to post-class, and did not decrease a month later.



**Figure 11.** Mean values for desire to acquire knowledge of the mechanisms that cause disasters (Q4).

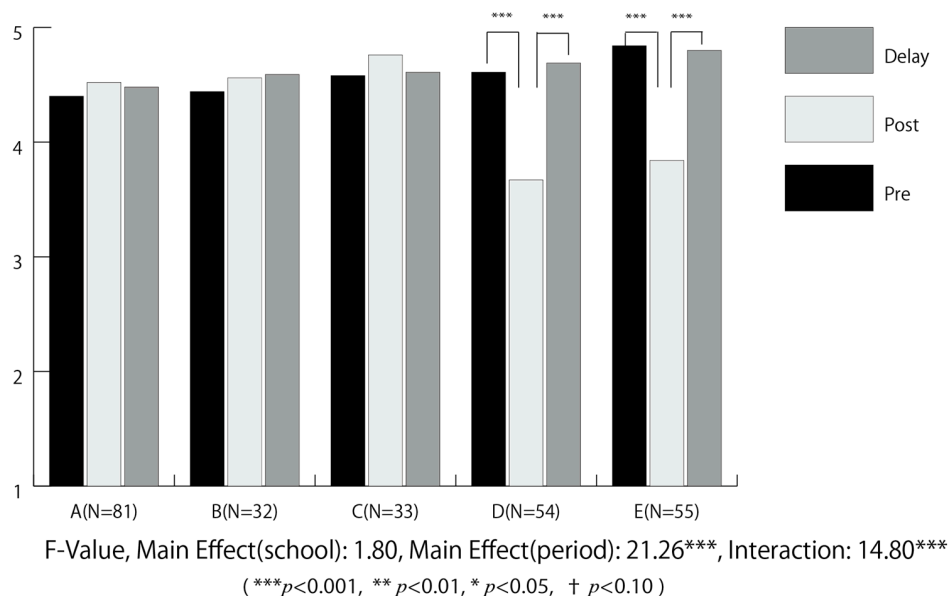
Figure 12 shows the mean values for the confidence in evacuation activity during a disaster (Q5), the main effect of the period ( $F(2, 500) = 21.26, p < 0.001$ ) and the interaction effect between two factors ( $F(8, 500) = 14.80, p < 0.001$ ) were found to be significant. Given that the interaction effect was significant, the simple main effect of the period for each school was verified. As a result, it was found that the simple main effect of period for Schools D and E (both  $p < 0.001$ ) was significant. The results of multiple comparison showed that in those schools, the scores effectively decreased from pre-class to post-class (all  $p < 0.001$ ), and increased significantly from post-class to a month later (all  $p < 0.001$ ). In other schools, the simple main effect of the period was not significant.

Figure 13 shows the mean values for the rules during disasters among family (Q6), the main effect of the school ( $F(4, 250) = 2.55, p < 0.05$ ), the main effect of the period ( $F(2, 500) = 68.00, p < 0.001$ ), and the interaction effect between two factors ( $F(8, 500) = 8.30, p < 0.001$ ) were all found to be significant. Given that the interaction effect was significant, the simple main effect of the period for each school was verified, revealing that the simple main effect of period for all schools was significant (School E:  $p < 0.001$ , School D:  $p < 0.001$ , School A:  $p < 0.001$ , School B:  $p < 0.01$ , and School C:  $p < 0.05$ ). The results of multiple comparison showed that for Schools A and E, a significant difference was seen for all periods, with the score increasing significantly from pre-class to post-class (both  $p < 0.001$ ) and significantly decreasing from post-class to one month later (School E:  $p < 0.001$ , School A:  $p < 0.05$ ), with the scores for one month later being significantly higher than pre-class (School E:  $p < 0.01$ , School



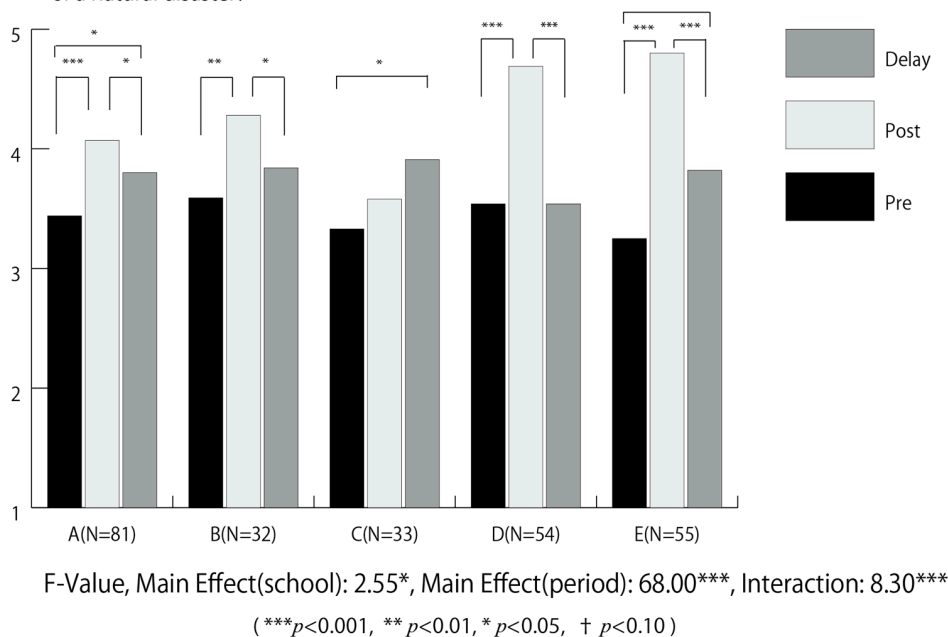
A:  $p < 0.05$ ). Furthermore, the scores significantly increased from pre-class to post-class for Schools B and D (School D:  $p < 0.001$ , School B:  $p < 0.01$ ) and decreased significantly from post-class and one month later (School D:  $p < 0.001$ , School B:  $p < 0.05$ ), showing no significant difference between pre-class and one month later. On the other hand, for School C, a significant difference was seen only for pre-class and one month later ( $p < 0.05$ ), with the scores for one month later being significantly higher than pre-class.

Q5. Do you think you could evacuate safely if an earthquake, tsunami, typhoons, heavy rain or volcanic eruption were to occur?



**Figure 12.** Mean values for confidence in evacuation activity during a disaster (Q5).

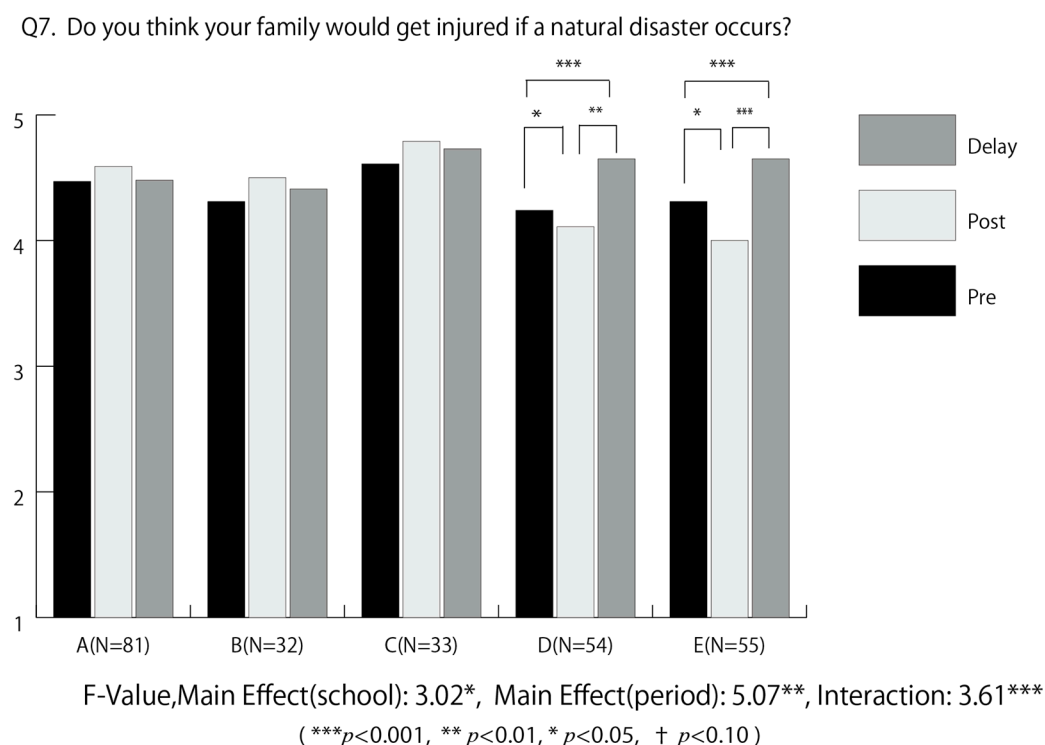
Q6. Do you think you need to talk with your family to decide what to do in the event of a natural disaster?



**Figure 13.** Mean values for rules during disasters among family (Q6).

### 3.3. Q7–Q11

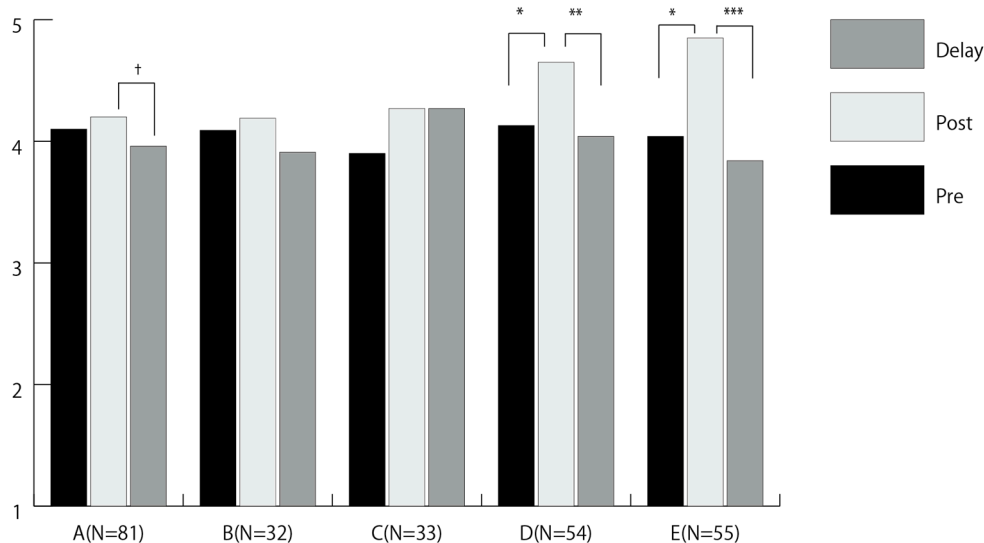
Figure 14 shows the mean values for the possibility of family members becoming injured during disasters (Q7), the main effect of the school ( $F(4, 250) = 3.02, p < 0.05$ ), the main effect of the period ( $F(2, 500) = 5.10, p < 0.01$ ) and the interaction effect between two factors ( $F(8, 500) = 3.61, p < 0.001$ ) were found to be significant. Given that the interaction effect was significant, the simple main effect of the period for each school was verified, which showed that the simple main effects of period for Schools D and E were significant (both  $p < 0.001$ ). These two schools had scores of one month later significantly higher than pre-class and post-class (School E:  $p < 0.05, p < 0.001$ , School D:  $p < 0.05, p < 0.01$ ). Other schools did not show a significant difference in the simple main effect of the period.



**Figure 14.** Mean values for possibility of family members becoming injured during disasters (Q7).

Figure 15 shows the mean values for the awareness of the need to share disaster-prevention class content with family (Q8), the main effect of the period ( $F(2, 500) = 24.16, p < 0.001$ ) and the interaction effect between two factors ( $F(8, 500) = 4.78, p < 0.001$ ) were found to be significant. Given that the interaction effect was significant, the simple main effect of the period for each school was verified, which showed that the simple main effects of period for School E and School D were significant (both  $p < 0.001$ ). The results of multiple comparison showed that for these two schools, the scores increased significantly from pre-class to post-class (School E:  $p < 0.001$ , School D:  $p < 0.01$ ) and significantly decreased from post-class to one month later (both  $p < 0.001$ ). Although the simple main effect of the period for Schools A and C showed a marginally significant effect ( $p < 0.10$ ), a marginally significant effect between later and one month later was only found for School A, with School C showing no significant difference between any period. The significant main effect for the period of School B was found to be not significant.

Q8. Do you want to tell your family about how to protect each other's lives based on what you 've learned from studying disasters?



F-Value, Main Effect(school): 1.16, Main Effect(period): 24.17\*\*\*, Interaction: 4.78\*\*\*  
 (\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ , † $p < 0.10$ )

**Figure 15.** Mean values for awareness of the need to share disaster-prevention class contents with family (Q8).

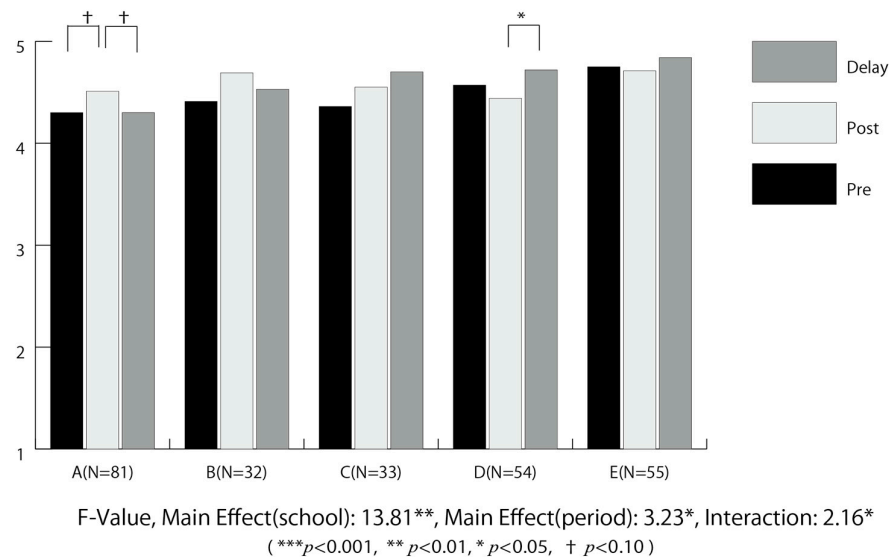
Figure 16 shows the mean values for disaster-prevention rules within family (Q9), the main effect of the school ( $F(4, 250) = 3.81, p < 0.01$ ), the main effect of the period ( $F(2, 500) = 3.23, p < 0.05$ ), and the interaction effect between two factors ( $F(8, 500) = 2.16, p < 0.05$ ) were found to be significant. Given that the interaction effect was significant, the simple main effect of the period for each school was verified, which showed that the simple main effect of period for Schools A and D were significant (both  $p < 0.05$ ). The results of multiple comparison showed a significant difference between post-class and one month later for School D ( $p < 0.05$ ). However, with School A, the difference between the pre-class and post-class, and post-class and one month later, both showed a marginally significant effect ( $p < 0.10$ ). Other schools did not show any significance for the simple main effect of the period.

Figure 17 shows the mean values for the prediction of family members being able to evacuate safely during a disaster (Q10), the main effect of the period ( $F(2, 500) = 7.01, p < 0.01$ ) and the interaction effect between two factors ( $F(8, 500) = 4.96, p < 0.001$ ) were found to be significant. Given that the interaction effect was significant, the simple main effect of the period for each school was verified, which showed that the simple main effect of period for Schools D and E were significant (School E:  $p < 0.01$ , School D:  $p < 0.001$ ). The results of multiple comparison showed that with these two schools, the scores decreased significantly from pre-class to post-class (School E:  $p < 0.01$ , School D:  $p < 0.001$ ) and significantly increased from post-class to one month later (School E:  $p < 0.05$ , School D:  $p < 0.001$ ). In other schools, the simple main effect of period was not significant.

Figure 18 shows the mean values for the confidence of being able to protect one's own life during a disaster (Q11), the main effect of the period ( $F(2, 500) = 22.65, p < 0.001$ ) and the interaction effect between two factors ( $F(8, 500) = 3.72, p < 0.001$ ) were found to be significant. Given that the interaction effect was significant, the simple main effect of the period for each school was verified, which showed that the simple main effect was significant or marginally significant for all schools (School E:  $p < 0.001$ , School D:  $p < 0.001$ , School A:  $p < 0.01$ , School B:  $p < 0.01$ , and School C:  $p < 0.10$ ). The results of multiple comparison showed that with four schools, other than school C, the scores significantly increased from pre-class and post-class or had marginally significantly increased (School E:  $p < 0.001$ , School

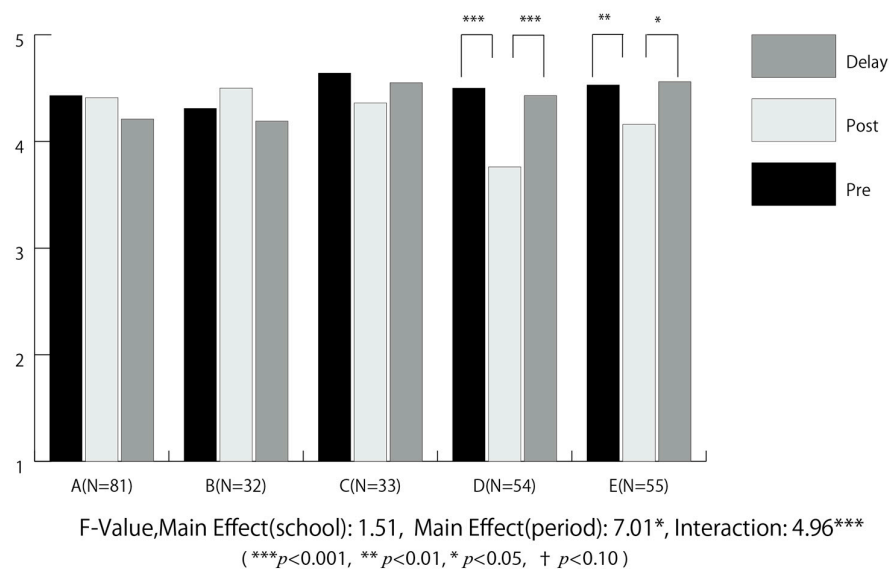
D:  $p < 0.001$ , School A:  $p < 0.10$ , and School B:  $p < 0.05$ ), and significantly decreased from post-class to 1 month later (School E:  $p < 0.001$ , School D:  $p < 0.001$ , School A:  $p < 0.05$ , and School B:  $p < 0.01$ ). A marginally significantly increase was found between pre-class and a month later for School C ( $p < 0.10$ ), with the value of one month later being high.

Q9. Do you think your family would become safer if you talked and made promises to improve preparedness?

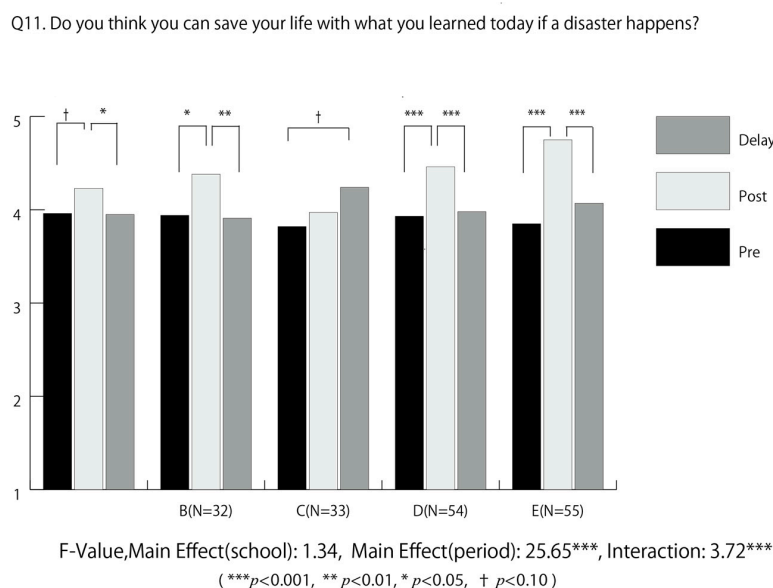


**Figure 16.** Mean values for disaster-prevention rules within family (Q9).

Q10. Do you think your family could evacuate safely if an earthquake, tsunami, typhoons, heavy rain or volcanic eruption were to occur?



**Figure 17.** Mean values for prediction of family members being able to evacuate safely during a disaster (Q10).



**Figure 18.** Mean values for confidence of being able to protect one's own life during a disaster (Q11).

### 3.4. Q12–Q14

The number of people who said YES to each option for Q12 and 13, which were added for a survey conducted a month later, were counted. Children who checked at least one item among those they discussed with their families in preparation for natural disaster accounted for 93% of the total. For Q13, 85% of the children checked at least one item among items relating to specific measures they implemented with their families. Children who did not check any item for either discussions with their families or specific measures taken were only 7% of the total. The tabulated result for each item is displayed in Table 2. As an overall trend, there were many children who discussed with their families the evacuation place (75.3%) or actually decided on the evacuation place (62.4.0%), followed by those who discussed or checked essential items (51.4%, 48.6%). On the other hand, not many discussed or developed measures for hazard maps and pets. Concerning the difference between the schools, when a  $\chi^2$  test was conducted for the percentage of children who answered YES for each option, significance or marginal significance was seen in differences in schools in Q12 for evacuation site ( $\chi^2 = 21.45$ ,  $df = 4$ ,  $p < 0.001$ ), evacuation route ( $\chi^2 = 15.63$ ,  $df = 4$ ,  $p < 0.01$ ), contact method ( $\chi^2 = 28.20$ ,  $df = 4$ ,  $p < 0.001$ ), evacuation materials ( $\chi^2 = 9.47$ ,  $df = 4$ ,  $p < 0.10$ ), essential items ( $\chi^2 = 13.22$ ,  $df = 4$ ,  $p < 0.05$ ) and responsibilities ( $\chi^2 = 30.06$ ,  $df = 4$ ,  $p < 0.001$ ). In Q13, significance or marginal significance was seen in differences in schools for checking the evacuation site ( $\chi^2 = 15.42$ ,  $df = 4$ ,  $p < 0.01$ ), checking the evacuation route ( $\chi^2 = 22.84$ ,  $df = 4$ ,  $p < 0.001$ ), deciding contact methods ( $\chi^2 = 27.80$ ,  $df = 4$ ,  $p < 0.001$ ), checking whether your house is safe or not ( $\chi^2 = 11.65$ ,  $df = 4$ ,  $p < 0.05$ ), checking essential items ( $\chi^2 = 9.04$ ,  $df = 4$ ,  $p < 0.10$ ), checking each person's responsibilities ( $\chi^2 = 25.89$ ,  $df = 4$ ,  $p < 0.001$ ), and checking local hazard maps ( $\chi^2 = 8.13$ ,  $df = 4$ ,  $p < 0.10$ ). The residual analysis result showed that for School A, the response rate was significantly high for evacuation site, contact method, essential items, and responsibilities for Q12, and checking the evacuation site, checking the evacuation route, deciding contact methods, checking whether your house is safe or not, checking essential items, and checking each person's responsibilities for Q13. For School C, the response rate was significantly high for evacuation site, evacuation route, and evacuation materials for Q12, and checking local hazard map for Q13, while in the case of essential items, it was significantly low for Q12. For School D, the response rate was significantly low for evacuation site, evacuation route, and contact method for Q12, and checking the evacuation site, checking the evacuation route, checking whether your house is safe or not, and checking each person's responsibilities for Q13. For School E, the response rate was significantly low for contact method and responsibilities for Q12 and checking the evacuation route and decide contact method for Q13.



**Table 2.** The percentage of items that the children discussed with their families (Q12) and the items executed (Q13) for each school.

No.	Question Contents		Evacuation Site	Evacuation Route	Contact Method	Check Your House Is Safe or Not	Evacuation Materials	Essential Items	Stock Pile	Responsi-Bilities	Local Hazard Map	Your Pet's Whereabouts
Q12	Have you talked with your family about disasters? Please select what you've discussed below	A (N = 81)	84.0	28.4	59.3	46.9	44.4	66.7	18.5	38.3	16.0	12.3
		B (N = 32)	78.1	46.9	31.3	43.8	56.3	43.8	28.1	18.8	15.6	15.6
		C (N = 33)	90.9	45.5	30.3	33.3	42.4	54.5	27.3	18.2	15.2	15.2
		D (N = 54)	53.7	13.0	25.9	29.6	27.8	48.1	20.4	13.0	7.4	11.1
		E (N = 55)	72.7	14.5	20.0	36.4	30.9	47.3	23.6	7.3	9.1	16.4
		Average	75.3	24.3	38.4	38.8	37.6	51.4	21.2	20.0	11.4	12.9
		$\chi^2$	21.45 ***	15.63 **	28.20 ***	4.74	9.47 <sup>†</sup>	13.22 *	1.41	30.06 ***	4.19	1.26
Q13	What disaster preparations have you done with your family? Please select from the choices below.	A (N = 81)	75.3	38.3	54.3	43.2	38.3	60.5	19.8	37.0	7.4	19.8
		B (N = 32)	68.8	31.3	40.6	25.0	31.3	37.5	15.6	9.4	0.0	3.1
		C (N = 33)	63.6	39.4	27.3	24.2	45.5	36.4	24.2	18.2	18.2	12.1
		D (N = 54)	44.4	9.3	24.1	18.5	22.2	42.6	11.1	7.4	5.6	11.1
		E (N = 55)	54.5	12.7	14.5	25.5	27.3	50.9	14.5	7.3	5.5	14.5
		Average	62.4	25.9	34.1	33.3	32.5	48.6	16.9	19.2	7.8	13.7
		$\chi^2$	15.42 **	22.84 ***	27.80 ***	11.65 *	7.06	9.04 <sup>†</sup>	3.28	25.89 ***	8.13 <sup>†</sup>	5.94

\*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ , <sup>†</sup>  $p < 0.1$ .

Figure 19 shows Q14, added a month after the class (asking if the children would like to repeat the group activity game conducted in Part 2), the responses were tabulated by assigning a score of 1 for Strongly Disagree, 2 for Disagree, 3 for Undecided, 4 for Agree, and 5 for Strongly Agree. The mean value by school is presented in Figure 7. In all schools, the mean value exceeded the score of 4, with many children wanting to repeat the activities. A one-way analysis of variance was conducted by using schools as a factor. As a result, the main effect was found to be significant ( $F(4, 250) = 4.81$ ,  $p < 0.001$ ), with the results of multiple comparison via the Bonferroni method showing School A being significantly lower than School C and D (in order,  $p < 0.05$ ,  $p < 0.01$ ).

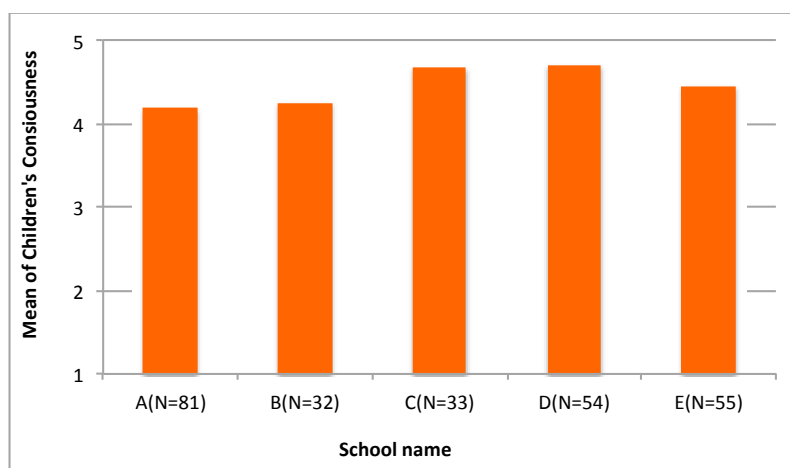


Figure 19. Group activity games interest levels.

## 4. Discussion

### 4.1. Temporal and Regional Differences

Concerning Q1 to Q3, all scores increased temporarily in all schools due to the disaster-prevention education program conducted in this study. However, the scores tended to return to their original values after one month. These are question items related to the sense of fear of natural disasters and perceptions of disaster risk. It was found that awareness of such threats from disasters can be heightened temporarily from one class, but that it was difficult for such a level to be sustained in the long term. This suggests that the fear of disasters raised by disaster education does not necessarily last long. Furthermore, geographical differences were also found. Fear of disasters and feeling that one might become injured was high at School D; fear that a natural disaster could occur in the region they live in was high at School C. School D is located inland within Fukushima prefecture and is a region that did not suffer direct damage from the Great Tohoku Earthquake; however, Fukushima prefecture is a prefecture that suffered significant damage from the earthquake, tsunami, and nuclear power accident during the Great Tohoku Earthquake. As such, it could be inferred that the elementary school students within this prefecture have a strong fear of disasters. Furthermore, School C is located in the coastal area of Wakayama prefecture and is a region that can expect great damage if the Nankai Earthquake occurs. Therefore, the estimation of the risk of disaster occurrence is believed to be high. On the other hand, the desire to acquire knowledge of the mechanisms which cause disasters (Q4) increased due to the disaster-prevention education program conducted during this study, with this high state maintained even a month later. Although the awareness of threat weakens with time, it was found that the desire to obtain knowledge of disasters remained, even after a month had passed. Therefore, it is concluded that this program has the effect of helping children to be continuously aware of the necessity of having knowledge of natural disasters.

Concerning the awareness of one's own and one's family's disaster responding ability, the children from Schools D and E differed from other schools in their feelings. These two schools share the commonality that neither the children nor their parents had experience of recent major disasters. After having taken the disaster-prevention education program, the children from these two schools had a lowered belief that they and their families could safely evacuate during disasters (Q5 and Q10), while their feelings that their family members might get injured (Q7) and the desire to inform their families of what they learned (Q8) strengthened. Furthermore, the feeling of need for making rules within the family (Q6) also became stronger (the need for rules also increased for Schools A and B). However, this change in awareness was temporary, with the tendency for this awareness to return to its original state a month later. A reason for this is that even if the children brought back home the content of a disaster-prevention class and wanted to discuss with their families, if the family did not want to take on board how the children felt and did not want to discuss what sort of measures to take, the communication became one-sided. If the children could not discuss with their families in detail and implement proper measures, their desire to share the content of disaster-prevention classes with their families and to create rules within the family, which had once strengthened, would rapidly decrease.

School C also showed a different and interesting characteristic from other schools. School C is located near the Nankai Trough, which is said to be approaching a large-scale earthquake and tsunami occurrence period. Therefore, it has a regional characteristic of having a high likelihood of suffering major damage from earthquake and tsunami. For this reason, the estimation of disaster occurrence risk in the residential area (Q3) was higher than at the other schools, with students feeling the need to create rules for during disasters among the family (Q6) and confidence in protecting one's own life during a disaster (Q11) increased one month after the class. The reason behind this is that the local community itself believes that they will suffer severe damage if they do not set up any measures against earthquakes and tsunami, with the municipalities frequently informing the residents that they are in a region that is geographically at risk, in addition to the school perhaps providing follow-up lessons to the disaster-prevention class. This resulted in an interaction effect with the disaster-prevention education conducted during this study, which appeared in the survey result conducted a month later.

From Q12 and Q13, conducted a month after the classes, it was revealed that 93% of the attending children actually discussed the issue with their families, or took on coping behaviors. The disaster-prevention education program affected even the children's behavior in their homes. By item, it was revealed that the most common item was confirming with their families where their evacuation place would be. Naturally, where to evacuate in the event of a disaster striking was deemed to be important. The item that was most commonly discussed next was the possessions that each person will carry. This revealed that it was commonly understood that, during disasters, people would have to live inconveniently without having access to proper resources. The two items listed in Q12 and Q13 that were selected the least were checking the hazard map and the treatment of pets. Since some households do own a pet while others do not, this item may not have been applicable to some households; unfortunately this problem was not identified prior to the fieldwork, but any future study using the same item in a similar questionnaire will need to add a check question asking the children if there are pets in their household. In contrast, the low level of interest in hazard maps raises an important issue for hazard education. Although hazard maps are important tools for professional workers in hazard management and disaster risk reduction, and public guidance states that frequent checking and discussion is important even within the school and the local community, the results of Q12 and Q13 reveal that this does not often take place within households or among children. It seems from our study that for children of 10–11 years of age, disaster education using hazard maps is difficult and of limited practical benefit in terms of promoting effective disaster mitigation behaviors. A similar conclusion was reached by Haynes and colleagues (2007) from the results of public workshops, such as one that used 3D maps to educate participants in which side of an island is more dangerous in case of a volcano eruption on Caribbean islands. While those who had received more education could easily interpret hazard maps to reach the correct conclusion on this, the same task was difficult for a group

that was less educated [45]. Thus, combining hazard and disaster education with topography and geographical knowledge education, to enable the children to better understand and appreciate hazard maps, is considered necessary in the future [46].

#### 4.2. Other Regional Differences

Furthermore, there were clear differences between regions concerning this item. Although this was emphasized to an extent in coastal regions, not very many children in inland regions picked out this item concerning hazard maps. Although sediment disaster alert areas do exist, it was found that awareness of checking the hazard map and estimating the region's disaster risk was low. Furthermore, there were regional differences in the degree to which families discussed or adopted coping behaviors, with children from Schools A and C discussing and adopting coping behaviors with family members at a relatively high rate. Schools D and E had a lower percentage compared to other schools. As mentioned previously, School A had received 3850 evacuees immediately after the Great Tohoku Earthquake, which means that children and their parents or guardians have seen or heard about the afflicted areas within regions extremely close to theirs. This, in turn, is believed to have led to discussion and coping behavior within the family. Similarly, with School C, as mentioned previously, both the children and their parents or guardians are engaged in various advocacy activities believing that a major disaster will strike in the future for certain. If children talk about the disaster-prevention classes they took, the parents or guardians will listen to them, which is believed to have led to discussion and taking corresponding action. On the other hand, Schools D and E have not experienced direct damage and have not seen disaster-afflicted areas within their everyday lives, and the regional properties whereby the children's parents' generation has not experienced a major disaster make such discussions difficult within families, making them less likely to adopt actual disaster-prevention measures.

Concerning the children's interest level in group activities (Q14), it was inferred that children participated in group activity games with interest and enjoyed them. There were two types of group activity games: the FD game and the stamp rally. School A, which used the FD game, showed that the children were less interested in trying the activity again compared to the other schools that did stamp rallies. This means that the stamp rally was rated higher among the children. This could be attributed to that fact that rather than being a group activity that is conducted by sitting still in one location, the stamp rally involved movement (e.g., stamping and going as a group to different tables that have questions and stamps), which could have made children think the stamp activity was fun. Furthermore, this activity resulted in a product in which colorful stamps with great designs were lined up on the cardboard, which is also believed to have led to the high evaluation from the children.

#### 4.3. Indications for Future Studies

In this study, five schools with different regional characteristics were studied, with results showing that the effect of the disaster-prevention education program differed in accordance with the different regional characteristics. Regions that did not have direct damage from disasters but saw significant damage in their vicinity (Schools A and B) had an easy time envisioning the disaster, with the strengthening of the awareness of threats from disasters and disaster prevention from disaster-prevention education seen. However, if the sense of threat of future disaster was not high, this effect did not seem to be sustained for long. On the other hand, a region that did not have any experience of disasters, but is predicted to suffer from a great disaster in the future (School C), had a strong image of future disaster and found it easy to maintain the effects from disaster-prevention education. Regions that did not experience disasters directly and whose neighboring regions did not suffer any damage (Schools D and E) saw an increase in the awareness of threat of disasters from disaster-prevention education, in addition to a decrease in the confidence in one's own evacuation ability and a strengthening of their feelings toward family due to this effect. However, perhaps because of the lack of knowledge, such effects were merely temporary without a proper follow-up. This is because, as Tversky and Kahneman (1974) say, people make estimates by starting from an initial

value that is adjusted to yield the final answer [47]. In particular, in the context of disaster-prevention education, it is necessary to raise this initial value, because types and features of disaster risk vary depending on the region.

In this research, we developed a disaster-prevention education program, put it into practice, and investigated the effect of our proposed disaster education method in five elementary schools with different regional characteristics (including partially different activities in one school). We also examined differences in the educational effects at each school while relating them to the school's regional characteristics. However, this research is an exploratory study and cannot sufficiently control various factors affecting the results. In order to strongly verify the regional characteristics that affect the effectiveness of disaster-prevention education, in the future, it will be necessary to conduct and measure the effectiveness of the proposed educational program in at least two schools that have the same regional characteristics.

#### 4.4. Recommendations for Future Studies

According to this research, students showed high interest in disaster-prevention education using concrete learning tools. In addition to text-based education, school education should incorporate group work using such tools. Schools should devise ideas for children to focus on learning by themselves and to positively improve awareness. This initiative can foster a sense of disaster prevention for children unfamiliar with the earthquake disasters that will increase in the future.

Future research also requires developmental studies of versatile tools that can be implemented at many schools. The sustainability of disaster reduction consciousness was found to differ depending on the regional characteristics where a school was located. Regarding this point, we can develop research that collaborates with human science and disaster science fields, such as those investigating characteristics of local life and culture. In any case, it is desirable to sustain research that reflects changing social conditions. This new education program can also possibly be used as an educational tool in English and, therefore, be delivered to other disaster-affected areas in other countries.

**Acknowledgments:** This project was supported by the Tohoku University Foundation (Disaster reduction education research subsidy fund). The research into disaster mitigation consciousness was supported by the Grant-in-Aid for Challenging Exploratory Research (15K12717). The authors are thankful to our participants and the Boards of Education of Iwate, Miyagi, Fukushima, and Wakayama that supported the selection of the schools. The authors are also thankful to the Tohoku University Public Relations Division. The author is especially grateful to Tatsuro Sugai, Kei Sato, Sachiko Watanabe, Hideki Sato, and Rumiko Ishizawa for their help in this project. The authors are also thankful to the Sendai Broadcast Corporation and the Shachihata Inc. Corporation, which co-developed the stamp. The authors are also thankful to the Tokio Marine & Nichido Fire Corporation. The authors would like to thank Anawat Suppasri, Fumiyasu Makinoshima, David Nguen, and Maly Elizabeth, for helpful comments, and Akiyoshi Hara and Fumihiko Imamura, who supported the activities of the YUI project. The authors would especially like to thank the reviewers; their comments helped to improve the article considerably.

**Author Contributions:** Toshiaki Muramoto, Rui Nouchi, and Mari Yasuda conceived and designed the experiments; Mari Yasuda performed the experiments; Toshiaki Muramoto analyzed the data; Mari Yasuda wrote the paper.

**Conflicts of Interest:** The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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