Behavioral Impact of Disaster Education: Evidence from a Dance-Based Program in Indonesia

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6 August 2019

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Abstract

Despite its potential role in reducing disaster mortality, the rigorous evaluation of the impact of disaster education on children's disaster responses, such as evacuation behavior, is scarce. This study examines the impact of a newly introduced Indonesian program on students' earthquake response. The program is carefully designed based on psychological theories and anecdotal lessons from different countries. It is also easy to understand and cost-effective. Exploiting the fact that the treatment schools for the pilot program were selected based on two observable criteria, we employ the propensity score weighting estimation. The results show positive effects on perception regarding students' ability to cope with disaster risk and likelihood of taking appropriate response during an earthquake. The participants are also more likely to self-learn and have higher knowledge of disaster risks. Furthermore, there exists a significant effect on earthquake response even among students with poor learning attitude at school. This feature is preferable for disaster education in developing countries, as those residing in disaster-vulnerable areas tend to have poor educational background.

Keywords: disaster education, disaster response, non-formal education, Indonesia

JEL Codes: I25; Q54; O53

Funding Source: This study is supported by Japan Society for the Promotion of Science KAKENHI Grants Number 16K03657 (PI: Masahiro Shoji).

Acknowledgements: The authors would like to thank Yukichi Mano, Mai Seki, Izumi Yamasaki, and seminar participants at JICA and Japanese Economic Association. The usual disclaimers apply.

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Declaration of interest: none

1. Introduction

Natural disasters cause immense loss of human lives. Between 1996 and 2015, 1.35 million people have been killed by 7,000 natural disasters worldwide, of which 56 percent are victims of earthquakes and tsunamis (UNISDR and CRED 2016). Given the significance of this issue, the Sustainable Development Goals aim to reduce the number of disaster victims through disaster education. The urgency and importance of such programs is well-documented in the literature (Izadkhah and Hosseini 2005; Shaw et al., 2015). Scholars contend that these programs significantly improve participants' disaster preparedness, such as attitude to, knowledge about, and behavior for preparation (Adiyoso and Kanegae 2012, Clerveaux et al. 2010, Faupel et al. 1992, Faupel and Styles 1993, Mishra and Suar 2012, Muttarak and Pothisiri 2013, Ronan et al. 2012, Ronan and Johnston 2001, 2003, Shaw et al. 2004, Soffer et al. 2010, Tanaka 2005).[1]

However, the literature leaves two issues unaddressed: First, most studies rely on a *before–after* comparison, while rigorous empirical studies are still scarce (Codreanu et al. 2014; Johnson et al. 2014; Ronan et al. 2015). Second, while the studies examine disaster preparedness, the impact on disaster response, such as evacuation behavior, is poorly understood (Codreanu et al. 2014). This is crucial because high-risk perception and knowledge do not guarantee appropriate response in an emergency, especially when cognitive biases strongly affect individuals' decision-making (Kahneman and Tversky 1972).[2]

We bridge these gaps in the literature by evaluating the impact of a newly introduced disaster education program in Indonesia—*Maena for Disaster Education*—on students' earthquake response. This program has been made compulsory in the elementary schools of South Nias Regency since 2019. The program has many intriguing features; it has been carefully designed based on psychological theories and anecdotal lessons drawn from different countries. It is especially made to be easily understood and cost-effective.

It is also enlightening to explore the earthquake response of Indonesian children because Indonesia

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[1] Disaster preparedness refers to pre-disaster activities that are undertaken within the context of disaster risk management and are based on sound risk analysis (UNISDR 2008).

[2] A cognitive bias is defined as a pattern of deviation in judgment that occurs in particular situations, leading to perceptual distortion, inaccurate judgment, illogical interpretation, or what is broadly called irrationality (Kahneman and Tversky 1972).

suffers from frequent earthquakes and tsunamis (Amri et al. 2017, Rafliana 2012). Between 1996 and 2015 alone, 180,000 human lives were lost due to disasters (UNISDR and CRED 2016).[3]

We also examine the heterogeneity of the program impact by analyzing students' learning attitude at school. This is critical in the context of developing countries, as disaster-vulnerable areas generally have less educated residents. If the program has impact only for students with better learning attitude, those who need the program most will be left behind. In fact, this may be plausible, given that learning attitude is positively associated with school performance (Osborne et al. 2003; Singh et al. 2002), while educational background is an important determinant of disaster preparedness and survival (Frankenberg et al. 2013; Gaillard and Mercer 2013; Hoffmann and Muttarak 2017; Muttarak and Pothisiri 2013).[4]

However, a challenge in evaluating a compulsory program is the difficulty in defining a suitable control group because all students in the area participate in the same program. A comparison with students from a different regency may be problematic, given their difference in socio-economic and geographic characteristics. We address this problem by analyzing the pilot program conducted in 2017–2018 only in a part of the regency. This allows us to compare the participants as well as other students in the same regency.[5] Furthermore, the treatment schools for the pilot program were selected based on only two criteria: distance from the coast and school size. We use this fact to assume the selection-on-observables, and employ the propensity score weighting (PSW) estimator of Hirano et al. (2003) combined with difference-in-differences (DID).[6]

The results show that the participants are more likely to recognize their ability to cope with disaster

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[3] This is the second highest in the world following Haiti. See Djalante and Garschagen (2017) for a comprehensive discussion on disaster damages in Indonesia.

[4] We examine the role of learning attitude rather than that of school performance because asking about the school performance, which could be a sensitive question for some students, may decrease the response rate of the survey and cause a sample selection bias.

[5] However, since the pilot program was conducted at schools near the coast, it may have a larger impact than the compulsory program. We discuss this issue in Section 6.

[6] A potential issue in this approach is the bias driven by unobserved heterogeneity at the school level. We test the severity of this issue in Section 6.

and respond to earthquakes appropriately. Upon sensing a quake, students' probability of taking an immediate response, such as moving under the table, is higher by 14.9 percentage points than the control school students. The program also has positive effects on students' self-learning behavior and knowledge. Finally, we find significant effects on earthquake response even among students with poor learning attitude.

The rest of this study is organized as follows: Section 2 describes our study site and details about Maena for Disaster Education. Sections 3 and 4 document our dataset and identification strategy, respectively. The estimation results are presented in Section 5, and Section 6 discusses the findings. Finally, Section 7 concludes.

2. Background

2.1. Study Site

Our study site is South Nias Regency in Nias Island, which is a part of North Sumatra Province, Indonesia.[7] This area is one of the most earthquake/tsunami-vulnerable areas in Indonesia (Badan Nasional Penanggulangan Bencana 2014). As shown in Figure 1, the island is located 100 km east of Sunda Trench, the boundary between the Eurasian Plate (Sunda Plate) and Australian Plate (Sahul Shelf). This location exposes the island to a high risk of earthquakes and tsunamis (Hsu et al. 2006). The region experienced severe damage from two devastating earthquakes in 2004 and 2005. In December 2004, the island was affected by the Indian Ocean Earthquake (magnitude 9.0), and the following tsunami caused 154 reported deaths and left 1,832 people missing. The Nias–Simeulue earthquake (magnitude 8.7) occurred three months after the 2004 tsunami, causing even more damage: reportedly 851 deaths with 6,278 missing people.

The damage from these earthquakes was exacerbated due to institutional, socio-economic, and cultural reasons. First, none of the schools in the island had disaster education in their curriculum at the time. Thus, the villagers' disaster preparedness was poor. Second, housings in rural areas are not quake-resistant. Finally, the residents of this region maintain a traditional culture influenced by an animism that perceives all

[7] In this island, 90% of the working-age individuals are farmers and 62% of the working-age individuals have only elementary education (Badan Pusat Statistik Kabupaten Nias Seltan 2017). Unlike the rest of the country, where 90% of the population is Muslim, Christians account for 80% of the population.

things—such as animals, plants, rocks, rivers, weather systems, and human handiwork—as possessing a spiritual essence and are, thus, alive. Hence, the villagers believe that discussing and preparing for future disasters will instead enrage their god, that is, lead to more natural disasters.

[Figure 1]

2.2. Maena for Disaster Education Program

In South Nias Regency, a unique disaster education program—Maena for Disaster Education—has been made compulsory in all elementary schools since 2019. In contrast to West Sumatra Province, where disaster education using evacuation drills has been part of the school curriculum since 2011, North Sumatra Province has never had such programs despite its high disaster risk. Maena for Disaster Education is, therefore, one of the first programs that were made compulsory in this province.

Maena is the traditional dance and song of Nias Island. The dance is simple and easy even for children to grasp. It is performed during special occasions, such as wedding and welcoming ceremonies. There are various types of Maena, such as thanksgiving for nature or welcoming the safe arrival of guests.

Maena for Disaster Education incorporates Maena in the one-year disaster education program. In this program, students first gain basic knowledge about the mechanism of disasters and appropriate responses via picture-card show, movies, lectures, and drills. Then, they create a unique Maena for each class that encourages prompt evacuation and disaster preparation. Further, these Maena are demonstrated at local events and ceremonies. More details about the program implementation are presented in Appendix.

Before this program was made compulsory, a pilot program was conducted between September 2017 and April 2018.[8] The program contents are exactly the same as the compulsory program, but it was conducted only at six elementary schools in the regency. The treatment schools for the pilot program were selected based on only two criteria: distance from the coast and school size. As we show below, the average

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[8] The compulsory program is implemented by the regency government. However, the pilot program was originally designed by a research team of Wako University in Japan, funded by Japan International Cooperation Agency (JICA) as a Grassroots Technical Cooperation Projects, and implemented by a local NGO, Yayasan Obor Berkat Indonesia.

school is located 320 meters away from the coastal line and has 266 students. These targeting criteria aim to provide disaster education to as many students exposed to a high tsunami risk as possible. While the head of school can determine the grade at which disaster education is incorporated in the compulsory program, the lessons were taught to the fourth and fifth graders in the pilot program.

2.3. Conceptual Framework

We now summarize the extant theoretical arguments on the determinants of disaster response, and follow with a discussion on how Maena for Disaster Education could influence children's earthquake response. Among the psychological theories, the protection motivation theory suggests that high risk perception and perceived ability to cope with disaster are essential for individuals to prepare for and respond to disasters (Becker et al. 2014, Mulilis and Lippa 1990, Rogers 1975, Rogers and Prentice-Dunn 1997). Risk perception describes how a person assesses a threat's probability and potential damage if he/she does not take any response. It is determined by perceived probability, perceived severity, fear, and perceived reward from maladaptive responses.[9] On the other hand, the perceived coping ability is characterized by the perception of the effectiveness of a protective response (response efficacy), ability to take the response (self-efficacy), and cost of taking the response. This model is consistent with individuals' behavioral patterns observed in previous studies (Becker et al. 2014; Grothmann and Reusswig 2006; Mulilis and Lippa 1990).

However, people may not be able to maintain high perceptions for disaster risk and coping ability during an earthquake. Unlike hurricanes and floods, whose disaster impact is announced beforehand and people have enough time to make evacuation decisions, it is impossible to predict the timing of an earthquake or a tsunami, forcing people to respond immediately. Decision-making during such events is, thus, subject to various cognitive biases (Kahneman and Tversky 1972). In particular, the normalcy bias causes children to underestimate the probability and severity of disaster damage, while the abnormalcy bias causes them to underestimate their coping ability (Drabek 1986; Omer and Alon 1994; Perry et al. 1982).

[9] Dash and Gladwin (2007) propose that six factors—namely, socio-economic factors, experience factors, trust of authority, disaster knowledge, home characteristics, and message—interactively determine individuals' risk perception and, therefore, evacuation decision.

Both biases lower the likelihood of taking immediate response even among those who normally have high risk perception and perceived coping ability.

Hence, compared with floods and hurricanes, disaster education programs for earthquakes and tsunamis are required to have particularly larger effects on the participants' risk perception and coping ability. Maena for Disaster Education has three intriguing features to expect such effects. First, it is designed based on anecdotal lessons from various countries, such as from Japanese students who successfully evacuated during the 2011 tsunami.[10] This raises the participants' perception of their coping ability. Second, since the students learn about earthquake/tsunami response through songs and dances, it is easy even for those with poor reading ability to understand the program contents. Finally, psychological theories, such as cognitive ease (Kahneman and Egan 2011) and cognitive fluency (Reber et al. 2004), predict that students unconsciously gain a positive impression of the contents of disaster education and easily recall it even in an emergency when schools use a framework that is familiar to students (e.g., Maena). Moreover, the students can learn more if they enjoy the program (Pekrun 1992).

3. Dataset

3.1. Survey Design

We conducted a unique survey with students of 12 elementary schools: six schools conducting the pilot program (treatment schools) and the other six without the program (control schools). All the schools were located in South Nias Regency. Given the small number of survey schools, the estimation results could be sensitive to confounders at the school level. Therefore, the control schools were carefully selected to minimize the difference in observable characteristics with the treatment schools. In particular, following the selection criteria for the treatment schools, we also selected the control schools based on the distance from the coast and school size. The location and basic characteristics of the schools are presented in Figure A1

[10] The program is also designed based on the lesson from the Simeulue Island in Indonesia. The island has an oral history that encourages prompt evacuation to the upland upon sensing an earthquake. Because of this, most villagers in the coastal areas reacted appropriately in the 2004 tsunami and, consequently, only seven villagers were killed, even though the island is located only 60 km from the epicenter (McAdoo et al. 2006).

and Table A1, respectively.

The baseline survey was conducted with the fourth, fifth, and sixth grade students in September 2017. We sampled 1,112 students and obtained 963 responses.[11] The questionnaire elicits information on perceptions toward disaster risk and coping ability, disaster preparedness, response to recent earthquakes, attitude to learning science, and demographic and socio-economic characteristics of the household. After the disaster education program, we also conducted an endline survey in April 2018 to elicit the post-treatment outcomes; 843 of the 963 students participated in the survey, that is, 268 fourth grade students, 285 fifth grade students, and 290 sixth grade students.

Columns (1) and (2) of Table 1 present the characteristics of fourth and fifth grade students.[12] It appears that the treatment school has significantly larger number of students than the control schools, as expected. However, the student characteristics are mostly balanced between the schools except for the marginal difference in the attitude to learning science.[13]

[Table 1]

3.2. Outcome Variables

Our main dependent variables are perception of and response to an earthquake. The former outcomes include perception of (1) the severity of tsunami risk (risk perception), (2) the effectiveness of disaster preparation (response efficacy), and (3) the effectiveness of discussing how to cope with disasters (efficacy of discussion). The latter outcomes consist of (4) whether students take any immediate response when

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[11] The non-response rate is 13%, mainly because some students could not commute to the school on the survey day due to heavy rain.

[12] As mentioned in Section 2, the disaster education program covered only the fourth and fifth grade students.

[13] The students' attitude to learning science is elicited by the following question: *Do you generally have fun when you are learning science at school?* The answer options include (1) *Not at all*, (2) *Not very much*, (3) *Unsure*, (4) *Somewhat*, and (5) *Very much*. This is a modified version of the question used in Program for International Student Assessment 2015 (PISA). Given that 56% of students answered (5), we define a student to be interested in science if his/her answer is (5) in this study.

feeling an earthquake, such as moving under the table (immediate response), and (5) whether they consider the risk of tsunami and evacuate to a safe place after the quake (evacuation). In addition to these outcomes, we examine the self-learning behavior toward and knowledge about disasters for robustness in Section 6. The self-learning variables include learning from (6) the media, (7) family, and (8) neighbors. The knowledge includes (9) whether the student knows the location of the evacuation spot and (10) whether their parents know the spot. Table 2 documents the definition of each outcome variable.

Table 3 presents the summary statistics of the outcomes before and after the treatment. Column (1) shows that 72.3% of the fourth and fifth graders were aware of the tsunami risk before the program, and 75.3% perceive that they can mitigate the disaster damages if they prepare. Nonetheless, only 37.0% recognize the importance of discussing how to cope with disasters, presumably because of their belief that such a discussion will cause god's wrath, as discussed in Section 2.1. These patterns are common for both the treatment and control schools at the pre-treatment period (Columns [4] and [7]).

After the program intervention, most outcomes significantly improved among the treatment school students (Columns [2] and [3]), but not among the control school students (Columns [5] and [6]). Consequently, we find significant differences in the outcomes between the schools at the post-treatment period (Column [8]). Regarding the sixth-grade students who were not covered in the program, we find unstable patterns across outcomes regardless of the treatment.

[Table 2]

[Table 3]

4. Identification Strategy

Our identification strategy exploits the feature wherein the treatment schools were selected based only on the distance from the coast and school size. Therefore, assuming the selection-on-observables, we employ the propensity score weighting (PSW) of Hirano et al. (2003) and difference-in-differences (DID) estimators.[14] PSW controls for the difference in observable characteristics between the treatment and

[14] An alternative approach is the entropy balancing model, which nonparametrically reweights the control group such that its descriptive characteristics match those of the treatment group (Hainmueller 2012).

control school students. The use of DID eliminates the effects of time-invariant unobservable characteristics, such as the geographic characteristics and school characteristics. Although this approach is frequently used in the literature on program evaluation (Chen et al. 2009; Deininger and Liu 2013; van de Walle and Mu 2007), to the best of our knowledge, it has not been applied for the evaluation of disaster education.

Given that the program covered only the fourth and fifth grade students of the treatment schools, we use the samples of these graders to estimate the following weighted least square model;[15]

$$Y_{igs1} - Y_{igs0} = \beta_0 + \beta_1 Treat_s + \beta_2 X_{igs0} + \beta_3 School_s + \varepsilon_{igs}, \qquad (1)$$

where Y_{igst} is the disaster perception and response of student i in grade g of school s at period t (t=0, 1). Subscript t=1 is the post-treatment period and t=0 is the pre-treatment period. $Treat_s$ takes unity if Maena for Disaster Education was conducted in school s, and zero otherwise. X_{igs0} denotes the pre-treatment student characteristics: attitude to learning science, disaster experience of the student's parents in 2004 and 2005, and socio-economic status. Finally, $School_s$ includes the school characteristics: school size and distance from the coast. We employ the standard error clustered at the classroom level to correct for the correlation of residuals among the classmates.

In this equation, the observations are weighted by $1\ \hat{p}$ for the treatment school students and $1\ 1-\hat{p}$ for the control school students, where $0 < \hat{p} < 1$ is a consistent estimate of the propensity score for being a treatment school student: $\Pr\left(Treat_s = 1 \middle| X_{igs0}, School_s\right)$. The weighting reduces the influence of control school students with very different characteristics from the treatment school students. Hirano et al. (2003) show that weighting the observations this way yields an efficient estimator. Further, following Chen et al. (2009), Deininger and Liu (2013) and Jayachandran (2014), we also estimate the model using the trimmed samples with the propensity score between 0.1 and 0.9 for robustness.

However, given the small number of survey schools, we cannot employ this approach.

[15] Considering the structure of our dataset, it might be more straightforward to estimate the difference-in-differences-in-differences (DDD) model, which exploits two sets of control groups: fourth and fifth grade students in the control schools and sixth grade students in the treatment schools. However, it underestimates the treatment effect if there is a spillover effect on either set of the control groups, like our case. Since the contents of disaster education include a demonstration of Maena at school events, the sixth-grade students in the treatment schools might also benefit from the program.

A remaining issue in this model is the potential bias driven by time-variant unobserved characteristics. We address this issue in Section 6.

5. Results

5.1. Estimation of Propensity Score

Column (1) of Table 4 presents the Logit result for being a treatment school student. We find significant coefficients of both school characteristics. It also appears that the student characteristics—such as attitude to learning science, age, household head characteristics, and religious background—are statistically significant. The Kernel density of the estimated propensity score is depicted in Figure 2. We use this result to compute the propensity score weight.

Column (2) presents the result of the Logit model with the observations being weighted by the propensity score weight. Most coefficients become smaller and insignificant, but we still find a significant association with school size, age, occupation of head, and religion. Finally, in the weighted and trimmed model of Column (3), we restrict the observations with the estimated propensity score set between 0.1 and 0.9 to estimate the weighted logit model.[16] Most importantly, the pseudo R^2 decreases from 0.62 in Column (1) to 0.25 in Column (2) and 0.02 in Column (3). The point estimates also become even smaller, and their statistical significance mostly disappears in Column (3), although this may be partly attributed to the reduction of sample size. Finally, in Columns (3) to (6) of Table 1, we conduct the balancing test using the weighted and trimmed samples. It is confirmed that the covariates are balanced. These results support the validity of our identification strategy.

[Table 4]

[Figure 2]

5.2. The Impact on Perceptions and Earthquake Response

In Table 5, we show the impact of disaster education on students' perception of disaster risk and coping

[16] Since the region of common support is (0.04, 0.95) for our data, this model chooses an even tighter interval.

ability. The table reports three models for each outcome: DID, DID-PSW, and DID-PSW using the trimmed sample.

First, unlike previous studies such as Shiwaku et al. (2007), participation in disaster education does not affect the students' risk perception. This is presumably because the study site is prone to earthquakes and tsunamis, and the risk perception may be high enough even without the disaster education program, as shown in Table 3. By contrast, we find that the program participants are more likely to recognize the efficacy and importance of preparing for natural disasters and discussing how to cope with them. In the weighted and trimmed models, the estimated effects are 15.0 percentage points (Column 6) and 23.9 percentage points (Column 9), respectively. These findings are intriguing, particularly in the context of Indonesia, where the poor response efficacy driven by religious belief has long been a concern for policymakers (Ghafory-Ashtiany 2009; Lavigne et al. 2008).

Table 6 shows the main result of this study: the impact on earthquake response. Between the surveys in September 2017 and March 2018, our study site experienced 226 earthquakes, including 12 earthquakes sensed by the people. Particularly, the largest earthquake on March 1 recorded a magnitude of 5.7. According to our field interviews, although the quake lasted only for a short period, it was large and some villagers evacuated to a safer place. The estimation results show that, when these earthquakes occurred, the participants were more likely to respond immediately, such as moving under the table, than the non-participants by 14.9 percentage points (Column 3). This is robust across the estimation models. By contrast, the program does not necessarily encourage the participants to consider the tsunami risk and evacuate to a safe area (Columns 4 to 6).

Combining the findings from Tables 5 and 6 suggests that the program encourages an immediate earthquake response by changing the participants' perception about their ability to cope with the earthquake shock and making them aware of the importance of discussing how to cope with the shocks. For robustness, we further explore the underlying mechanisms of behavioral impact in Section 6.

[Table 5]

[Table 6]

5.3. Heterogeneous Effects

Although we have shown a significant and large treatment effect, some students may benefit from the program less than the others. Specifically, previous studies suggest that fewer years of schooling and poorer learning attitude at school lead to poorer performance in disaster preparedness and response (Gaillard and Mercer 2013; Hoffmann and Muttarak 2017; Muttarak and Pothisiri 2013; Shoji et al. 2019). Similarly, if the disaster education does not have an impact for students with poor learning attitude/performance, those who need the program most will be left behind because disaster-vulnerable regions in developing countries generally have less educated residents.

To explore this issue, we examine the interactive effect of disaster education and learning attitude at school. We examine the roles of learning attitude rather than that of school performance because asking about the school performance, which is a sensitive question for some students, may decrease the response rate of the survey and cause a sample selection bias. In addition, many studies confirm that these are positively and strongly correlated (Osborne et al. 2003; Singh et al. 2002). Table 7 demonstrates that the program has positive effects on the outcomes, including immediate response, even among the participants with poorer learning attitude at school. This is presumably attributed to the unique features of this program, as discussed in Section 2. Although the estimated coefficient is negative and marginally significant in the weighted regression model of evacuation behavior, this is not robust in the trimmed sample.

[Table 7]

6. Discussion

6.1. Selection on Unobservables

Our results may be biased if there are unobserved *time-variant* characteristics that are correlated with both the outcomes and the treatment variable. To assess the severity of a potential bias, we conduct two types of tests: First, we test whether the pre-treatment outcomes are balanced between the treatment and control school students even after controlling for the observables. The second test estimates Equation (1) with the sample of sixth grade students. Their geographic, community, and school characteristics are the same as the fourth and fifth grade students, but they did not participate in the program. Hence, if these unobserved characteristics do not drive the positive correlation between the students' outcomes and the treatment, the coefficient of the treatment school should be insignificant in this test. It should be mentioned that the program impact might spillover to the sixth-grade students in the treatment schools (see Section 2), leading to a positive coefficient even without the unobserved characteristics. Nonetheless, this issue should not affect the validity of the falsification test as long as the estimated coefficient is statistically insignificant or negative.

Tables A2 and A3 present the results. Table A2 confirms balanced pre-treatment outcomes between the schools even after we weighted and trimmed the sample. Table A3 also shows that, with the sample of sixth-grade students, none of the coefficients is significantly positive, while one of them yields a negative coefficient. We interpret these results as strong supporting evidence of our identification strategy.

6.2. Impact on Self-Learning Behavior and Knowledge

The findings in Section 5 suggest that disaster education encourages an earthquake response because such a program educates the participants about the importance of learning suitable earthquake responses and the efficacy thereof. In this section, we explore this possibility by estimating the impact of disaster education on self-learning and knowledge about disaster response. The outcome variables are defined in Section 2 and Table 2.

In Tables A4 and A5, we confirm that the program has positive effects on these outcomes. The program increases the likelihood of communicating about natural disasters with family members by 12.0 percentage points and with neighbors by 19.8 percentage points in the weighted and trimmed model (Columns [6] and [9] of Table A4). Furthermore, they are more likely to know the location of the evacuation spot for tsunami by 34.5 percentage points, and they are also more likely to be assured that their parents know the spot by 18.3 percentage points (Columns [3] and [6] of Table A5). These results lend support to our main findings.

6.3. External Validity

Since the pilot program was conducted only in large schools near the coast, the participant characteristics might differ between the pilot and compulsory programs in terms of, for example, parents' disaster experience and pre-treatment risk perception, thus affecting the magnitude of program impact (Mulilis et al., 1990). Admittedly, it is a challenge to rigorously identify the extent of this gap due to data limitations. However, as suggestive evidence, we discuss the potential severity of this issue by examining the extent to which the treatment effect varies with the distance between the school and coast as well as parents' disaster experience.

In Table A6, we examine the heterogeneity of the treatment effects between the schools located within 200 meters from the coast and more than 200 meters. Intriguingly, we find significant treatment effects on the response efficacy, self-learning from neighbors, and knowledge even among the schools located far away from the coast, although the impact on earthquake response becomes insignificant.

Table A7 presents the heterogeneity with parents' disaster experience. The program impact is larger and robust among the students whose parents have experienced previous disasters. However, even among the students without parents' disaster experience, we still find significant treatment effects on the response efficacy, self-learning from neighbors, and knowledge of the evacuation spot. Furthermore, we find an improvement in the risk perception, which was not observed in the full sample result. These results suggest that the compulsory program is beneficial even for students in the inland area.

7. Conclusions

This study evaluated the behavioral impact of a newly introduced disaster education program in Indonesia, namely, Maena for Disaster Education. Our main finding is that the program significantly increases the probability of taking an appropriate response to earthquakes. We find significant and large impact even for students with poor learning attitude at school. This is an important feature for a disaster education program, since those residing in disaster-vulnerable areas in developing countries generally have poor educational background. We also find that the program makes the participants aware of their coping ability, encourages self-learning behavior, and improves knowledge about disaster response.

Previous studies acknowledge the difficulty of taking appropriate response during earthquakes due to cognitive biases. Therefore, the large and significant impact of this program is insightful for policymakers.

Another preferable feature of this program is its cost-effectiveness; unlike the other education programs, it does not require expensive software or equipment. This program can be established easily if there is a traditional dance or song in the area. Therefore, this program could be an effective tool to reduce the mortality risk of children caused by earthquake and tsunami.

Appendix: Implementation of the Pilot Program

The main contents of Maena for Disaster Education are the following workshops and final contest;

For school staffs

Workshop 1: Meeting with the school staffs to share the importance of disaster education

Workshop 2: Making the annual plan for the disaster education program

Workshop 3: Determining the school staffs in charge of the disaster preparation, evacuation route, and means of communication in an emergency

For students

Workshop 4: Guidance for how to create Maena for Disaster Education

Workshop 5: Disaster education to the students by conducting lectures and picture-card show

Workshop 6: Conducting evacuation drill and demonstration of their Maena for Disaster Education

Final Contest: Contest of Maena for Disaster Education among the six treatment schools

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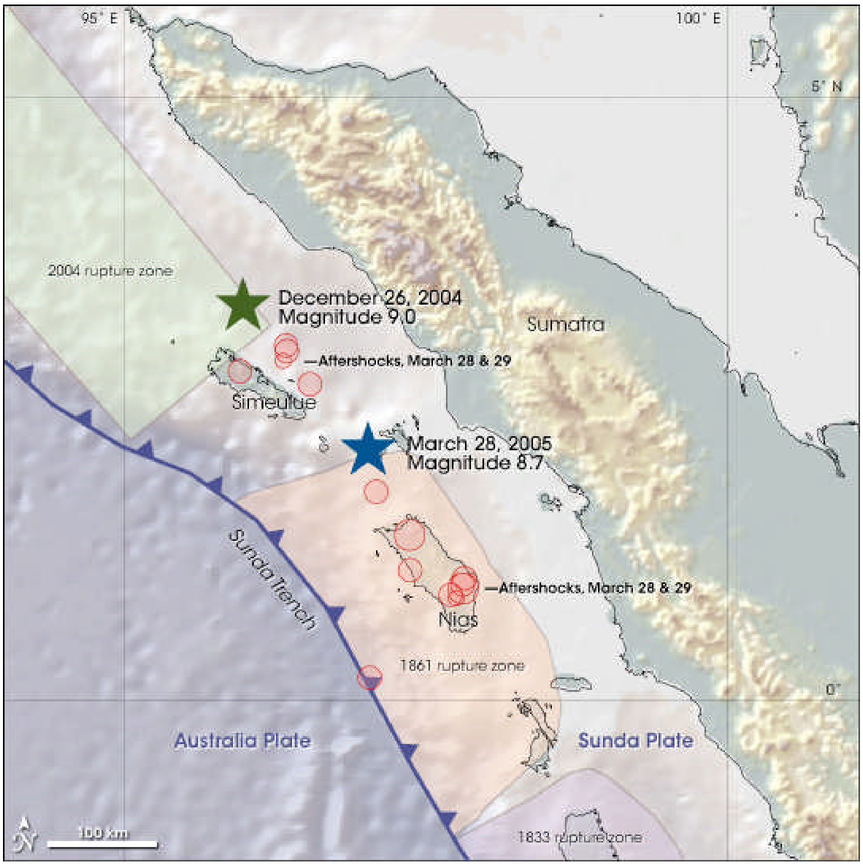

Source: NASA (https://earthobservatory.nasa.gov/images/5375/massive-earthquake-along-the-sunda-trench)

Figure 1: Nias Island and Epicenters of the 2004 and 2005 Earthquakes

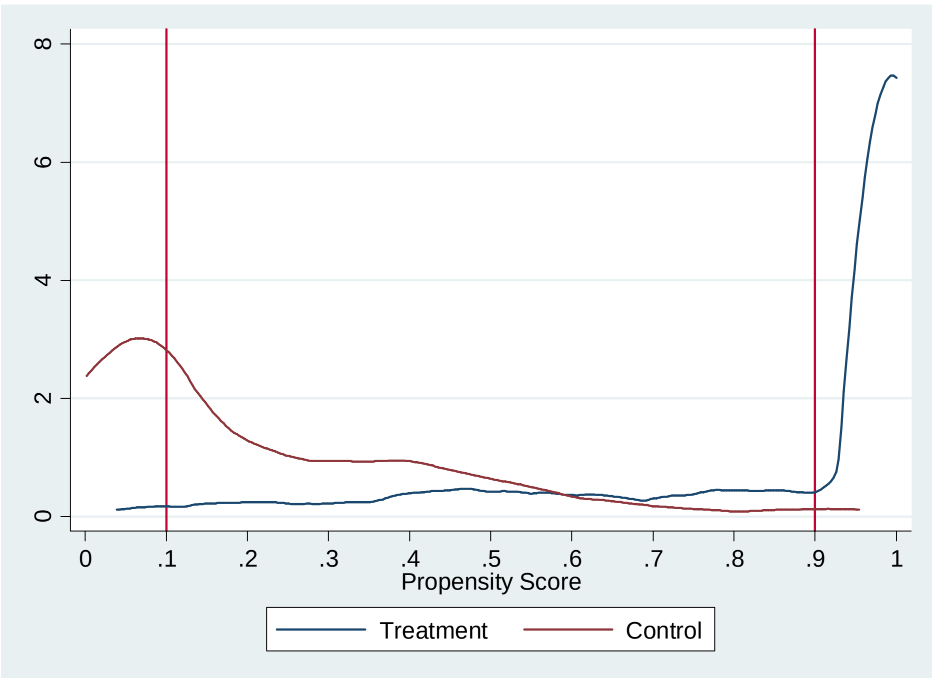

Figure 2: Kernel Density of Propensity Score

Table 1: Summary Statistics of Pre-Treatment Student Characteristics

School:	Treat (1)	Control (2)	Diff.	Treat (3)	Control (4)	Diff.	Treat (5)	Control (6)	Diff.
Distance from school to coast (km)	0.335	0.549		0.344	0.453		0.463	0.499	
	(0.257)	(0.434)		(0.286)	(0.424)		(0.361)	(0.417)	
School size (x10^3 students)	0.265	0.169	***	0.230	0.175	**	0.180	0.183	
	(0.063)	(0.039)		(0.071)	(0.034)		(0.038)	(0.027)	
1 if interested in science	0.611	0.471	*	0.468	0.386		0.452	0.499	
	(0.488)	(0.500)		(0.500)	(0.488)		(0.500)	(0.502)	
1 if affected in 2004/2005	0.364	0.312		0.331	0.309		0.343	0.371	
	(0.482)	(0.464)		(0.471)	(0.463)		(0.477)	(0.485)	
1 if there is a symbol of the past disasters in the village	0.485	0.457		0.481	0.478		0.417	0.432	
	(0.501)	(0.499)		(0.500)	(0.501)		(0.496)	(0.497)	
1 if boy	0.482	0.516		0.534	0.515		0.549	0.544	
	(0.500)	(0.501)		(0.500)	(0.501)		(0.500)	(0.500)	
Age of student	9.235	9.002		9.105	9.173		9.084	9.008	
	(0.989)	(1.064)		(0.930)	(1.269)		(0.949)	(1.135)	
1 if fourth grade	0.467	0.511		0.437	0.515		0.494	0.484	
	(0.500)	(0.501)		(0.497)	(0.501)		(0.503)	(0.502)	
1 if agricultural household	0.530	0.502		0.502	0.452		0.566	0.619	
	(0.500)	(0.501)		(0.501)	(0.499)		(0.498)	(0.488)	
1 if fishery household	0.123	0.127		0.141	0.134		0.113	0.107	
	(0.330)	(0.333)		(0.348)	(0.341)		(0.319)	(0.310)	
1 if household head is literate	0.777	0.760		0.793	0.743		0.688	0.702	
	(0.417)	(0.428)		(0.405)	(0.438)		(0.466)	(0.459)	
1 if own boat	0.145	0.186		0.188	0.245		0.223	0.173	
	(0.352)	(0.390)		(0.391)	(0.431)		(0.419)	(0.380)	
1 if own land	0.717	0.715		0.757	0.725		0.722	0.711	
	(0.451)	(0.452)		(0.429)	(0.448)		(0.451)	(0.455)	
1 if own car	0.157	0.136		0.181	0.210		0.148	0.156	
	(0.364)	(0.343)		(0.385)	(0.408)		(0.357)	(0.364)	
1 if own bike	0.759	0.774		0.794	0.794		0.756	0.742	
	(0.428)	(0.419)		(0.405)	(0.405)		(0.432)	(0.439)	
1 if own TV	0.711	0.674		0.707	0.714		0.667	0.647	
	(0.454)	(0.470)		(0.456)	(0.453)		(0.474)	(0.480)	
1 if Catholic	0.274	0.231		0.286	0.212		0.296	0.313	
	(0.447)	(0.422)		(0.453)	(0.410)		(0.459)	(0.466)	
1 if non-Christian	0.172	0.154		0.178	0.318		0.330	0.229	
	(0.378)	(0.362)		(0.383)	(0.467)		(0.473)	(0.422)	
Weighting	No	No		Yes	Yes		Yes	Yes	
Trimming	No	No		No	No		Yes	Yes	
Observations	332	221		332	221		89	117	

The samples of fourth and fifth grade students are used. Standard deviations are in parentheses. Mean difference is tested based on the standard error clustered at the classroom level. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 2: Description of Outcome Variables

Variable Name		Question and Answer Options	Definition of Dependent Variable
Perception			
[1]	Risk perception	If a tsunami would occur, do you think the waves would hit your house? 1. Not at all 2. Somewhat 3. Very much 4. Don’t know	Dummy for answering 2 or 3.
[2]	Response efficacy	Do you believe that you can mitigate the damage from disasters if you are well prepared? 1. Not at all 2. Somewhat 3. Very much	Dummy for answering 2 or 3.
[3]	Efficacy of discussion	Do you think it is good thing to discuss how to cope with disasters? 1. Not at all 2. Somewhat 3. Very much	Dummy for answering 3.
Earthquake Response			
[4]	Immediate response	Since last September, have you ever taken any reaction(s) when you felt earthquakes at home? 1.Took reactions in the house (moving to a safer place in the house such as under the table, etc.) 2.Moved to a safer place outside the house. 3.Both 1 and 2. 4.No, because I thought nothing serious would happen. 5.No, because I didn't know what to do and where to go. 6. I have never experienced an earthquake. 7.Don't remember	1 if answering 1, 2, or 3.
[5]	Evacuation	Since last September, after feeling an earthquake, have you tried to evacuate a safe place considering the risk of tsunami? 1. Yes. 2. Never. Because I didn't imagine a tsunami will come. 3. Never. Because the earthquakes were small. 4. Never. Because I didn't know what to do and where to go. 5. I have never experienced an earthquake. 6. Don't remember	1 if answering 1.
Preparedness: Self-Learning Behavior			
[6]	Learning from media	Since last September, have you learned about disasters from TV/radio/internet/books/newspapers? 1. Yes 2. No 3. Don’t remember	Dummy for answering 1.
[7]	Learning from family	Since last September, have you learned about disasters from your family? 1. Yes 2. No 3. Don’t remember	Dummy for answering 1.
[8]	Learning from neighbors	Since last September, have you learned about disasters from your neighbors? 1. Yes 2. No 3. Don’t remember	Dummy for answering 1.

Preparedness: Knowledge			
[9]	Knowing evacuation spot	Do you know where the evacuation spot is in your neighborhood in the event of a tsunami? 1. Yes 2. No 3. Don't remember	Dummy for answering 1.
[10]	Parents knowing evacuation spot	Do your parents know where you would be evacuated in the event of a tsunami? 1. Yes 2. No 3. Don't remember	Dummy for answering 1.

Table 3: Summary Statistics of Outcome Variables

Grade:	Fourth and fifth grade								Sixth grade							
Schools:	Treatment			Control			Diff. T. and C.		Treatment			Control			Diff. T. and C.	
Period:	Before	After	Diff.	Before	After	Diff.	Before	After	Before	After	Diff.	Before	After	Diff.	Before	After
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Perception																
Risk perception	0.723	0.708		0.683	0.656				0.814	0.827		0.799	0.694	*		***
Response efficacy	0.753	0.828	**	0.787	0.719			**	0.827	0.801		0.806	0.836			
Efficacy of discussion	0.370	0.527	***	0.398	0.385			***	0.513	0.641	*	0.440	0.515			
Earthquake Response																
Immediate response	0.756	0.798		0.697	0.656			***	0.782	0.756		0.769	0.709			
Evacuation	0.361	0.482	**	0.303	0.348			**	0.468	0.397		0.418	0.351			
Self-Learning																
Learning from media	0.714	0.774		0.661	0.747				0.782	0.808		0.701	0.784			
Learning from family	0.581	0.717	**	0.633	0.674				0.788	0.712		0.746	0.731			
Learning from neighbors	0.425	0.476		0.480	0.380	**		*	0.474	0.391		0.440	0.478			
Knowledge																
Knowing evacuation spot	0.319	0.584	***	0.326	0.471	**		**	0.333	0.686	**	0.276	0.328			***
Parents knowing spot	0.383	0.500	***	0.407	0.416				0.417	0.455		0.336	0.336			
N	332	332		221	221				156	156		134	134			

Mean difference is tested based on the standard error clustered at the classroom level. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 4: Estimation of Propensity Score Using the Logit Model (Dep Var: 1 if treatment school student)

	(1)	(2)	(3)
Distance from the school to coast (km)	-4.672***	-2.294	-0.670
	(1.649)	(1.439)	(2.482)
School size (x10^3 students)	64.936***	27.718***	7.898
	(16.844)	(9.645)	(30.934)
1 if interested in science	1.423***	0.438	-0.030
	(0.423)	(0.485)	(0.263)
1 if affected in 2004/2005	0.699	0.056	-0.000
	(0.482)	(0.459)	(0.468)
1 if there is a symbol of the 2004/2005	-0.333*	-0.173	-0.234*
disasters in the village	(0.189)	(0.213)	(0.124)
1 if boy	-0.151	0.512	-0.223
	(0.205)	(0.340)	(0.139)
Age of student	0.543***	-0.249*	0.284
	(0.131)	(0.133)	(0.192)
1 if fourth grade	0.713	-0.623	0.341
	(1.331)	(1.270)	(1.287)
1 if agricultural household	0.475	0.004	-0.135
	(0.290)	(0.318)	(0.340)
1 if fishery household	1.029**	0.745*	-0.278
	(0.440)	(0.427)	(0.474)
1 if household head is literate	-0.630**	0.161	-0.014
	(0.279)	(0.209)	(0.288)
1 if own boat	-0.328	0.195	0.095
	(0.413)	(0.410)	(0.416)
1 if own land	-0.159	0.256	0.077
	(0.379)	(0.359)	(0.390)
1 if own car	-0.016	0.052	-0.210
	(0.525)	(0.463)	(0.482)
1 if own bike	0.083	0.122	0.133
	(0.203)	(0.216)	(0.206)
1 if own TV	0.286	-0.098	0.069
	(0.297)	(0.380)	(0.314)
1 if Catholic	0.888**	0.431	0.276
	(0.416)	(0.337)	(0.425)
1 if non-Christian	2.407***	-0.645**	0.912***
	(0.307)	(0.261)	(0.319)
Constant	-16.903***	-2.258	-3.926
	(3.531)	(2.538)	(5.097)
Weighting	No	Yes	Yes
Trimming	No	No	Yes
Pseudo R-squared	0.620	0.250	0.024
Obs.	553	553	206

All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column. The models of trimming use the subsamples with the estimated propensity score in the first column being between 0.1 and 0.9. Coefficients are reported. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 5: The Impact of Disaster Education on Perception

	Risk perception			Response efficacy			Efficacy of discussion		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1 if treatment school	-0.016	0.047	0.113	0.204**	0.197**	0.150*	0.099	0.165	0.239**
	(0.073)	(0.047)	(0.072)	(0.079)	(0.076)	(0.085)	(0.082)	(0.099)	(0.081)
1 if interested in science	-0.089**	-0.071	-0.145	-0.066*	-0.049	-0.017	-0.019	0.007	-0.128
	(0.042)	(0.061)	(0.144)	(0.038)	(0.043)	(0.105)	(0.057)	(0.053)	(0.076)
1 if affected in 2004/2005	-0.108	-0.016	-0.039	-0.121***	-0.114*	-0.058	0.028	0.085	-0.062
	(0.078)	(0.105)	(0.181)	(0.043)	(0.061)	(0.100)	(0.065)	(0.069)	(0.100)
1 if there is a symbol of the past	0.086*	-0.011	-0.092	0.077	0.032	0.155	0.017	0.094	-0.002
earthquakes in the village	(0.047)	(0.057)	(0.075)	(0.055)	(0.065)	(0.117)	(0.063)	(0.071)	(0.078)
1 if boy	-0.112**	-0.140**	-0.218**	-0.075	-0.023	0.027	-0.059	-0.003	-0.152
	(0.052)	(0.052)	(0.084)	(0.053)	(0.075)	(0.124)	(0.054)	(0.071)	(0.096)
Age of student	0.062**	0.066**	0.120**	-0.065***	-0.053*	-0.024	0.045	0.013	0.012
	(0.025)	(0.027)	(0.044)	(0.020)	(0.027)	(0.021)	(0.029)	(0.055)	(0.043)
1 if fourth grade	0.033	0.115*	0.132	-0.011	0.034	0.063	0.040	-0.078	-0.063
	(0.061)	(0.059)	(0.078)	(0.056)	(0.082)	(0.115)	(0.064)	(0.105)	(0.093)
1 if agricultural household	0.005	-0.062	-0.192**	0.022	-0.046	-0.141	-0.047	-0.052	-0.113
	(0.063)	(0.070)	(0.067)	(0.056)	(0.062)	(0.092)	(0.077)	(0.086)	(0.117)
1 if fishery household	0.042	-0.007	-0.362**	0.110*	0.087	0.175	0.063	-0.011	-0.282**
	(0.102)	(0.105)	(0.170)	(0.064)	(0.066)	(0.113)	(0.104)	(0.125)	(0.122)
1 if household head is literate	-0.034	-0.028	0.098	-0.031	-0.002	-0.009	-0.010	-0.042	-0.009
	(0.075)	(0.089)	(0.120)	(0.048)	(0.053)	(0.058)	(0.063)	(0.076)	(0.078)
1 if own boat	0.031	0.031	0.123	0.104	0.023	0.054	-0.040	-0.043	0.214*
	(0.069)	(0.074)	(0.190)	(0.072)	(0.059)	(0.114)	(0.078)	(0.125)	(0.117)
1 if own land	-0.186***	-0.170**	-0.138	-0.027	-0.027	0.008	-0.041	-0.108	-0.025
	(0.061)	(0.067)	(0.100)	(0.050)	(0.077)	(0.120)	(0.070)	(0.068)	(0.118)
1 if own car	0.042	0.023	-0.074	-0.043	0.011	0.024	0.005	-0.025	0.035
	(0.095)	(0.110)	(0.193)	(0.087)	(0.106)	(0.170)	(0.065)	(0.079)	(0.073)
1 if own bike	-0.043	-0.087	-0.006	-0.072	-0.129*	-0.255**	0.169**	0.116	-0.007
	(0.066)	(0.086)	(0.131)	(0.063)	(0.064)	(0.107)	(0.067)	(0.088)	(0.142)
1 if own TV	-0.036	0.035	-0.117	0.047	0.052	0.057	0.085	0.084	-0.072
	(0.053)	(0.083)	(0.102)	(0.059)	(0.047)	(0.061)	(0.066)	(0.074)	(0.114)
1 if Catholic	0.084	0.040	0.076	0.044	0.052	0.136	0.089	0.098	-0.060
	(0.050)	(0.051)	(0.120)	(0.059)	(0.056)	(0.121)	(0.061)	(0.078)	(0.072)
1 if non-Christian	0.052	-0.026	-0.204	-0.018	0.015	0.096	-0.006	0.032	-0.203*
	(0.075)	(0.075)	(0.193)	(0.073)	(0.080)	(0.192)	(0.075)	(0.113)	(0.097)

Distance from the school to coast	0.198**	0.200**	0.274	0.185***	0.217***	0.189	-0.077	-0.034	0.489**
	(0.083)	(0.076)	(0.271)	(0.053)	(0.071)	(0.192)	(0.098)	(0.118)	(0.176)
School size (x10^3 students)	0.695	0.216	-4.287	0.057	0.244	0.227	0.426	0.093	-9.323***
	(0.591)	(0.462)	(3.174)	(0.557)	(0.621)	(3.611)	(0.470)	(0.526)	(2.672)
Constant	-0.569**	-0.508*	-0.011	0.503*	0.345	0.056	-0.594*	-0.209	1.700**
	(0.254)	(0.272)	(0.805)	(0.263)	(0.331)	(0.836)	(0.292)	(0.512)	(0.584)
Weighting	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Trimming	No	No	Yes	No	No	Yes	No	No	Yes
Obs.	553	553	206	553	553	206	553	553	206
R-squared	0.074	0.073	0.133	0.069	0.084	0.133	0.053	0.062	0.141

All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses.
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 6: The Program Impact on Earthquake Response

	Immediate response			Evacuation		
	(1)	(2)	(3)	(4)	(5)	(6)
1 if treatment school	0.095*	0.097**	0.149**	0.023	-0.134	0.104
	(0.052)	(0.036)	(0.062)	(0.096)	(0.093)	(0.133)
1 if interested in science	0.098*	0.039	-0.042	-0.112*	-0.066	-0.097
	(0.055)	(0.051)	(0.077)	(0.057)	(0.060)	(0.082)
1 if affected in 2004/2005	-0.026	0.003	0.068	-0.018	-0.046	-0.016
	(0.048)	(0.045)	(0.065)	(0.061)	(0.095)	(0.076)
1 if there is a symbol of the past	0.091*	0.063	0.019	0.166***	0.134**	0.142
earthquakes in the village	(0.054)	(0.051)	(0.083)	(0.056)	(0.049)	(0.117)
1 if boy	-0.001	-0.026	-0.098	-0.010	-0.031	-0.068
	(0.050)	(0.050)	(0.070)	(0.062)	(0.078)	(0.082)
Age of student	-0.004	0.014	0.008	0.101***	0.159***	0.106
	(0.032)	(0.024)	(0.054)	(0.030)	(0.031)	(0.063)
1 if fourth grade	-0.032	0.013	-0.033	0.114	0.137	-0.057
	(0.054)	(0.040)	(0.081)	(0.074)	(0.089)	(0.128)
1 if agricultural household	0.074	0.031	0.033	-0.028	-0.068	-0.269***
	(0.053)	(0.049)	(0.086)	(0.060)	(0.059)	(0.086)
1 if fishery household	-0.114	-0.118	-0.138*	-0.175*	-0.431***	-0.477**
	(0.087)	(0.074)	(0.078)	(0.103)	(0.111)	(0.182)
1 if household head is literate	-0.125**	-0.128***	-0.105*	-0.037	-0.077	0.030
	(0.059)	(0.042)	(0.054)	(0.074)	(0.091)	(0.097)
1 if own boat	0.028	-0.007	-0.108	0.090	0.076	0.254
	(0.073)	(0.069)	(0.118)	(0.091)	(0.157)	(0.194)
1 if own land	-0.033	-0.024	-0.043	-0.009	-0.032	-0.011
	(0.045)	(0.040)	(0.066)	(0.053)	(0.050)	(0.034)
1 if own car	0.083	0.033	-0.038	-0.027	-0.018	0.078
	(0.064)	(0.077)	(0.141)	(0.069)	(0.072)	(0.119)
1 if own bike	0.144**	0.122**	0.074	0.002	-0.019	-0.020
	(0.060)	(0.058)	(0.102)	(0.067)	(0.070)	(0.118)
1 if own TV	-0.149**	-0.074	0.038	-0.023	-0.034	0.064
	(0.072)	(0.066)	(0.093)	(0.063)	(0.061)	(0.059)
1 if Catholic	0.003	-0.006	0.033	0.004	0.087	-0.126
	(0.044)	(0.040)	(0.062)	(0.078)	(0.108)	(0.130)
1 if non-Christian	-0.032	-0.025	0.004	0.058	0.330***	-0.099
	(0.058)	(0.042)	(0.109)	(0.082)	(0.115)	(0.211)
Distance from the school to coast	0.031	0.046	0.111	-0.096	-0.092	-0.303
	(0.069)	(0.063)	(0.199)	(0.089)	(0.097)	(0.347)
School size (x10^3 students)	-0.140	-0.150	0.283	0.310	1.408**	1.456
	(0.455)	(0.372)	(2.163)	(0.556)	(0.529)	(4.742)
Constant	0.009	-0.120	-0.138	-0.874**	-1.501***	-0.822
	(0.338)	(0.245)	(0.739)	(0.335)	(0.312)	(0.983)
Weighting	No	Yes	Yes	No	Yes	Yes
Trimming	No	No	Yes	No	No	Yes
Obs.	553	553	206	553	553	206
R-squared	0.058	0.043	0.092	0.061	0.189	0.149

All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 7: The Heterogeneity of Impact Relative to Learning Attitude

Treatment school × Interested in science		Treatment school × NOT interested in science					
Coef.	S.E.	Coef.	S.E.	Weighting	Trimming	Obs.	R-squared
Risk perception							
-0.003	(0.097)	-0.028	(0.075)	No	No	553	0.074
0.048	(0.079)	0.047	(0.055)	Yes	No	553	0.073
0.087	(0.120)	0.136	(0.123)	Yes	Yes	206	0.134
Response efficacy							
0.245**	(0.094)	0.165*	(0.083)	No	No	553	0.071
0.232**	(0.086)	0.177*	(0.089)	Yes	No	553	0.085
0.267**	(0.124)	0.048	(0.138)	Yes	Yes	206	0.138
Efficacy of discussion							
-0.017	(0.090)	0.206*	(0.106)	No	No	553	0.060
0.063	(0.093)	0.224*	(0.126)	Yes	No	553	0.065
0.175*	(0.083)	0.295**	(0.104)	Yes	Yes	206	0.142
Immediate response							
0.053	(0.096)	0.134*	(0.068)	No	No	553	0.059
0.048	(0.088)	0.125***	(0.042)	Yes	No	553	0.044
0.056	(0.085)	0.231**	(0.087)	Yes	Yes	206	0.096
Evacuation							
0.060	(0.099)	-0.011	(0.126)	No	No	553	0.062
0.019	(0.101)	-0.224*	(0.112)	Yes	No	553	0.196
0.080	(0.184)	0.125	(0.152)	Yes	Yes	206	0.149

The coefficients of treatment school are presented. All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Note: Blue flags denote the treatment schools. Green flags denote the control schools.

Figure A1: Location of Survey Schools

Table A1: School Characteristics

School ID	Year of Establishment	Affected by the 2004/2005 Disasters	Distance to Coastal Line	Num. of Teachers	Num. of Students
Treatment Schools					
A	1982	1	100	24	331
B	1975	1	875	13	223
C	1993	0	100	26	351
D	2008	0	300	24	265
E	1987	1	150	14	147
F	1961	1	400	23	279
Mean	1984.3	0.7	320.8	20.7	266.0
Control Schools					
G	1980	1	200	12	143
H	1980	1	225	17	129
I	1985	1	100	17	186
J	1952	1	1090	20	196
K	2011	0	100	14	96
L	1979	1	946	14	206
Mean	1981.2	0.8	443.5	15.7	159.3

Table A2: Falsification Test Using the Pretreatment Outcomes

Coef.	S.E.	Weighting	Trimming	Obs.	R-squared
Risk perception					
0.034	(0.072)	No	No	553	0.075
0.028	(0.075)	Yes	No	553	0.069
-0.055	(0.059)	Yes	Yes	206	0.152
Response efficacy					
-0.069	(0.080)	No	No	553	0.030
-0.029	(0.074)	Yes	No	553	0.063
-0.042	(0.071)	Yes	Yes	206	0.169
Efficacy of discussion					
0.028	(0.076)	No	No	553	0.044
-0.031	(0.093)	Yes	No	553	0.107
-0.068	(0.061)	Yes	Yes	206	0.196
Immediate response					
0.040	(0.069)	No	No	553	0.048
0.062	(0.056)	Yes	No	553	0.090
0.076	(0.069)	Yes	Yes	206	0.098
Evacuation					
0.021	(0.076)	No	No	553	0.062
0.087	(0.057)	Yes	No	553	0.121
-0.024	(0.091)	Yes	Yes	206	0.136

The coefficients of treatment school are presented. All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A3: Falsification Test Using the Sixth Grade Students

Coef.	S.E.	Weighting	Trimming	Obs.	R-squared
Risk perception					
0.098	(0.066)	No	No	290	0.045
0.015	(0.081)	Yes	No	290	0.061
-0.042	(0.072)	Yes	Yes	88	0.177
Response efficacy					
-0.071	(0.178)	No	No	290	0.098
-0.118	(0.149)	Yes	No	290	0.380
-0.049	(0.040)	Yes	Yes	88	0.305
Efficacy of discussion					
0.027	(0.070)	No	No	290	0.102
0.042	(0.065)	Yes	No	290	0.129
-0.367*	(0.172)	Yes	Yes	88	0.366
Immediate response					
0.160	(0.099)	No	No	290	0.062
0.057	(0.048)	Yes	No	290	0.212
0.073	(0.135)	Yes	Yes	88	0.377
Evacuation					
0.011	(0.127)	No	No	290	0.075
-0.066	(0.157)	Yes	No	290	0.365
-0.153	(0.081)	Yes	Yes	88	0.245

The coefficients of treatment school are presented. All the estimations use the samples of sixth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A4: The Program Impact on Self-Learning Behavior

	Learning from media			Learning from family			Learning from neighbors		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1 if treatment school	-0.013	0.128	0.009	0.097	0.157**	0.120**	0.205***	0.190***	0.198***
	(0.092)	(0.102)	(0.119)	(0.097)	(0.074)	(0.056)	(0.073)	(0.052)	(0.050)
1 if interested in science	-0.019	-0.044	-0.089	-0.036	0.006	0.145	-0.125*	-0.102	-0.002
	(0.058)	(0.081)	(0.135)	(0.060)	(0.070)	(0.146)	(0.062)	(0.065)	(0.135)
1 if affected in 2004/2005	-0.133**	-0.197***	-0.090	0.027	0.104	0.135	-0.018	0.025	0.170
	(0.050)	(0.068)	(0.074)	(0.067)	(0.083)	(0.086)	(0.065)	(0.072)	(0.136)
1 if there is a symbol of the past	0.158***	0.167***	0.118	0.195***	0.138**	0.049	0.045	0.098	0.158
earthquakes in the village	(0.040)	(0.050)	(0.111)	(0.060)	(0.052)	(0.063)	(0.065)	(0.068)	(0.128)
1 if boy	-0.007	-0.080	-0.087	0.006	-0.014	-0.164	-0.085	-0.038	-0.026
	(0.046)	(0.085)	(0.104)	(0.056)	(0.053)	(0.109)	(0.064)	(0.060)	(0.106)
Age of student	0.013	-0.010	-0.040	0.022	0.002	0.003	0.064**	0.069**	0.144***
	(0.026)	(0.035)	(0.065)	(0.028)	(0.026)	(0.056)	(0.027)	(0.033)	(0.042)
1 if fourth grade	0.124	0.023	-0.028	0.088	0.206***	0.394***	0.040	0.084	0.148**
	(0.078)	(0.090)	(0.155)	(0.089)	(0.073)	(0.084)	(0.060)	(0.060)	(0.057)
1 if agricultural household	-0.100	-0.149*	-0.182	-0.035	-0.048	-0.040	-0.026	-0.082	-0.160
	(0.072)	(0.077)	(0.128)	(0.076)	(0.072)	(0.092)	(0.069)	(0.091)	(0.154)
1 if fishery household	-0.204***	-0.099	-0.422***	-0.149	-0.174	-0.323	-0.133	-0.234***	-0.482**
	(0.069)	(0.093)	(0.129)	(0.124)	(0.135)	(0.228)	(0.096)	(0.083)	(0.179)
1 if household head is literate	-0.084	-0.042	0.019	-0.040	-0.046	-0.120	-0.126*	-0.073	0.066
	(0.070)	(0.058)	(0.079)	(0.060)	(0.060)	(0.091)	(0.068)	(0.080)	(0.096)
1 if own boat	-0.002	-0.001	-0.220**	-0.001	-0.055	-0.012	0.025	0.027	0.093
	(0.083)	(0.119)	(0.093)	(0.073)	(0.071)	(0.185)	(0.084)	(0.097)	(0.166)
1 if own land	-0.047	-0.163**	-0.239**	0.078	0.058	0.010	-0.042	-0.057	-0.132*
	(0.043)	(0.076)	(0.093)	(0.053)	(0.054)	(0.099)	(0.057)	(0.048)	(0.064)
1 if own car	-0.033	-0.122	0.150	-0.046	0.073	-0.009	-0.169	-0.227**	-0.239
	(0.069)	(0.090)	(0.118)	(0.082)	(0.083)	(0.085)	(0.103)	(0.103)	(0.165)
1 if own bike	0.007	-0.006	-0.004	0.003	0.009	-0.036	0.092	-0.017	-0.120*
	(0.057)	(0.070)	(0.129)	(0.069)	(0.054)	(0.068)	(0.077)	(0.070)	(0.068)
1 if own TV	-0.073	-0.059	-0.178	-0.002	0.008	0.011	-0.041	0.066	0.204
	(0.061)	(0.064)	(0.130)	(0.068)	(0.063)	(0.064)	(0.061)	(0.091)	(0.175)
1 if Catholic	0.058	-0.027	0.085	0.027	-0.070	-0.180	0.079	0.023	0.040
	(0.054)	(0.083)	(0.140)	(0.074)	(0.074)	(0.115)	(0.076)	(0.066)	(0.082)
1 if non-Christian	0.092	-0.014	0.287*	0.043	-0.045	0.120	0.029	0.063	0.261

	(0.103)	(0.101)	(0.136)	(0.110)	(0.103)	(0.222)	(0.090)	(0.067)	(0.168)
Distance from the school to coast	0.057	0.088	0.422	0.064	0.001	-0.057	-0.032	0.010	-0.416**
	(0.101)	(0.091)	(0.271)	(0.114)	(0.122)	(0.288)	(0.085)	(0.084)	(0.195)
School size (x10^3 students)	0.098	-0.938	-2.635	0.091	-0.418	0.256	-0.560	-0.435	6.286**
	(0.752)	(0.663)	(4.251)	(0.757)	(0.745)	(4.081)	(0.587)	(0.408)	(2.862)
Constant	0.038	0.631	1.166	-0.329	-0.074	-0.101	-0.390	-0.524	-2.398***
	(0.311)	(0.485)	(1.278)	(0.340)	(0.390)	(1.213)	(0.292)	(0.377)	(0.760)
Weighting	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Trimming	No	No	Yes	No	No	Yes	No	No	Yes
Obs.	553	553	206	553	553	206	553	553	206
R-squared	0.065	0.092	0.155	0.044	0.068	0.146	0.050	0.061	0.169

All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A5: The Program Impact on Knowledge

	Knowing evacuation spot			Parents knowing evacuation spot		
	(1)	(2)	(3)	(4)	(5)	(6)
1 if treatment school	0.314***	0.236**	0.345***	0.102*	0.237***	0.183*
	(0.098)	(0.089)	(0.096)	(0.057)	(0.035)	(0.090)
1 if interested in science	-0.141**	-0.201***	-0.125	-0.033	-0.118	-0.096
	(0.062)	(0.063)	(0.092)	(0.058)	(0.075)	(0.135)
1 if affected in 2004/2005	-0.122**	-0.053	-0.096	-0.013	-0.076	0.044
	(0.054)	(0.061)	(0.086)	(0.052)	(0.058)	(0.052)
1 if there is a symbol of the past	0.153**	0.133	-0.116	0.084	0.133**	0.058
earthquakes in the village	(0.070)	(0.105)	(0.169)	(0.056)	(0.049)	(0.102)
1 if boy	0.023	-0.027	-0.032	0.059	0.026	0.117
	(0.082)	(0.108)	(0.193)	(0.049)	(0.056)	(0.091)
Age of student	0.007	0.007	-0.017	0.049	0.019	-0.047
	(0.026)	(0.046)	(0.051)	(0.036)	(0.034)	(0.075)
1 if fourth grade	-0.037	-0.023	-0.046	-0.112**	-0.176***	-0.239***
	(0.056)	(0.070)	(0.107)	(0.049)	(0.045)	(0.065)
1 if agricultural household	-0.111	-0.137	-0.115	-0.022	-0.029	-0.094
	(0.069)	(0.090)	(0.120)	(0.060)	(0.055)	(0.082)
1 if fishery household	-0.071	0.010	-0.409	-0.011	-0.012	-0.333*
	(0.135)	(0.214)	(0.313)	(0.094)	(0.112)	(0.183)
1 if household head is literate	-0.103	-0.145	-0.091	-0.068	-0.063	-0.034
	(0.082)	(0.107)	(0.144)	(0.065)	(0.085)	(0.116)
1 if own boat	0.061	-0.067	-0.115	-0.064	0.079	0.123
	(0.073)	(0.096)	(0.131)	(0.087)	(0.102)	(0.155)
1 if own land	-0.028	-0.079	-0.178	-0.069	-0.053	-0.049
	(0.065)	(0.092)	(0.119)	(0.053)	(0.052)	(0.119)
1 if own car	0.071	0.119	0.210	0.038	-0.037	0.035
	(0.085)	(0.099)	(0.127)	(0.089)	(0.080)	(0.139)
1 if own bike	0.149**	0.161**	0.134	0.103	0.091	-0.009
	(0.062)	(0.069)	(0.128)	(0.063)	(0.072)	(0.107)
1 if own TV	-0.015	0.076	0.042	0.011	0.045	0.172
	(0.056)	(0.057)	(0.097)	(0.054)	(0.053)	(0.118)
1 if Catholic	-0.036	-0.128*	-0.080	0.101	0.146*	0.175
	(0.059)	(0.071)	(0.151)	(0.087)	(0.085)	(0.150)
1 if non-Christian	-0.249*	-0.159	-0.110	-0.056	-0.179*	-0.223
	(0.137)	(0.143)	(0.274)	(0.084)	(0.099)	(0.200)
Distance from the school to coast	0.204**	0.153	0.038	-0.123	-0.114	-0.157
	(0.093)	(0.106)	(0.286)	(0.076)	(0.069)	(0.312)
School size ($x10^3$ students)	-1.210*	-1.051*	2.746	-0.366	-1.372***	0.431
	(0.596)	(0.545)	(4.121)	(0.553)	(0.394)	(3.964)
Constant	0.302	0.442	0.164	-0.278	0.237	0.556
	(0.270)	(0.482)	(0.948)	(0.352)	(0.350)	(1.008)
Weighting	No	Yes	Yes	No	Yes	Yes
Trimming	No	No	Yes	No	No	Yes
Obs.	553	553	206	553	553	206
R-squared	0.077	0.098	0.170	0.049	0.128	0.141

All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A6: The Heterogeneity of Impact Relative to Distance from the Coast

Treatment school × School located within 200 meters from the coast Coef.	S.E.	Treatment school × School located more than 200 meters from the coast Coef.	S.E.	Weighting	Trimming	Obs.	R-squared
Risk perception							
0.081	(0.070)	-0.035	(0.074)	No	No	553	0.078
0.101*	(0.050)	-0.009	(0.063)	Yes	No	553	0.077
0.073	(0.102)	0.160	(0.109)	Yes	Yes	206	0.134
Response efficacy							
0.217*	(0.126)	0.201**	(0.075)	No	No	553	0.069
0.196*	(0.104)	0.198***	(0.066)	Yes	No	553	0.084
0.087	(0.175)	0.225**	(0.100)	Yes	Yes	206	0.135
Efficacy of discussion							
0.245***	(0.080)	0.070	(0.074)	No	No	553	0.062
0.246**	(0.115)	0.078	(0.090)	Yes	No	553	0.070
0.321***	(0.101)	0.142	(0.138)	Yes	Yes	206	0.144
Immediate response							
0.076	(0.058)	0.098*	(0.057)	No	No	553	0.058
0.077**	(0.037)	0.117**	(0.054)	Yes	No	553	0.044
0.147	(0.093)	0.152	(0.130)	Yes	Yes	206	0.092
Evacuation							
-0.023	(0.121)	0.032	(0.096)	No	No	553	0.062
-0.222**	(0.103)	-0.041	(0.094)	Yes	No	553	0.197
0.119	(0.107)	0.086	(0.222)	Yes	Yes	206	0.149
Learning from media							
0.031	(0.146)	-0.021	(0.088)	No	No	553	0.066
0.205	(0.129)	0.047	(0.086)	Yes	No	553	0.099
0.090	(0.212)	-0.086	(0.160)	Yes	Yes	206	0.158
Learning from family							
0.257**	(0.095)	0.066	(0.107)	No	No	553	0.054
0.247***	(0.080)	0.063	(0.104)	Yes	No	553	0.077
0.089	(0.137)	0.157	(0.122)	Yes	Yes	206	0.146
Learning from neighbors							
0.300***	(0.087)	0.186**	(0.081)	No	No	553	0.053
0.196***	(0.051)	0.185**	(0.077)	Yes	No	553	0.061
0.084	(0.109)	0.331***	(0.081)	Yes	Yes	206	0.173
Knowing evacuation spot							
0.269**	(0.108)	0.323***	(0.096)	No	No	553	0.078
0.186*	(0.096)	0.288***	(0.088)	Yes	No	553	0.101
0.140	(0.154)	0.587***	(0.132)	Yes	Yes	206	0.184
Parents knowing evacuation spot							
0.158**	(0.066)	0.091	(0.056)	No	No	553	0.050

0.294***	(0.042)	0.177***	(0.049)	Yes	No	553	0.132
0.148	(0.116)	0.225*	(0.120)	Yes	Yes	206	0.141

The coefficients of treatment school are presented. All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A7: The Heterogeneity of Impact Relative to Disaster Experience of Family

Treatment school × Parents affected in 2004/2005 Coef.	S.E.	Treatment school × Parents NOT affected in 2004/2005 Coef.	S.E.	Weighting	Trimming	Obs.	R-squared
Risk perception							
-0.049	(0.127)	0.001	(0.079)	No	No	553	0.074
-0.012	(0.136)	0.076	(0.056)	Yes	No	553	0.074
-0.061	(0.207)	0.206*	(0.115)	Yes	Yes	206	0.142
Response efficacy							
0.277**	(0.102)	0.166**	(0.079)	No	No	553	0.071
0.367***	(0.112)	0.114*	(0.062)	Yes	No	553	0.095
0.322*	(0.164)	0.058	(0.064)	Yes	Yes	206	0.143
Efficacy of discussion							
0.191	(0.121)	0.051	(0.092)	No	No	553	0.056
0.178	(0.131)	0.158	(0.116)	Yes	No	553	0.062
0.522***	(0.096)	0.087	(0.083)	Yes	Yes	206	0.167
Immediate response							
0.069	(0.101)	0.107**	(0.052)	No	No	553	0.058
0.100	(0.081)	0.095**	(0.042)	Yes	No	553	0.043
0.182	(0.107)	0.131	(0.085)	Yes	Yes	206	0.092
Evacuation							
0.040	(0.095)	0.014	(0.113)	No	No	553	0.061
-0.161	(0.121)	-0.121	(0.107)	Yes	No	553	0.190
0.094	(0.128)	0.109	(0.167)	Yes	Yes	206	0.149
Learning from media							
-0.026	(0.109)	-0.006	(0.102)	No	No	553	0.065
0.173	(0.135)	0.106	(0.124)	Yes	No	553	0.093
0.054	(0.172)	-0.015	(0.119)	Yes	Yes	206	0.155
Learning from family							
0.171	(0.134)	0.059	(0.107)	No	No	553	0.046
0.336**	(0.140)	0.070	(0.082)	Yes	No	553	0.077
0.355**	(0.141)	-0.005	(0.088)	Yes	Yes	206	0.161
Learning from neighbors							
0.239**	(0.113)	0.188**	(0.085)	No	No	553	0.050
0.249**	(0.095)	0.162**	(0.075)	Yes	No	553	0.061
0.240	(0.161)	0.175*	(0.099)	Yes	Yes	206	0.169
Knowing evacuation spot							
0.393***	(0.140)	0.273***	(0.097)	No	No	553	0.079
0.308*	(0.162)	0.201**	(0.075)	Yes	No	553	0.100
0.513**	(0.177)	0.256**	(0.107)	Yes	Yes	206	0.176
Parents knowing evacuation spot							
0.113	(0.089)	0.096	(0.068)	No	No	553	0.049
0.232***	(0.077)	0.240***	(0.052)	Yes	No	553	0.129
0.265*	(0.128)	0.139	(0.094)	Yes	Yes	206	0.142

The coefficients of treatment school are presented. All the estimations use the samples of fourth and fifth grade students. The models of weighting use the propensity score weighting computed from the first column of Table 4. The models of trimming use the subsamples with the estimated propensity score being between 0.1 and 0.9. Standard errors clustered at the classroom level are in parentheses. * Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.