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ORIGINAL RESEARCH PAPER

Informal education for disaster risk reduction

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Abstract Our children are the future: their school buildings must be safe in the face of natural hazards and children must be empowered with an understanding of natural hazards and actions they can take to be better prepared for the next "event". With respect to natural hazards, educational institutions have dual roles of caretakers who must ensure the safety of students in their charge and teachers responsible for educating students about natural hazards. This article presents a comparative study on earthquake risk reduction efforts in primary and secondary schools, based on surveys conducted in areas of varying seismic hazard in Iceland, Italy, and Portugal. The study evaluated the degree to which local authorities were involved in the dissemination of earthquake risk and hazard mitigation information, and specifically how this information was channelled to schools. Vulnerability mitigation for school building interiors (contents) and efforts towards educating pupils towards a culture of safety were also measured. In addition the article presents the risk reduction efforts implemented in Icelandic institutions that serve groups who are especially vulnerable in emergencies and compares those efforts with the efforts made in schools.

Keywords Earthquake risk · School buildings · Preventive measures · Preparedness · Risk reduction · Risk awareness

1 Introduction

Education is a long-term defence against natural disasters that enables societies to better cope with seismic hazard in different ways. It can directly influence risk perception, promote access to information and resources, and teach skills and knowledge needed for

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hazard mitigation. The H group of the 'Urban Disasters Prevention Strategies using Macroseismic Faults' (UPStrat-MAFA) project investigated various disaster mitigation strategies, including education.

One of the main challenges in risk education is to help children to use their own abilities to conceptualise and analyse risk. However, as research shows, their risk perception is built upon their own experiences of local disasters combined "with information gained from external information sources, such as the media, school curricula and training sessions" (Tanner 2010:343). The importance of schools in regard to societal risk reduction is unquestionable. Schools can channel knowledge, and thus awareness, of risk in different ways. With the inclusion of hazard and disaster risk reduction into school curricula, appropriate information can be provided to children at an early age, to increase the likelihood of their continued development of risk-awareness behaviour along with their increased maturity (UN/ISDR 2007; Nathe 2000). The H-task group analysed both formal and informal education. The analysis of formal education is presented in another article of this volume entitled "Education: a bottom-up strategy for earthquake disasters prevention." That study indicates that the authorities and scientists need to take actions for the introduction of hazard education into schools curricula and to provide better information on the hazard at the local level (Musacchio et al. 2015). This article provides an analysis of more informal risk-reduction education and implementation of preventive measures within schools in Iceland, Italy and Portugal. Such preventive measures within the school buildings not only create safer environments for children, but also raise their awareness of the hazard as well as simple mitigation measures.

The implementation of risk reduction efforts (i.e., both preventive measures and preparedness) in schools was measured using a survey. The questionnaire was developed and tested in Hveragerði, an Icelandic town in the South Iceland Seismic Zone. After finalising the questions, the survey was conducted in the earthquake zone of Iceland as well as in major urban areas of Italy and Portugal that are exposed to all ranges of seismic hazard. The Heads of schools were contacted by email, and they were asked to participate in the survey online by clicking a link at the end of the message to open the questionnaire. Each participating country ran the survey in its native language. In total, there were ten questions, four of which were so-called filter questions; i.e., to answer the subsequent question (see questionnaire in "Appendix"). The main answers discussed in this article focus on how risk is being communicated and vulnerabilities mitigated, and how the risk-reduction behaviour of the children is encouraged.

One of the most important roles of risk governance is to raise the awareness of the public of the probable risks they face. It is encouraging that risk communication is like the heart of risk governance, in that it circulates the information to all of the stakeholders. This process includes information creation, presentation and persuasion, and strategic messaging (Sheppard et al. 2012). With increasingly complex technology, the public does not always have the resources to understand the probable dangers that they face. The greater their vulnerability, the more the public has to put its trust in the government to provide the necessary research and organisation to protect them from harm. Based on this increasing importance of risk governance, we decided to measure in particular how actively the local responsible authorities disseminated information on risk and risk reduction, and how they channelled this information to schools.

"It's not the Earth's shaking itself that causes the most injury and harm. Instead, it's the things that the earthquake puts into motion: the shaking of buildings, structures, and even ordinary household items. Anything that can move, fall, break or cause a fire can be an earthquake hazard. In an earthquake, most injuries and deaths are caused by loose objects

in and on buildings" (Caribbean Disaster Emergency Management Agency 2010). The encouraging concept is that this vulnerability can be relatively easily mitigated. In the survey, we determined such efforts by asking directors and the Heads of the schools whether loose objects, such as hanging pictures, statues and shelves, had been especially attached within the buildings.

Noting that we generally remember 20 % of what we hear, 40 % of what we see, and 80 % of what we do (Wiman and Meierhenry 1960), the school environment provides an important venue for shaping the behaviour of children, by involving them in the proposed activities and in the process of reflection. The survey determined this in particular by asking whether special action had been taken towards pupil education on the topic. In the case of such action, further information on the type of education was collected, whether it was in the form of training, information processing about school buildings in regard to risk, or special lectures. The encouragement of interactivity was measured by enquiring whether the children were asked to gather information on their houses, and whether they were questioned to describe their experiences during earthquakes. The frequencies of earthquake drills within the schools were also determined.

2 Iceland

"The seismic activity in Iceland is attributed to the boundary of the diverging North American and the Eurasian tectonic plates. A shift in the boundary results in two major transform or fracture zones in Iceland, one in the south, the South Iceland Seismic Zone (SISZ), and one in the north, commonly called the Tjornes Fracture Zone. All major damaging earthquakes in Iceland have originated within these two zones. Outside these two major earthquake zones, there is significant seismic activity that is most commonly related to the spreading axes and to volcanoes" (Sigbjornsson and Ragnarsdottir 2008).

To cover these two earthquake zones, all of the Icelandic preschools (children aged 1–5 years) and compulsory schools (children aged 6–16) located in these zones were included. The survey was also sent to health institutions and homes for the elderly and disabled, as institutions that serve groups who are especially vulnerable in emergencies. This was the case, for instance, during the hurricane Katarina disaster in 2005, when dozens of people died in nursing homes and medical centres (Inclusion Daily Express 2008). Local authorities in Iceland bear the financial responsibility for both the schools and the welfare institutions in their communities. Indeed, the list of welfare institutions and their contact information had to be obtained through the local administrations. This information gathering met with some resistance, which might be explained on the basis that similar surveys had not been carried out among these institutions before. Nevertheless, we decided to report on the answers received, to provide some insight into how these vulnerable groups are protected and prepared for disaster, and to raise awareness of how important it is for these institutions to reduce their disaster risk. At the same time, the survey gives us the opportunity to detect differences in risk reduction efforts within local communities, depending on whether the institutions are serving education or health/welfare.

In total 477 institutions received the survey, of which 255 (53.4 %) responded. The division between schools and institutions that answered the online questionnaire was: 137 preschools, 82 elementary schools, and 36 health and/or welfare institutions (Table 1). The elementary schools had approximately 42,700 pupils registered in autumn 2011, of which

approximately 40,200 were in schools located in the seismic zones (Statistical Series 2012). Hence, the survey reached the schools that were responsible for the education of approximately 94 % of the Icelandic elementary pupils.

Analysis of the responses shows that less than half of the institutions in Iceland had information about preventive measures related to seismic risk that was delivered by the responsible local authorities (Fig. 1a). In comparison, the preschools most often had received the information but the health/welfare institution least often.

The test survey in Hveragerði revealed that whether the information was accessible or not depended more often on the institution management than the local authorities. Printed material was the most common source of information (Fig. 2). Thirty-three percent of the institutions had received guidelines printed by the Icelandic Civil Defence Department that show how to behave in the case of an earthquake.

The risk of harm due to loose objects falling during an earthquake needs to be well recognized among the general public in Iceland. For instance, research shows that when the earthquakes hit the Southland in 2000, residents in Hveragerði's community, an area that experienced frequent earthquakes in the 1990s, had secured their households better (e.g., by attaching loose objects) than communities in close proximity (and thus within the seismic zone) (Bernhardsdóttir and Thorvaldsdóttir 2002). This supports the suggestion that personally experiencing an earthquake is more likely to raise awareness and foster risk mitigation than just the knowledge of the strong likelihood of an earthquake that might have serious consequences. The survey revealed that 57 % of the institutions had made efforts to prevent objects from falling in the case of an earthquake (Fig. 3a).

The difference in distribution of information and guidelines on preventive measures based on the type of institutions reported above undoubtedly had an important role in the better risk awareness among the preschool managers on how to prevent the fall of loose objects in the case of an earthquake. Indeed, 75 % of preschools had taken care to fix loose objects, in comparison to 34 % of all of the elementary schools. The explanation for this difference related to the available information on hazard mitigation, such as attaching loose objects, appears to be due to a greater sense responsibility among the managers in preschools, as the preschools are not only educational institutions, but also day-care homes for small children. The same reason, i.e., the care-taking nature of health and welfare institutions, might also explain why preventive measures are taken more often there than in elementary schools. The low percentage of elementary schools that used this preventive measure (which is relatively easy to execute) indicates that it is necessary to raise the awareness of the school management of its role in ensuring the safety of the children within the school buildings.

The opportunity to raise risk awareness and encourage disaster preparedness through earthquake drills was only used in 22 % of all of the institutions (Fig. 4a). Organized drills were reported in 21 % of preschools, 29 % of elementary schools, and 17 % of health/

Table 1 The survey responders in Iceland

Type of institution	Sent to	Responses	Response rate (%)
Pre-school (age 2–5 years)	270	137	50.7
Elementary school (age 6–16 years)	135	82	60.7
Health/welfare institution	72	36	50.0
Total	477	255	53.4

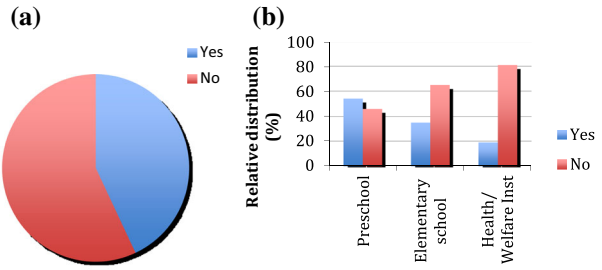

Fig. 1 Iceland: **a** Overall results of the returned test surveys for the question: "Have the authorities distributed information on seismic risk prevention?" **b** Results broken down according to the answers from the different types of institutions

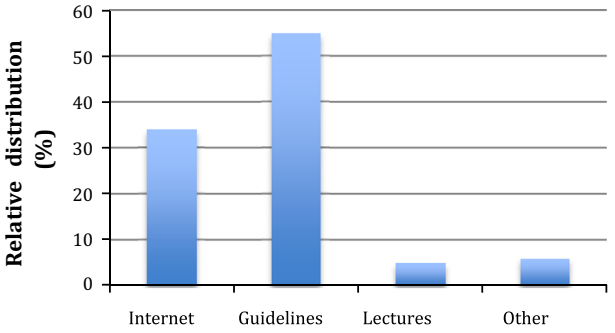

Fig. 2 Iceland: Results of the returned test surveys for the question: "How did the authorities process information"

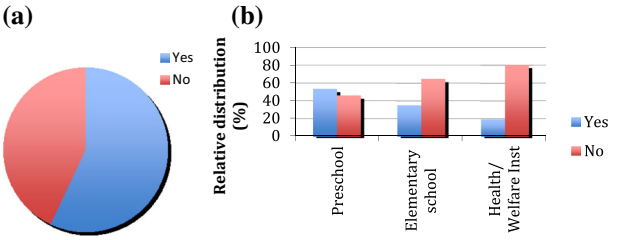

Fig. 3 Iceland: **a** Overall results of the returned test surveys for the question: "Have loose objects, like pictures/frames, statues and shelves, been especially attached?" **b** Results broken down according to the answers of the different types of institutions

welfare institutions. The task of providing emergency and prevention plans for earthquakes proved to be better followed than other tasks on risk reduction measured in the survey, but still only 69 % of all of the institutions had such a plan to rely on (Fig. 4b). When broken down according to institution, 69 % of preschools, 66 % of elementary schools, and 72 % of health/welfare institutions had such plans in place.

Only 23 % of all of the institutions (including 18 % of preschools and 33 % of elementary schools) offered special education on how to prevent harm and/or prepare for probable earthquakes. The most common action was to provide the children with information about their school buildings, in terms of where to find emergency exits and which places were the safest in the case of an earthquake (Fig. 5). Only 10 % of the institutions had equipment available to use in the aftermath of an earthquake. A possible explanation

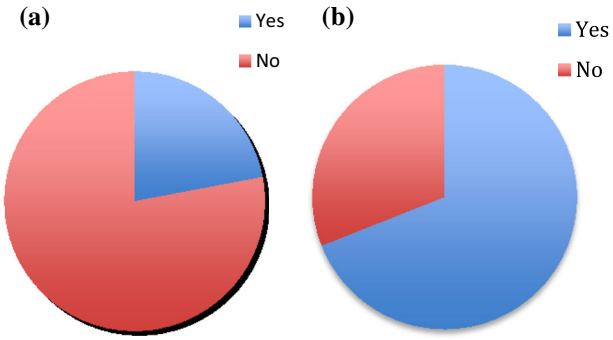

Fig. 4 Iceland: Overall results of the returned test surveys for the question: **a** "Does the institution execute any earthquake drill?"; and **b** "Does the institution have any emergency and prevention plan for earthquakes?"

for this low percentage might be the closeness of the volunteer groups, which provide emergency equipment in the case of need. Indeed, the belief that the Icelandic Red Cross and local rescue teams would provide the necessary equipment in response and relief operations was particularly salient in this test survey in Hveragerði.

3 Italy

The convergent margin between the Africa and Eurasian plates runs down the Italian peninsula, which causes active volcanism and seismicity. Medium-to-strong earthquakes, coupled with densely, sometimes old, urbanised areas and an overall vulnerable infrastructure, results in a high level of threat. The seismic hazard classification has subdivided the Italian municipalities into four seismic zones, which each now have enforced building codes (Gruppo di Lavoro 2004; Stucchi et al. 2011).

Local authorities and school Heads bear the responsibility for security according to different rules: the local authorities are committed to keeping the buildings secure, while the school Head has to take actions on emergency plans, preventive measures and indoor safety. Therefore, the survey was sent to a list of institutions, with their contact taken through the local administrations. However, as this blind action of intervention met with some resistance, it was decided to submit the survey as a pilot study to those schools that

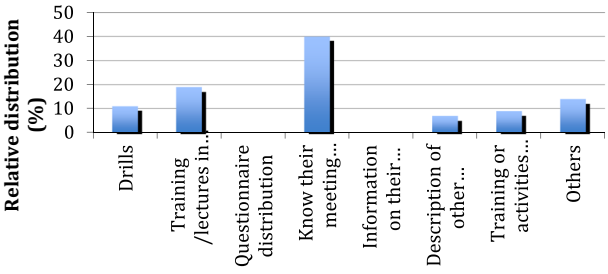

Fig. 5 Iceland: Results of the returned test surveys for the question: "Were special actions taken towards children's education on the topic? If yes, what kind of education?"

showed interest during the research centre open-door events, or that had been previously involved in science outreach programmes.

The result was a sample of 27 schools, of which 33 % were primary schools (children of 6–9 years of age) and the remaining were secondary schools (children of 10–13 years of age). The sample addressed institutions with a total population of about 11,500 pupils and school personnel, which were spread over all of the seismic zones of Italy. The schools surveyed ranged in location from cities with high earthquake hazard, such as Catania in the south of Italy, to cities with medium earthquake hazard, such as Rome in central Italy, and cities with low earthquake hazard, such as Varese in the north of Italy.

The local authorities, which provide information on seismic risk prevention, represented 37 % of the sample. This information was distributed through guidelines, lectures, compact disks or training courses from the National Civil Protection, or from research institutions that shared their duties, projects and activities with the National Civil Protection (Fig. 6a). The information circulated to the schools focused mostly on how to behave in the case of an earthquake.

In Italian schools, the earthquake preparedness to reduce non-structural hazards was low. Although there are guidelines to reduce injuries from loose objects falling during an earthquake, the issue is far from being taken care of by the schools (Fig. 6b). As a matter of fact, guidelines were usually distributed to school personnel only, and this appeared to be enough to prevent disasters.

Most of the schools (70 %) carried out drills at least once a year, and they appear to have emergency plans. Indeed, drills appeared to be considered as among the most valuable actions taken towards the children's education on earthquake preparedness, together with training and lectures at the schools or specifically organised for the schools by scientific institutions (Fig. 7).

4 Portugal

The seismicity of Portugal is moderate to strong, and it has alternating periods of large events with long periods of quiescence. The most active area is the southern region at the transition between the oceanic and continental crusts. In this area of collision, there were earthquakes in 1356, 1755, and more recently, 1969. Western Portugal is a locus for important intraplate seismicity, with destructive earthquakes in 1531, 1858 and 1909. These are events related to the Lower Tagus River fault structure.

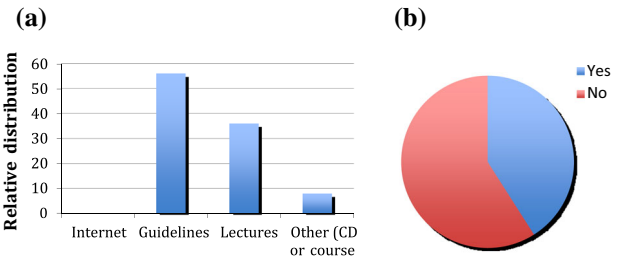

Fig. 6 Italy: Results of the returned test surveys for the questions: **a** "Have the authorities distributed information on seismic risk prevention?", "How did they process the information". **b** "Have loose objects like pictures/frames, statues, shelves been especially attached?"

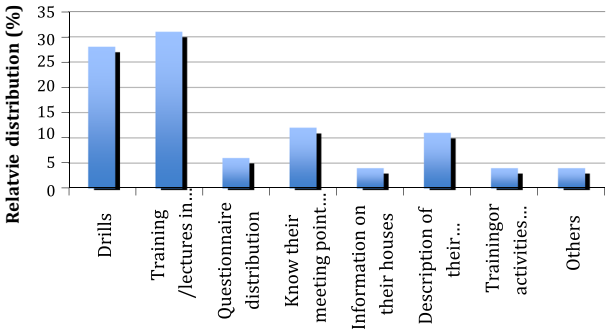

Fig. 7 Italy: Results of the returned test surveys for the question: "Were special actions taken towards the children's education on the topic? If yes, what kind of education?"

The 1755 Lisbon earthquake was one of the largest events in the history of Europe, and it severely damaged a wide area, which included the Iberian Peninsula and the Atlantic Coast of Morocco, and caused a destructive tsunami. Lisbon and the cities of southern Portugal were almost completely destroyed. Most Portuguese people have heard about this event at least once in their lifetime (Oliveira et al. 2004).

In Lisbon, 35 schools completed the online questionnaire. The sample comprised a total of 30 primary schools (children aged 6–9) (EB1/JI) and five kindergartens (children aged 3–5) (JI), which represented 8200 pupils between the ages of 3 and 9 years. In the first cycle of the basic education, the earthquake theme was addressed in their last year only.

Information related to earthquake hazard prevention and mitigation was not well disseminated. According to the questionnaire, the Lisbon municipality distributed about 30 % of the information concerning seismic disaster prevention measures to schools. Information on earthquakes was distributed through guidelines, lectures, compact disks or training courses by the National Civil Protection (Fig. 8a). The schools had low earthquake preparedness regarding non-structural hazards, as most schools had not secured school building components, furnishings or equipment from falling during an earthquake (Fig. 8b).

In Portugal, the drills traditionally carried out concern fire safety, as the authorities pay much less attention to earthquakes; this holds also for schools in Lisbon (Fig. 9a). However, the usefulness of fire drills should be recognized, because fires can often follow a seismic event, due to damage to the water supply system (tanks, piping), the fire-fighting systems, and the electricity supply. The types of equipment available in schools were clearly devoted to the prevention of fires spreading (i.e., fire extinguishers). It is important

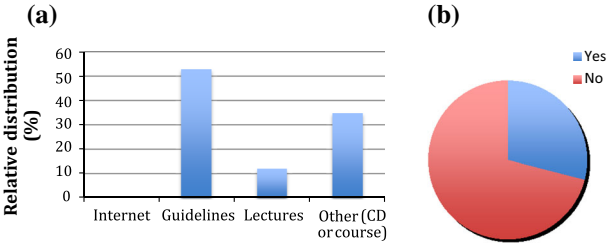

Fig. 8 Portugal: Results of the returned test surveys for the questions: **a** "How were information on seismic risk prevention processed?" **b** "Have loose objects like pictures/ frames, statues, shelves been especially attached?"

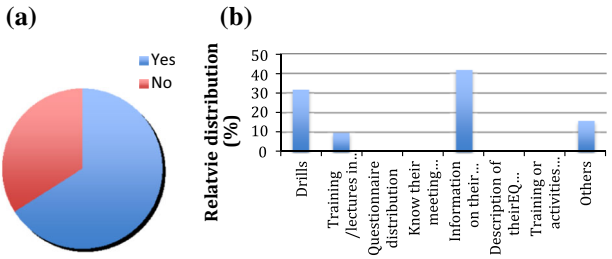

Fig. 9 Portugal: Results of the returned test surveys for the questions: **a** "Does the institution execute any drills (fire or earthquake)?"; and **b** "Were special action taken towards the children's education on the topic? If yes, what kind of education?"

to note that regular earthquake reactions and evacuation drills should occur separately from, but with the same frequency as, fire drills.

The pupils had neither an awareness of the local seismic hazard nor sufficient training to evacuate the school following an earthquake. Even their families were not aware of the actions to be taken (e.g., family disaster plans) to prepare for an emergency. This can be explained in part because recent generations in Portugal have not experienced earthquakes (Fig. 9b).

5 Conclusions

The present study provides a comparative analysis of earthquake risk reduction efforts within schools. It includes all of the schools in the seismic zone in Iceland, and despite the limited number of schools covered in Italy and Portugal, it depicts the situation in these countries as well, covering all ranges of seismic hazard, from low to high. The age range of school children reflected in the surveys is from 2 to 16 years in Iceland, 6–13 in Italy and 3–9 in Portugal. Despite the difference in the countries' sample methodology, both in regard of relative size and the age of school children (that the risk reduction is supposed to prevent or prepare for disasters) it indicates some similarities and differences noted here. It shows that all three of these countries put emphasis on having emergency plans to rely on in the case of an earthquake. In Italy, 70 % of the schools had emergency plans, compared to 57 % in Portugal, and 68 % in Iceland.

The differences between the Icelandic and Italian schools become evident with regard to the number of earthquake drills and whether there were special actions towards pupil education on the topic organised by the school management. In Italy and Portugal, most of the schools (70, 66 %, respectively) considered it valuable to carry out earthquake drills, even in cities where the seismic hazard is low. However, in Portugal, fire drills were much more common than earthquake drills, which reflects an insufficient level of awareness of the seismic risk. In Iceland, only 24 % of schools had regular earthquake drills. The equipment available in the case of an earthquake provides the greatest difference between these countries. None of the Italian schools reported having any equipment available, while only 10 % of the Icelandic schools did have equipment available. In contrast, the Portuguese schools appeared to be more prepared, as 86 % had equipment available, although this was focussed on the case of an emergency fire, which is only a secondary effect of an earthquake occurrence.

Although state plans do not include efficient actions towards hazard education (Musacchio et al. 2015), many schools were involved in training and lectures organised by research institutions or individual experts on the topic. This does not appear to be a rule for Iceland, where only 23 % of schools took on specific actions towards the education of the pupils on seismic hazard.

The involvement of the local authorities with respect to the distribution of the necessary tools to raise awareness and spread the culture of safety depicts Iceland as slightly better (47 %) compared to Italy (37 %) and Portugal (31 %). In Italy, even the schools located in seismic zone 1 (highest earthquake risk) that had experienced a recent destructive earthquake indicated that the local authorities did not provide the necessary guidelines to prevent disasters.

The earthquake preparedness of the schools reflects some peculiarities concerning the earthquake risk in the different countries. For example, the 2008 earthquake in south Iceland highlighted non-structural vulnerability, as the ground motion caused extensive interior damage to buildings. Nonetheless, only 47 % of the Icelandic schools had specifically attached loose objects to prevent them from falling in the case of an earthquake. In Portugal 29 % of schools had taken this preventive measures and 41 % in Italy, where earthquakes often cause extensive building damage.

In Iceland, earthquake risk reduction was also measured in health and welfare institutions. This part of the study shows that these institutions generally lag behind the schools in terms of the information available from the local authorities. Within the institutions, tasks such as securing the building interiors and providing emergency plans were taken care of better than the dissemination of information. Both of these tasks were, however, taken care of better than within the elementary schools, which show the lowest scores of the three types of institutions. That leads us to the main lesson that this comparison can give to the elementary school managers: they should approach earthquake risk reduction considering their dual roles of both educators and caretakers. Schools are certainly a working place for both the staff and the pupils, but the vulnerability of the children and teenagers who work and play in the school buildings needs special care and attention.

Risk education and consequent hazard mitigation are very important issue but, as indicated in this study, not adequately attended to in many schools in areas prone to earthquakes. Local authorities and the managers of schools and health institutions can reduce the threat to their clients by providing better information about preventive measures, more frequent earthquake drills and necessary equipment to use in the aftermath of earthquakes.

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Appendix

Questionnaire: ***Prevention and preparedness in emergency situations for schools and health/welfare institutions***

Locality information

School Name	*Address*	*Scholar population (include staff)*

Note: multiple choice questions can ask for single or multiple answers.

What is the type of institute?
☐ *Pre-school*
☐ *Elementary school*
☐ *Health/welfare institute*

1. Have the local responsible authorities distributed information about preventive measures related with seismic risk among schools, public institutions?

☐ *Yes* ☐ *No*

2. If yes, how did the authorities process the information?

☐ *They have published information on the web*
☐ *They have distributed guidelines*
☐ *They have organized training or lectures on the topic*
☐ *Others*

3. If yes, what kind of information is given?

☐ *Type of construction*
☐ *Seismic or volcanic risk information*
☐ *Behaviour to take in case of an earthquake*
☐ *General information on simple measure to reduce risk*
☐ *Others*

4. Have loose objects like pictures/frames, statues, shelves etc been especially attached?

☐ *Yes* ☐ *No*

5. Has the management of the institution distributed guidelines on preventive measures among school staff members?

☐ *Yes* ☐ *No*

6. Were special action taken towards kids' education on the topic?

☐ *Yes* ☐ *No*

7. If yes what kind of education?

☐ *Children were invited to special training days*
☐ *Training and/or lectures were offered within the schools*
☐ *Questionnaire were distributed among the children*
☐ *Children were informed about their school's building in regard to...*
☐ *Children were asked to gather information on their houses*
☐ *Children were asked to describe their experiences on earthquake*
☐ *Training or activities were organized within Science Festivals or other local educational festivals*
☐ *Others*

8. Does the institution execute any earthquake drills?

☐ *Yes* ☐ *No*
If yes, how frequently?
☐ *Every year*
☐ *Once in a while*
☐ *Every decade*

9. Does the institution have any emergency and prevention plan for earthquakes?

☐ *Yes* ☐ *No*

10. Has the institution available equipment to use in case of earthquakes/eruptions?

☐ *Yes* ☐ *No*
If yes, what kind of equipment?
☐ *Rope, shovels, hammer, screwdriver, etc.*
☐ *for heating and lighting*
☐ *for communication*
☐ *Others*

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