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How Can You Advocate for School Earthquake Safety in Your Community Through Classroom Education and Outreach?

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Abstract

EERI's School Earthquake Safety Initiative (SESI) is a global and collaborative network of diverse, expert, and passionate professionals who are committed to creating and sharing knowledge and tools that enable progressive, informed decision making around school earthquake safety. The Classroom Education and Outreach Subcommittee of SESI is focused on this mission through efforts inside the classroom where engineers expose students to earthquake and structural engineering principals. While other subcommittees within SESI focus on a top-down approach to policy and advocating for safety through ordinances that can be enforced within jurisdictions, the Classroom Education and Outreach subcommittee focuses on a grassroots approach. The aim is to create a bottoms-up momentum towards seismic safety where the general public, ranging from school administrators, parents, teachers, and students, can advocate for seismic safety in their classroom and make local change.

This committee has launched educational pilots primarily in the United States in elementary and high school classes using curriculum that is designed to introduce technical concepts and preparedness thinking at an accessible level. These lessons are intended to promote seismic education and awareness in classrooms where EERI members have direct access to students, teachers, and school administrators. The first pilots centered around schools in the San Francisco Bay and San Diego areas of California. To promote broader impact, the pilots have since spread to other regions where EERI student chapters already exist such as in Washington, Oregon, British Columbia, Canada, and Columbia.

Through these pilot efforts, SESI's lesson plans and equipment resources have been tested and vetted to improve effectiveness and adaptability to multiple classroom environments. Looking forward, SESI's goal is to make its resources more available and adaptable to assist with implementation into classrooms more globally. This paper will describe the SESI curriculum based on experience gained from the prior trials, as well as provide best practices for implementation in the classroom. This focus will help interested parties to start outreach programs in their local communities by acting as a starters guide. Links to all resources are included so that the activities described can be easily replicated or expanded by others who want to enhance school seismic safety in their own community.

Keywords: school seismic safety, advocacy, education, outreach



1. Introduction – EERI's School Earthquake Safety Initiative

The School Earthquake Safety Initiative (SESI) is a multi-approach effort by the Earthquake Engineering Research Institute (EERI) to advocate for the seismic safety of schools around the world. SESI takes advantage of EERI's interdisciplinary membership consisting of engineers, geoscientists, architects, urban planners, public officials, social scientists, educators, government officials, building code regulators, and other practicing professionals and students in order to make a broad impact in promoting school earthquake safety.

Per its mission statement, SESI is a global and collaborative network of diverse, expert, and passionate professionals who are committed to creating and sharing knowledge and tools that enable progressive, informed decision making around school earthquake safety [1]. The Classroom Education and Outreach subcommittee is part of the greater SESI network. SESI is led by an executive committee that coordinates the overall groups resources and goals for its five sub- committees: 1) Safety Screening, Inventory, and Evaluation of Schools, 2) Classroom Education and Outreach, 3) Tsunami Mitigation for Schools, 4) Code Updating and Improvements, 5) Safety Advocacy and Messaging. The organization structure and demographics of SESI can be found in more detail in previous SESI publications highlighting the initiative and its history [2].

1.1 SESI's Mission and Motivation

As part of SESI's mission, it "strives to serve everyone with a stake in school earthquake safety, from children and their parents, to teachers and administrators; from developers and architects, to engineers and builders; from financial institutions and building officials, to government agencies and emergency managers; from civil servants and commissioners, to local politicians and state and federal legislators" [1]. SESI leverages the extensive expertise and reputation of its members to conduct regionally appropriate actions that make a tangible and positive difference in communities around the world, by protecting the lives of all who inhabit school buildings.

The motivation to focus on schools specifically is related to unique characteristics about school structures. First, schools are the only high occupancy public buildings other than prisons and courthouses whose occupants are legally mandated to be inside them. Additionally, community members and public officials often hold higher expectations that schools will provide community shelter or host public services in the event of a natural disaster, even if this elevated performance criteria is unfounded. Among these reasons and others which are listed in a previous SESI publication for the American Society for Engineering Education (ASEE) [3], EERI has prioritized advocating for seismic safety for school buildings and established SESI to address this global need.

1.2 Classroom Education and Outreach Subcommittee

The goal of the Classroom Education and Outreach subcommittee is to take a grassroots approach to advocating for seismic safety in schools. By going into classrooms for outreach, SESI is creating ongoing dialog with community members, thereby developing community support for school seismic safety. While other subcommittees within SESI focus on a top-down approach to policy and promoting safety through ordinances that can be enforced within jurisdictions, this subcommittee aims to create a bottoms-up mechanism where the general public, ranging from school administrators, parents, teachers, and students, can be actively involved and take a leadership role in promoting seismic safety in their classroom and schools, which will ultimately influence local change.



There are three main objectives that motivate the outreach and education goals to which this subcommittee is dedicated [4]:

- 1) Earthquake safety to make advocates and connections at local school to assist future efforts to incorporate earthquake science and safety topics
- 2) Education standard to give schools immediate benefit of high-quality science lessons that satisfy latest education standards at a national and state level
- 3) Engineering principles to develop engaging, hands-on, project-based learning engineering curriculum which uses shake table technology to aid instruction

To address these goals, the Classroom Education and Outreach subcommittee created quality curriculum for multiple student audiences and set up pilots to vet and develop its outreach strategies and materials. The following sections review the committee's efforts to achieve the above goals.

2. SESI's Classroom Methods

The Classroom Education and Outreach subcommittee has achieved many of its goals to develop earthquake engineering curriculum, test it with pilot outreach launches, and create mechanisms to disseminate and share its resources with groups around the world.

2.1 Curriculum Development

In order to create quality curriculum, SESI developed the following strategy [4]:

- 1. Select one K-8 and one High School activity and assemble it into a lesson plan with appropriate documentation.
- 2. Collaborate with Advocacy Subcommittee, Screening Subcommittee, and Executive Committee to develop messaging to share with teachers, parents, and administrators.
- 3. Recruit and select final pilot groups and schools.
- 4. Create training materials.
- 5. Host training workshops in pilot regions.
- 6. Support pilot launch to local schools.

The selected target audiences for the curriculum are 4th graders and high school students. Though the breadth and degree of information varies between the two lesson plans, the basic templates are similar. Both lessons involve introductory overviews of earthquake and structural engineering concepts followed by a hands-on activity/design challenge. The specific learning objectives of these two curricula as well as a detailed history of the lessons' development can be found in a previous SESI publication targeted towards educators [3]. The 4th grade plan asks the students to develop a building structure from K'NexTM materials and provide lateral resistance to the building using diagonal braces or shear walls. Similarly, the high school design challenge requires students to retrofit a balsa wood structure by adding lateral resistance to the base model through the creative use of diagonal braces, shear walls, and gusset plates. In both challenges, the concept of minimizing the use of materials (related to cost implications) is also introduced. Both activities ultimately test the students' structures on a table-top educational electronic shake table to review performance and showcase how different retrofit strategies and designs perform. The students get a realistic sense on how their design decisions are directly related to the ultimate performance of their buildings and are introduced to basic engineering and design principles. Figure 1 shows an example of the high school design challenge with the balsa wood base model, retrofitted structure, and the test set-up on the instructional shake table.



Fig. 1 – Balsa Wood Structures for High School Design Challenge

2.2 Outreach Pilots

To further develop and test the curriculum for 4th grade and high school students, SESI launched pilots at different schools in California to vet the materials, troubleshoot challenges, and compile best practices to share with future users. The first two pilots occurred at UC Berkeley and UC San Diego and focused on developing the 4th grade and high school curriculum respectively. Details for these initial launches are included in SESI's ASEE publication [3].

A detailed review of some of the other pilots that have engaged with SESI since the initial launch can be found in SESI's previous publication for the 11th US National Conference on Earthquake Engineering [4]. These pilots covered represent the various schools that SESI had expanded its collaboration in 2018 and include UC Berkeley, Stanford University, and the University of Washington. Since its launch SESI has continued to expand and has reached EERI chapters around the world including California, Washington, Oregon, British Columbia, Canada, and Columbia. These efforts have been supported through each local university's EERI Student Chapter and has relied on student volunteers from those chapters to prepare and conduct outreach at schools in their local communities. The different organizers at these chapters have regularly met on Classroom Education and Outreach committee calls to discuss lessons learned and best practices to share knowledge with each other.

As the pilot network expanded, SESI members realized that similar challenges were experienced by members from around the world. These issues were centered on volunteer retention, transitional knowledge between graduating and incoming students, and resource acquisition. As SESI's outreach efforts continue to develop with the initiative, its goals have evolved from development of curriculum and pilot launching, to wider and more effective dissemination techniques and sustainability strategies.



3. Sustainability and Organizational Strategies for Retention

One of the biggest challenges faced by the initiative is sustainability in its member retention. While the Classroom Education and Outreach subcommittee of SESI has consistent members that help provide continuity for its goals and efforts, much of the leg work for SESI around the world is done by student chapters from various universities. The transient nature of this student help leads to unique challenges in creating a sustainable and consistent model for SESI's outreach efforts.

3.1 - Retention of Student Involvement

One of the key aspects of the current SESI outreach model is relying on student volunteers from EERI student chapters at universities around the world. Many of the students currently involved with outreach are either undergraduates who participate in the EERI Seismic Design Competition (SDC) or are graduate students involved with an EERI student chapter. These students often have an approximate two-year window between when they get involved with SESI and when they graduate. This leads to much turnover amongst the volunteers and makes it challenging to avoid losing familiarity and institutional knowledge of SESI outreach. This obstacle has hindered momentum from some outreach efforts that have been very active in a community or university one year, then fade off during the following term.

One of the goals of the subcommittee is to find new ways to broaden participation with SESI outreach amongst students. An option that the committee is exploring is engaging with other student groups outside of EERI. One opportunity would be to engage with the American Society of Civil Engineers (ASCE) student chapters at universities. These chapters tend to have many undergraduate students who are involved yearround in various engineering activities and design competitions. By engaging with more student groups at universities and not limiting SESI outreach to EERI affiliates, the pool of engineering students volunteering with SESI can widen and become more embedded in engineering student culture. This ideally would create a more consistent flow of volunteers as students graduate and new students join the organization.

3.2 – Integration with the Student Leadership Council

One of the primary sustainability goals of SESI is to utilize the connection with the EERI Student Leadership Council (SLC) as a hub for coordination with student chapters and volunteers. The SLC is a council within EERI with the mission to 1) help students to develop leadership and interpersonal skills, while gaining practical experience within the earthquake engineering fields, 2) serve as an active student earthquake engineering community for sharing knowledge, exchanging experiences and promoting education, and 3) represent home EERI student chapters and have the opportunity to positively impact other EERI student chapters [5]. Each year they organize, facilitate, and host the Seismic Design Competition (SDC) in which students from around the world design and build balsa wood towers and test them on a shake table to evaluate seismic performance. The SLC acts as the communication hub for this competition and maintains contact with EERI student chapters internationally.

The SLC has been gradually integrated into the Classroom Outreach and Education subcommittee. The SLC has implemented a SESI Chair on their council who acts as a year-round liaison between the SLC and SESI. This has provided much more effective communication and access for SESI to reach out to student members and provide opportunities for them to get involved with SESI as a committee and start their own SESI outreach programs at their schools.

An example of this successful integration with the SLC is a SESI Outreach Training Workshop "K'Nex with Your Community" hosted at the EERI Annual Meeting. This workshop started at the 2019 meeting in Vancouver, Canada, and has been a useful opportunity for SESI to advertise its outreach program to students and professionals. The SLC has been integral in getting the word out to students who are already attending the meeting as part of the SDC. Through this workshop, students learn about SESI's outreach program and go through the hands-on activity using K'NexTM to build and test their own structures as done in the 4th grade curriculum. By walking through the steps of the activity, the students feel more familiar with

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the process and are better prepared to continue outreach at their own schools using SESI's same lesson plans and materials.

3.3 Proposed Organizational Strategy

Figure 2 shows a proposed organization strategy of how SESI can integrate more effectively with the SLC. By placing the SLC as the primary point of engagement with student chapters, students will have a consistent communication channel to direct outreach questions regarding training, best practices, and local coordination. SESI will still manage and continue to develop its lessons and materials, but the regular trouble shooting and introductory questions that new students may have every term can be directed to and addressed by the SESI Chair on the SLC.

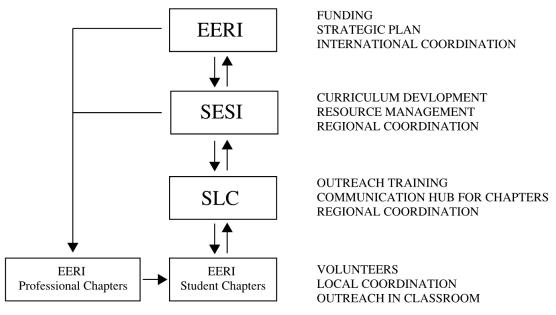


Fig. 2 – Proposed SESI Outreach Organizational Strategy

The SLC will make sure from year to year that transitional knowledge and resources about SESI are shared to continue momentum from term to term. By integrating with the constant position of a SESI Chair on the SLC, students will have a regular point of contact and institutional knowledge can be better transitioned each year. This centralization of a point of contact through the SESI Chair will help with sustainability of the initiative as it continues to grow.

Additionally, one goal is to engage with the local EERI professional chapters to conduct outreach. The vision is that professionals and students can work on outreach together within local communities, not only as a networking opportunity to collaborate with each other, but to tandemly serve their local communities as professionals and students. Professionals are more likely to have contacts in local schools and can help reach out to school administrators to offer outreach programs. Also, professional members are better equipped to provide visual screenings and evaluations of the schools where outreach occurs. By integrating them directly in the classroom outreach with students, the necessary follow-up conversations are more likely to happen and the benefits to school seismic safety and preparedness are more likely to occur.



4. How to Do Classroom Outreach

Getting mobilized to start an outreach program can be the most challenging hurdle to overcome. Many chapters have enthusiasm and motivation to start their own outreach efforts in their local communities, but experience friction in acquiring resources and effectively communicating what their outreach program should look like to administrators. This section is intended to provide some guidance and direction to resources to help anyone start a local outreach effort in their community. The following steps are recommended to launch a SESI outreach program:

- 1. Contact the SESI Classroom and Education Outreach subcommittee (email at sesi@eeri.org) about getting started and/or visit SESI website (eeri.org/projects/schools)
- 2. Contact local EERI student and professional chapters for support, fundraising assistance, and local school contacts.
- 3. Acquire funds through school, company, and/or EERI support. (see Section 4.1.2)
- 4. Download curriculum lesson and documents from SESI website. (see Section 4.1.3)
- 5. Purchase building materials and purchase or borrow shake table for use with lessons.
- 6. Recruit volunteers from student and professional EERI chapters. (see Section 4.2)
- 7. Contact local schools and coordinate outreach visits. (see Section 4.3)
- 8. Train volunteers with SESI training videos and/or workshops. (see Section 4.4)
- 9. Conduct classroom visits in local community.
- 10. Maintain relationships with school administration teachers to build regular outreach and continue conversation about seismic safety in schools.
- 4.1 Acquiring Resources and Funding

Getting the resources, materials, and funding needed to conduct outreach can seem intimidating to a group starting off. It is highly recommended to contact SESI initially to get the insight accrued through SESI's pilot launches and current ongoing outreach. Specifically, it is advised to let the Classroom Outreach and Education subcommittee or SLC SESI Chair know that there is interest to start a new outreach effort in a community to access the latest advice and materials. SESI can share examples of past budgets to provide an idea of expected costs when launching an outreach chapter. Table 1 shows an example budget that was used in 2019 by the University of Washington's EERI chapter to launch their own SESI outreach effort for the 4th grade curriculum.

Item	Cost
Portable Shake Table	\$3995.00
Pelican Carrying Case	\$259.00
Weight Catchers/Suspender	\$198.00
K'Nex Pieces	\$240.00
Supplies Storage Container	\$50.00
Accelerometers	\$70.00
Overhead (5%)	\$240.00
Total	\$5052.00

Table 1 – Example Budget for SESI Outreach Launch from University of Washington Proposal

There are some items, like the K'NexTM, that require an initial investment but may be reused year to year. Contrastingly, for the high school activity, the balsa woods supplies are not reusable and need to be purchased for each classroom visit.



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4.1.2 Acquiring Funding

One of the first challenges that can deter a chapter from starting outreach is a lack of funding. Many chapters have been successful in finding funding sources that can cover launch costs to get started with outreach. This early funding can come from a variety of sources including engineering departments, EERI student chapters, EERI regional chapters, and even local firms. SESI can provide examples of past letters, proposals, and templates for donation requests that other chapters have used to help acquire financial resources.

There are cases where SESI can directly support a chapter's launch funding needs. Furthermore, by coordinating with SESI, some resources like the electronic shake table, can be borrowed from nearby chapters or neighboring universities to reduce initial costs and help new chapters get started.

4.1.2 Downloading Materials and Lessons

The SESI Classroom Education and Outreach website [6] currently provides the published lessons available for download and organized into lesson/material categories. Both the 4th grade and high school lessons are available free of charge online for anyone to access as shown in Figure 3 below.

Classroom Curriculum The following 4th grade and High School lesson plans were developed to teach engineering principles and seismic safety to students.	
4th Earthquake Engineering Classroom Lesson Plan:	
1- Intro for teachers material Download material (6.1 MB .zip)	
 Lesson Summary and Curriculum Mapping (.docx, PDF) Materials List (.docx, PDF) 	
2- Posters material Download material (7.8 MBzip)	
 Engineering Design Process (.docx, PDF) Talk Like a Scientist (.docx, PDF) Vocabulary List (.docx, PDF) 	
3- Lessons 1-2 Download material (22 MB .zip)	
 Lessons 1-2 Combined (.docx, PDF) Design Element Worksheets – Teacher version with answers (.docx, PDF) Design Element Worksheets – Student version (.docx, PDF) Group Data Sheets (.docx, PDF) Lesson 1 Supplement (.docx, PDF) 30 day M 4.5 Earthquakes Worldwide (.png) Performance Descrption Chart (.png) 	
Eathering Easter Provide Provide (ant)	

- Earthquake Engineering Presentation (.ppt)

Fig. 3 - SESI Website Curriculum Download Section

This section of the SESI website divides the material into categories to help the user get started. It provides introduction materials, poster materials, and individual lessons with supplemental documents to help the user keep related items grouped and organized.

4.2 Volunteer Recruiting

A critical task in conducting outreach is assembling a team of volunteers to go into the classrooms to teach the lessons. Many college students are eager and enthusiastic to help with outreach but can understandably become too busy and over committed to other activities. EERI student chapters are a valuable pool of potential volunteers, especially graduate students. Advertising to these members early is key to recruiting them prior to them becoming overbooked. Orientation events are a great opportunity to advertise since most students have not decided which extracurricular activities to get involved in. ASCE and SDC events are also useful opportunities to access undergraduate students who may be interested in outreach and may have more time compared to graduate students.



Additionally, EERI professional members may be interested in helping with outreach, particularly if they have children in school. These members can also be great contacts to reach teachers and local school administrators to start the conversation about visiting their classrooms. Reaching out to a local EERI regional chapter can be the easiest way to access a pool of professional members who may be interested in volunteering or connecting your chapter to schools in the area.

4.3 Outreach Coordination to Local Schools

Finding contacts at schools in the area is another critical step in conducting outreach. Many universities do outreach programs already. In fact, education departments on campus have connections to local school districts and teachers and may be able to provide contacts to administrators. Identifying good candidate schools in the area that are accessible to volunteers is helpful prior to reaching out. Teachers are often excited to hear about the opportunity to have engineering students provide lessons for their classrooms, especially for curriculum that has been developed to meet state and national education standards. When starting off, it is better to not over commit to conduct outreach at too many schools as to avoid volunteer burn out or not being able to provide the requested classroom visits.

It is also important to consider the time of year when planning outreach. Avoiding times when important exams are coming such as Advanced Placement (AP) or International Baccalaureate (IB) testing is a good practice for high school classroom visits. The pilots in high schools have used the window after AP testing as an easy time to visit AP Physics classrooms. Though the curriculum does not require an AP Physics background, these classrooms tend to be more relaxed and eager to have outreach visits once they are done with their AP tests. Considering this when requesting to visit a classroom helps create a better opportunity for the teacher/administrator to go through with the visits.

Once a school has declared interest it is important to follow through and maintain the relationship. Some teachers are happy to continue with outreach every year and can also provide connections to other schools in the area.

4.4 Curriculum Training

Through the pilots over the past few years, SESI has recorded presentations from various classroom visits to act as training videos for anyone seeking to use the prepared presentations. Figure 4 shows how the online training videos are divided into different lessons on SESI's website.



SESI-Classroom-Training-Video-4th-Grade-Lesson-2015-12 from EERI on Vimeo.

Fig. 4 – SESI Website Curriculum Training Videos Section



These videos act at the most accessible form of outreach training as they show how a presenter gives each lesson and engages with students. Though SESI offers the occasional hands-on training workshop at conferences, these videos provide the easiest instruction for chapters to use on their own time and as often they would like. Though there has been work to modify the lessons for audiences of difference languages, specifically Spanish, that development is still an ongoing effort and no materials have currently been published through SESI in any language other than English.

4.5 Communication with SESI

One of the critical aspects of effective and sustainable outreach programs is consistent communication with the SESI network. Many chapters have common issues and best practices that are better realized and addressed via communication with SESI. As some chapters have established outreach programs, they can provide guidance to newer chapters that are navigating launching a program for the first time. Additionally, SESI has established monthly calls for chapters to provide updates about their programs and hear about what other chapters around the world are doing. This communication channel provides a lens into similar efforts that can have new ideas and fresh perspectives regarding local outreach, school recruitment, volunteer retention, etc. Maintaining healthy and regular communication between the Classroom Outreach and Education subcommittee and the EERI student chapters allows both parties to grow and learn from the collective experiences of the initiative and helps the overall outreach network become more connected and robust.

5. Conclusions – Future Work and Goals

Since SESI's inception in 2014, much has been learned and vetted from the various working groups and committees. SESI's Classroom Outreach and Education subcommittee is entering a phase in its development where dissemination and resource sharing are taking the forefront of its goals looking forward. As SESI hopes to act as a hub for communication and resource collaboration for individual regions' outreach efforts, its future goals focus on developing SESI's central infrastructure and communications channels.

5.1 External and Internal Library of Seismic Safety Resources

SESI wants to develop is resources and document sharing systems to be able to act as a library of seismic safety resources. Ideally this library will have two main functions. First, the library would act as an internal resource for SESI outreach where chapters can find the latest lessons, materials, and references to be able to conduct their own outreach efforts in local communities. Second, the library would also have a section for external, non-EERI affiliated parties to be able to access information about school seismic safety. These documents would help guide stakeholders to make informed decisions about why and how to seek professional services to evaluate and potentially retrofit school buildings to better seismic performance criteria.

One item that SESI aims to add to its library is fact sheets on school seismic safety that can be shared with school administrators, teachers, children, and parents. These sheets will provide the opportunity to leave information with classes after outreach visits that can stay with them to help better prepare their classrooms, school buildings, and homes for earthquakes. This fact sheet would include information to help empower laypeople to better prepare for earthquake hazards. It would include information ranging from bracing non-structural components in classrooms to understanding what type of buildings are vulnerable in earthquakes to help create advocates for seismic safety in schools and at home.

5.2 Improved Integration with Other SESI Subcommittees

An ongoing goal of SESI has been to improve the integration between its various subcommittees. Of the five current subcommittees, the Classroom Education and Outreach subcommittee is the most active and integrated with EERI's membership. The initial vision of the subcommittees included collaboration to where each group could help the others with opportunities to reach stakeholders and share their expertise. For example, while the Classroom Education and Outreach group would start the conversation of seismic safety

with a school and its administration, the Safety Screening, Inventory, and Evaluation group would ideally follow-up and continue the dialogue by providing visual screenings and evaluations of structures to give school occupants and administrators accurate information about the seismic hazards and performance expectations of their buildings. Additionally, the Safety Advocacy and Messaging subcommittee could provide materials and literature to leave in classrooms after an outreach visit that could better inform teachers of how to prepare their classroom to reduce non-structural damage or hazards to their students. This meshing between subcommittees has yet to materialize and is potentially the initiative's biggest obstacle and opportunity to improve its effectiveness in advocating for seismic safety.

These future goals and targeted improvement have been works-in-progress for SESI since its inception. Though there is still much to accomplish to reach its ideal model, significant progress has been achieved due to the generous volunteer time that its members and supporting students have committed. The hope is that more people around the world can join SESI's momentum and support the initiative's ambition of truly making all schools a safe place for students everywhere.

6. Acknowledgements

The authors of this paper would like to express their gratitude to the members of the School Education and Outreach subcommittee and all the volunteers who have participated in outreach at schools around the world. The countless hours of volunteer time that these individuals have spent have allowed the SESI initiative to be so successful in advocating for school safety and have increased awareness of seismic hazards and preparedness to communities all over the country and globe.

Additionally, SESI is currently seeking support for its ongoing work. Since its inception, SESI has received grants and support from the following sources; FEMA, the EERI Endowment Fund, and the Coastal Zone Foundation. EERI acknowledges these supporters and thanks them for support they've provided to help SESI achieve its mission.

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