ShakeOut at OMSI: Museum-Wide Drill 2023

Summary and Evaluation Report

Museum visitors *Drop, Cover, and Hold On* in the Turbine Hall at OMSI

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OMSI Engagement Research and Advancement

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Executive Summary

The Great ShakeOut is a global earthquake preparedness event that occurs the third Thursday of every October. Individuals and organizations all over the world participate by practicing earthquake protective actions (e.g. Drop, Cover, and Hold On) and engaging in other activities to promote earthquake resilience.

This report describes a museum-wide earthquake drill that took place at the Oregon Museum of Science and Industry (OMSI) on October 19th, 2023 as part of the Great ShakeOut. This was a cross-departmental effort that involved staff working in facilities, education, guest services, research and evaluation, and more. The purpose of this report is to summarize plans, implementation, and evaluation of OMSI's ShakeOut drill, in order to improve future drills at OMSI as well as other Free-Choice Learning Environments (FCLEs).

In FCLEs like OMSI, a broad range of visitors and staff interact in a dynamic, social setting. This fact presents challenges when it comes to communicating and facilitating a campus-wide drill. At the same time, this diverse, dynamic, and interactive environment presents a unique opportunity for social learning.

With this in mind, successful elements of the drill included:

- Communicating with staff and visitors in advance, via multiple modalities
- Prioritizing inclusion and access by providing all information in both English and Spanish, and by including recommended protective actions for a range of physical abilities
- Encouraging participants to make plans with the people around them (whether fellow staff, fellow visitors, or both) for how they would respond during the drill and/or during a real earthquake
- Appointing OMSI staff around the museum to verbally encourage participation and model protective actions in different settings

Additionally, the drill revealed opportunities for improvement, both for future exercises and for responding to real-life earthquakes. These included:

- Challenges with the audio announcement and PA system used to facilitate the drill
- Concerns about specific parts of the OMSI campus, where historic infrastructure may pose additional hazards during shaking

Even with these challenges, evaluation results suggest that the drill was a positive experience for most participants, who broadly cited the benefits of planning and practicing protective actions—particularly in a public setting, with other people. FCLEs like OMSI, who wish to meaningfully impact learners' knowledge, confidence, or skills related to earthquake safety can continue to leverage social learning, whether through drills, hands-on activities, exhibits, or other experiences.

Background

The Great ShakeOut is a global earthquake preparedness event that occurs the third Thursday of every October. Individuals and organizations all over the world participate by practicing their earthquake protective actions, such as Drop, Cover, and Hold On, and engaging in other activities to promote earthquake resilience.

On October 19, 2023, OMSI participated in this global event by holding a museum-wide earthquake drill. This report describes:

- The rationale and research that informed this effort
- Drill plans and procedures
- Evaluation methods and results
- Recommendations for OMSI and other Free-Choice Learning Environments (FCLEs), to support future drills and related earthquake preparedness activities

OMSI is committed to advancing earthquake resilience, both within our own institution and in West Coast communities. In the Pacific Northwest where OMSI is located, the Cascadia Subduction Zone poses a significant earthquake hazard; meanwhile, communities in California are faced with seismic threats from the San Andreas Fault. One of OMSI's strategic priorities is promoting "informed action for complex challenges" (OMSI, 2020). Given the complex challenges of living in earthquake country, OMSI is called to prepare staff and visitors—as well as our broader, regional communities—with knowledge and skills that support earthquake resilience.

Historically, OMSI staff have participated in annual training for earthquakes and other emergencies, but prior to 2023, OMSI had never held a museum-wide drill with visitors during museum open hours. In planning our first public ShakeOut drill, our intent was to design an educational and accessible experience for both staff and visitors; build on existing research and resources related to earthquake learning; and produce new resources for OMSI and our colleagues in the Free-Choice Learning field. The findings from these efforts will be shared with other Free-Choice Learning professionals through the ShakeAlert EPIcenter Partnership.

Research and Rationale: Why Hold an Earthquake Drill in a Free-Choice Learning Environment?

Preparedness exercises (including drills, simulations, practice scenarios, and tabletop exercises) can equip people to respond quickly and effectively in the event of an earthquake or other emergency. These activities serve multiple learning purposes, including:

- ***Educational*** - Preparedness exercises, such as drills, support overall awareness of earthquake hazards and can establish or strengthen peoples' knowledge of protective actions and procedures (e.g. Blakley & Chen, 2009; Çoban & Göktaş, 2022; Koglbauer, 2016; Vinnell et al., 2020).
- ***Procedural*** - In a drill, participants rehearse specific actions and roles they can take to keep themselves and others safe, allowing them to respond quickly and automatically during a real emergency (Adams et al., 2022; Nakaya et al., 2018). Evidence suggests that regular (as opposed to one-time) practice has a cumulative effect, with each drill leading to subsequent improvements in participants' ability to effectively perform the practiced actions (e.g.,Schildkraut et al., 2022).
- ***Transformational*** - Preparedness exercises may reveal organizational inconsistencies, vulnerabilities, or other needs related to earthquake safety. Organizations can use these exercises to learn *from participants* how to improve their emergency procedures, as well as refine their communication about those procedures (e.g. Tipler et al., 2016; Simpson, 2002).

While many people living in earthquake-prone regions have experience with school-based earthquake drills, fewer have practiced protecting themselves at home, outdoors, at work, or in a public setting. According to official counts for the 2023 Great ShakeOut Drill, of the 578,506 individuals registered, over 90% participated in a school setting (K-12, college, or university), while fewer than 10% participated from *all other settings combined* (ShakeOut, 2023). Disaster researchers, too, find that, when it comes to earthquake response at home, in public, or in other non-school settings, people are less practiced, less knowledgeable, and ultimately less likely to perform a recommended protective action (e.g. Adams et al., 2022; Johnson, 2014; Vinnell et al., 2020). Similarly, in research conducted at OMSI, we found that while most OMSI visitors had practiced an earthquake drill at school, most had *not* practiced outside of school, nor had they practiced with the group of people (family or otherwise) with whom they came to OMSI (Herrán et al., forthcoming).

As social settings that engage broad, intergenerational groups of learners, FCLEs like OMSI can directly address this need. Earthquake learning should be social because earthquake experiences are inherently social; in real-life emergencies, people make protective decisions based not just on what they *know*, but on social, emotional, and environmental factors, such as the presence of children, cultural behavioral norms, and the responses of those around them (Adams et al., 2022; Lindell & Perry, 2012; Vinnell et al., 2022). What's more, by practicing earthquake protective actions in an unconventional setting like OMSI, participants may develop a broader situational awareness that could serve them *wherever* they experience a future earthquake—whether at OMSI, at home, at school, or another location.

Drill plans and procedures

In developing plans and procedures for the 2023 OMSI ShakeOut drill, we were driven by the needs and research described above, as well as needs for clear communication; social learning; inclusion and accessibility; and cross-museum coordination.

Clear and Advance Communication

Though "surprise" drills may have value in certain situations, we felt that to create a positive learning experience for staff and visitors, participants should know what to expect and how to respond. To this end, we planned multiple modes of communication with staff and visitors, both in the weeks leading up to the event and on the day of.

- **Staff (employees, volunteers, and contractors) –** An All-Staff Info Sheet (Appendix A) was distributed to staff via email approximately two weeks prior to the drill, and again the morning of October 19th. The same information was provided verbally at various all-staff and departmental meetings in the weeks prior. Several staff were appointed with specific roles for the drill including members of Facilities, Guest Engagement, Guest Services, Program Sales, Volunteer Services, and Engagement Research & Advancement. Many, but not the majority, of the staff members present had intermediate, advanced, or native Spanish language conversation skills.
- **School groups –** To ensure that students and teachers on scheduled field trips knew what to expect, a ShakeOut Letter for School Groups (Appendix B) was sent to participating schools in advance; school representatives were, in turn, encouraged to share the letter with the families of students participating in the OMSI visit.
- **General museum visitors –** Visitors who entered the museum on the morning of October 19th were provided information about the drill upon checking in or purchasing tickets. A guest services representative verbally informed them about the planned drill and provided a one-page info sheet in English and Spanish (Appendix C).

Social Learning

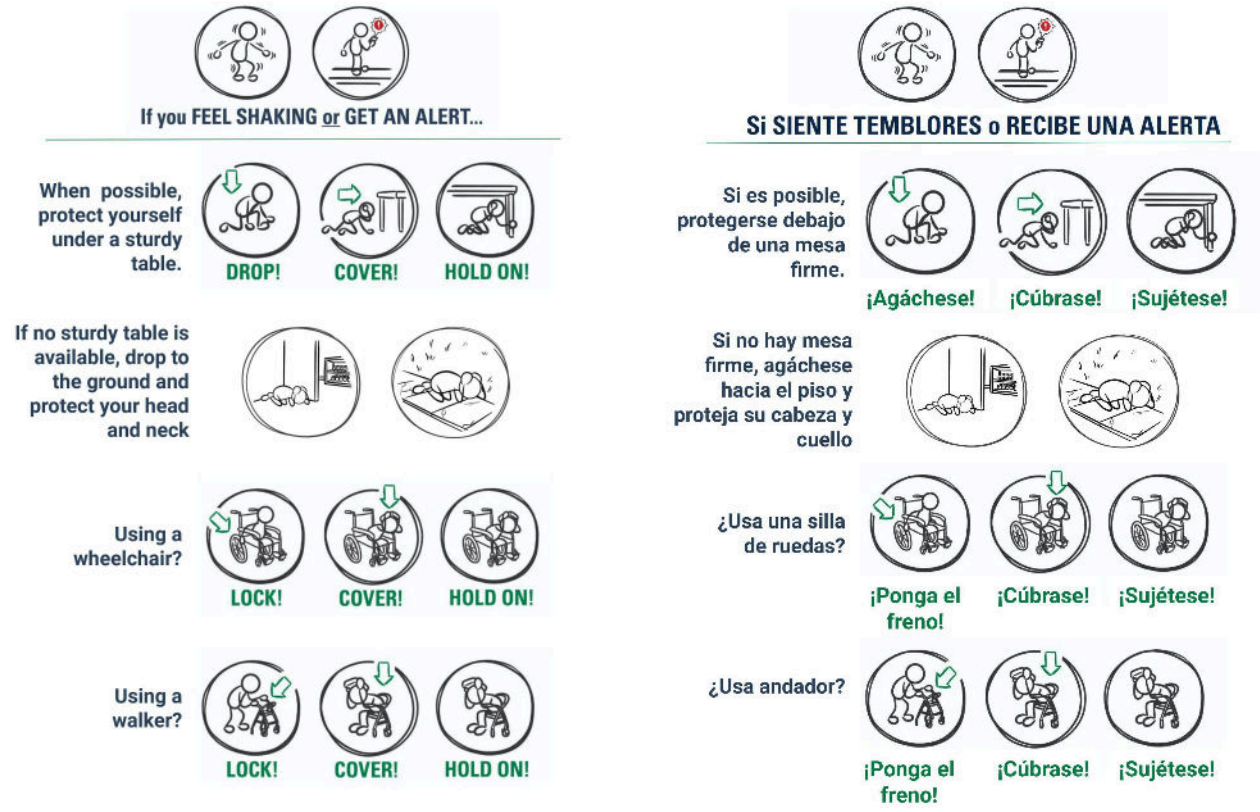
In planning the drill activities, we were mindful of creating a positive social learning experience. We knew from previous research with OMSI visitors (Herrán et al., forthcoming) that people were interested in learning about social and emotional factors related to earthquake safety, in addition to engaging with more fact-based information about the causes and effects of earthquakes. Participants in this prior study indicated that they benefited from discussing their earthquake plans with their families or other group members prior to engaging in a drill or similar activity. With this in mind, for the hour prior to and after the drill, OMSI staff facilitated two "ShakeOut stations" within the museum, where they encouraged visitors to learn about and discuss ways to protect themselves in various settings. Staff at these stations also facilitated hands-on earthquake activities, answered

questions, and provided information about earthquake science, preparedness, and safety. Additionally, in the minutes before the drill began, OMSI staff positioned themselves throughout the museum and verbally reminded visitors around them to assess their location, confer with their group members, and determine how and where they would Drop, Cover, and Hold On.

An educator at a ShakeOut Station provides information about protective actions and leads a hands-on earthquake science demo with OMSI visitors.

Inclusion and accessibility

OMSI is committed to creating inclusive and accessible experiences that serve our diverse visitors. For the purposes of the ShakeOut drill, we were particularly concerned with accessibility related to language and physical needs. To this end, all drill communications were provided in both English and Spanish (the second most commonly used language in Oregon). Additionally, all drill materials included language and graphic recommendations emphasizing a variety of ways to Drop, Cover, and Hold On—with or without a table, and with or without physically dropping to the ground.



All communications included language in English and Spanish and graphic depictions, as well as recommendations for a variety of physical needs and contexts.

Coordinated, Museum-wide Implementation

OMSI's Water Ave campus includes multiple structures and spaces used by visitors and/or staff. The primary museum building is the largest of these spaces, containing multiple exhibit halls, a theater, cafe, and planetarium, as well as off-stage staff areas (see Appendix D). In addition to the primary museum building, several auxiliary spaces are part of the OMSI campus and were included in the 2023 ShakeOut drill. These include: the Blueback Submarine, Pepco building (exhibit fabrication shop), and the 1800 building (outreach staff offices and facilities). Each of these spaces is unique, both in the hazards they present and the opportunities for cover they provide. We designed the drill procedures so that staff and visitors at each of these locations could simultaneously participate.

The official drill began at 10:40 am with a PA announcement, which was broadcast throughout OMSI campus via wall-mounted speakers and desk phone speakers. With this campus-wide PA system, wall-mounted speakers are designed to be audible throughout large, common areas (e.g. exhibit areas, cafe, hallways, etc.) while announcements pushed through desk phones are designed to reach smaller areas, such as staff offices and conference rooms.

The 2.5-minute, pre-recorded drill announcement included instructions in both English and Spanish and prompted people to Drop, Cover, and Hold On. The audio instructions

also provided guidance for wheelchair users and for people in areas of the museum without tables or other means of cover. For complete audio script in English and Spanish, see Appendix E.

During the drill, many OMSI staff participated on the museum floor alongside visitors, providing verbal encouragement and modeling effective protective actions. Other staff participated in off-stage areas (such as offices) where they were working at the time.

Afterwards, visitors were invited to take a short survey (see Methods) and to visit a ShakeOut Station to debrief or ask questions with an OMSI staff member, if desired.

Evaluation

Evaluation activities were planned and conducted as part of the 2023 OMSI ShakeOut drill, in order to improve future drills at OMSI and share lessons learned with the broader field of Free-Choice Learning Environments.

Study design

Our approach to this outcome-based evaluation was informed by many of the same considerations that informed the drill procedures themselves. Specifically, we hoped to better understand:

- Participant learning outcomes, particularly the impact of the drill experience on participants' **sense of safety** related to earthquakes
- **Social dimensions** of participants' drill experience
- The **environmental context**, including audio, visual, tactile, spatial and structural factors that affected participants' drill experience

In exploring these dimensions, we took an asset-based approach, assuming that all participants brought their own experience, expertise, and interests to the drill activity, and that these assets influenced their learning. These considerations ultimately informed the evaluation protocols and instruments for both public and museum staff.

Methods

Data collection instruments

To address the purposes described above, we relied on both categorical and open-ended data, reported by individuals who participated in the drill on October 19th. Primary means of data collection included:

Visitor surveys: Appointed OMSI staff offered adult visitors printed surveys in English and Spanish after the museum-wide ShakeOut drill was finalized (see Appendices F and G). Data collection lasted between 5–15 minutes depending on the time visitors took to

complete and return the survey to OMSI staff. Adults self-selected to respond to the survey; they answered demographic questions for themselves as well as some related to their group composition. Thirteen surveys were collected.

***Staff surveys*:** An online survey was sent to the All-staff email group which includes paid employees, volunteers, and retail contractor managers with an OMSI email address. These staff members were from all museum departments. The staff were invited via email to complete the online survey that included both closed- and open-ended questions about whether and where they were present during the drill and if so, their experience with that event (See Appendix H). Thirty-nine surveys were completed.

***Additional qualitative* observations:** In addition to collecting formal feedback via the visitor and staff surveys, this evaluation is also informed by qualitative observations and feedback shared by staff and visitors through other means (e.g. follow-up conversations and emails, etc.). These informal responses are equally important and inform the discussion and recommendations presented here.

Evaluation participants

Visitor sample size, demographics, and group composition

On the day of the drill, the museum attendance was comparatively low, as is typical for a weekday in October. Based on estimates from Program Sales, approximately **200 students and teachers** were onsite as part of school field trips. An additional **240 OMSI visitors** checked in at the ticket desk between 9:30am (when the museum opened) and 10:40 am (when the drill began). Staff onsite included **10 volunteers** and approximately **100 employees,** bringing the total number to approximately **550 individuals** onsite at the time of the drill.

Of those onsite, 13 visitors completed the Visitor Survey and 39 staff members completed the Staff Survey. Tables 1–3 describe respondents' self-reported gender, ethnicity, and group composition (open-ended response items).

Table 1. Visitor reported demographics: Gender

Please write the gender(s) that describe you (n = 13)

	Male	Female	Another	No response
Visitor (*n* = 13)	1	7	1	4

Table 2. Visitor reported demographics: Race and ethnicity

Please write the racial or ethnic groups that describe you (n = 13)

	White	Biracial	Another	No response
Visitor (*n* = 13)	8*	1**	0	4

*Respondents reported they self identify as White or caucasian.

**This person reported two ethnicities and races. In this case Filipino and White.

Table 3. Visitor reported demographics: Group composition

Who did you visit OMSI with today? Write the number of adults (including yourself) and minors in your group?

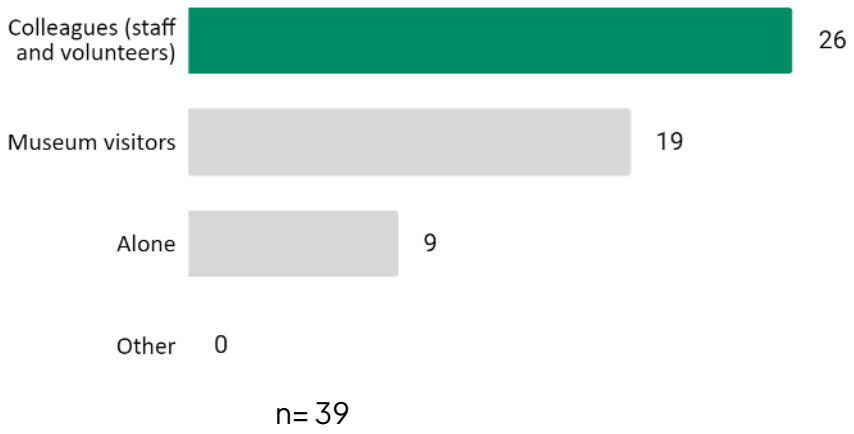
		1 Adult	2 Adults	3 Adults	4 Adults
	Total Groups	**8**	**2**	**1**	**1**
1 Child/youth	**6**	5	1		
2 Children/ youth	**1**	1			
3 Children/ youth	**2**		1		1
4 Children/ youth	**3**	2		1	
No response	**1**				

All of the visitor groups who responded to the survey included at least one child. The most common group composition consisted of a single adult with a single child.

Staff sample size and social situation

In addition to being asked about their physical location, staff were asked, "Who were you with at the time of the drill"? Most OMSI staff responding to the survey (30 out of 39) reported they were with someone at the time of the drill (see Figure 2). Of those 30, 12 reported that they were with both colleagues and visitors; 18 reported they were either with colleagues or visitors. (Responses add up to more than 39 because people could check all that apply).

Figure 2. OMSI Staff – who were you with at the time of the drill?

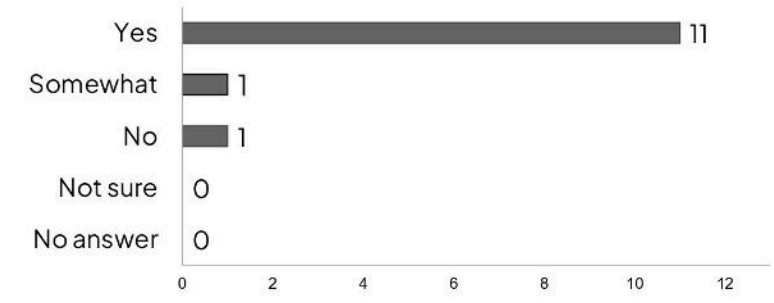


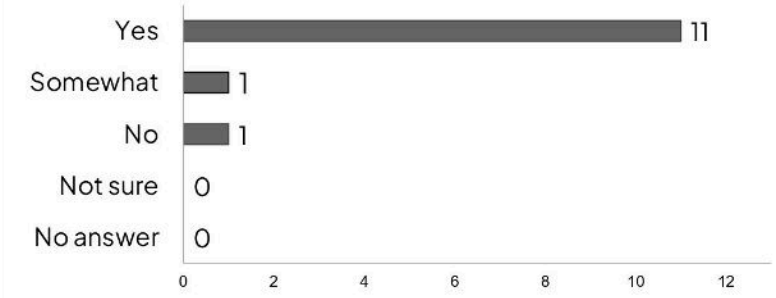
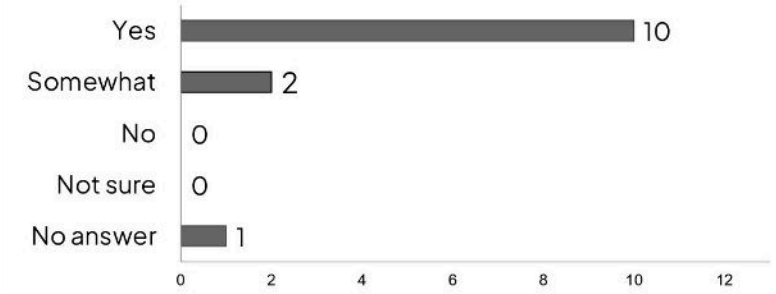
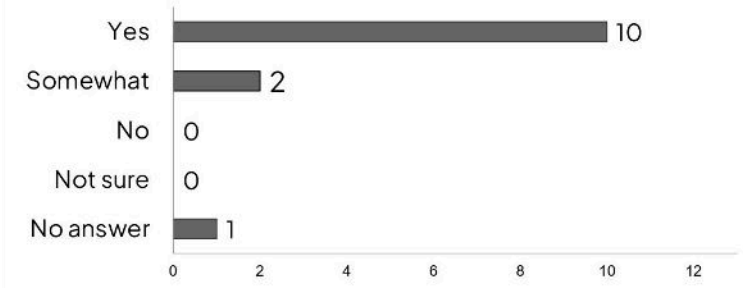
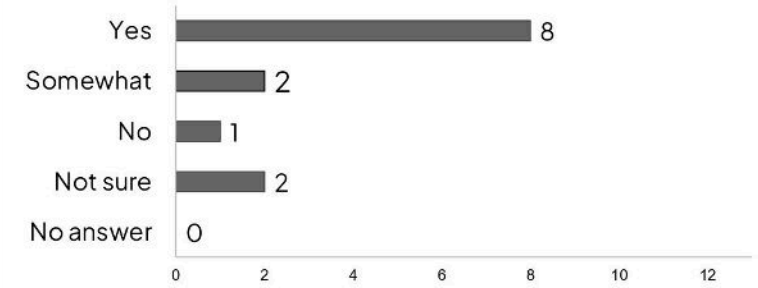
Results

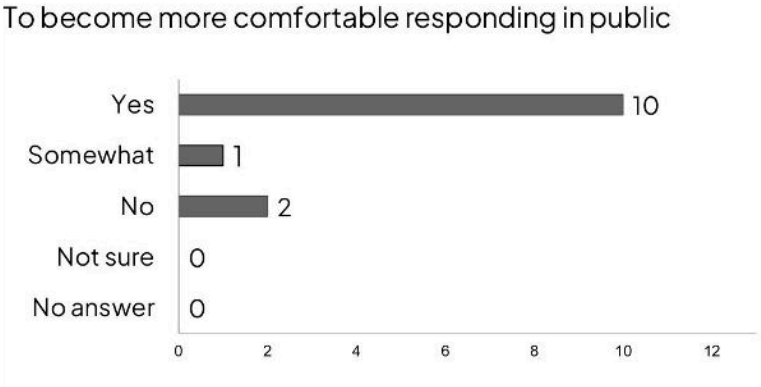
Visitor experience

Visitors were asked to consider a variety of ways that the earthquake drill may have been useful to them. For each of these potentially useful activities (e.g. practicing an earthquake drill in a less familiar location), participants were offered four response categories (yes, somewhat, no, and not sure). An additional, open-ended item asked visitors, "In what ways, if any, did this experience in the Great ShakeOut drill support your sense of safety for you and your group?" Table 4 summarizes results from both items, pairing categorical responses (left) with relevant open-ended responses (right)

Table 4. Visitor survey responses related to the usefulness of the earthquake drill

The earthquake drill at the museum was useful for me:	Related open-ended responses
To practice an earthquake drill in a less familiar location 	*"Was nice to know what it would sound like to practice in public w/ the kids."*

To have OMSI staff support us during the drill 	*[No related open-ended comments]*
To make a plan with my group before the drill 	*"It was good to know it was coming up, so we could find a table or bench. There were not many covered spaces."*
To respond as part of a group during the drill 	*"It taught my 2.5 year old the 'turtle' pose for earthquake safety."*
To gain awareness of the feelings expressed by my group 	*"We had our 3 year old granddaughter with us. It was age appropriate & not scary for her."* *"Good practice for the 3 year old. He participated & was not scared."*



"Was nice to know what it would sound like to practice in public w/ the kids"

"It's a good idea to practice in public spaces."

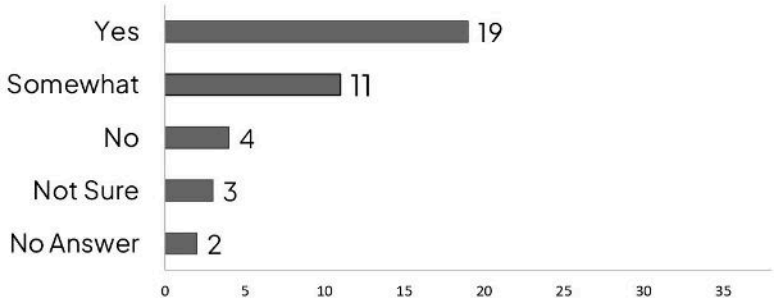
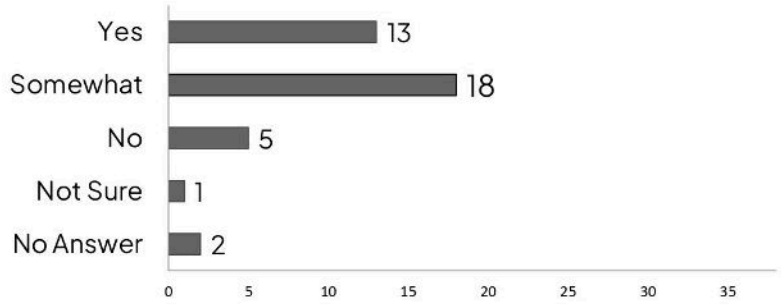
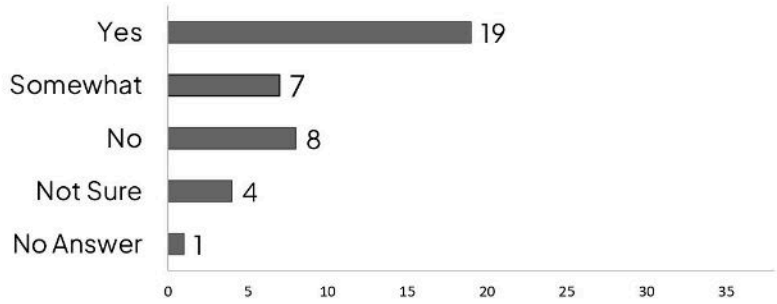
Both closed- and open-ended items indicate that the majority of respondents felt the drill was useful for them. In particular, participants valued the social and environmental affordances of the drill, including practicing in a new location, having support from OMSI staff, and making a plan with their group members.

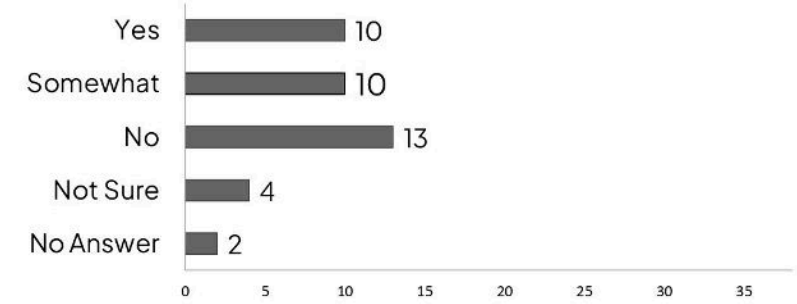
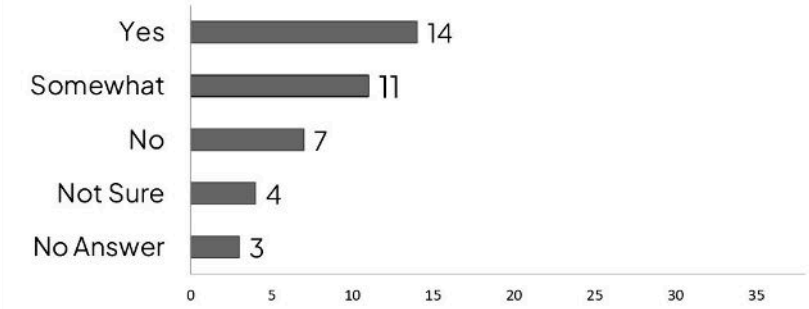
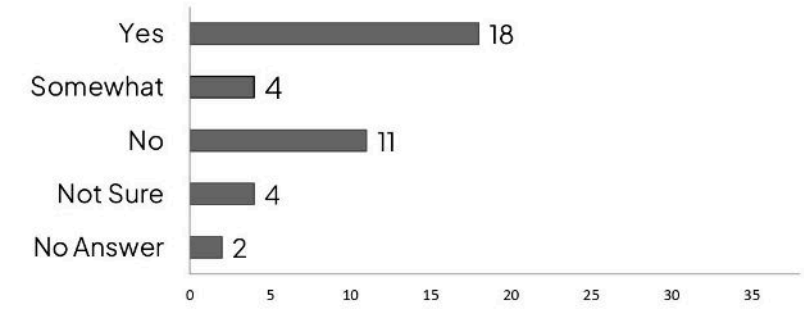
Of those participants who responded *somewhat, not sure,* or *no* to the above items, open-ended comments do not provide a direct explanation for those responses. However, eight out of 13 respondents did comment about the difficulty of hearing or understanding the PA announcement. For example, one participant who indicated that the drill did *not* help them become more comfortable responding in public, wrote: "*Could not understand instructions by staff. Too quiet and too garbled in microphone*." Another visitor responded, *"It was very hard to hear—the loudspeaker was not clear. I was in the orca exhibit on the top floor."* These responses are meaningful, particularly because the visitor survey did not directly ask about the understandability of the audio; the fact that a majority of participants volunteered this information suggests that the issue of audio intelligibility was a factor in the visitor experience.

Staff experience

OMSI staff were asked to consider a variety of ways that the earthquake drill may have been useful to them. For each of these potentially useful activities (e.g. learning about the constraints of the location), staff were offered four response categories (yes, somewhat, no, and not sure). Two open-ended items asked staff to reflect further, with, "Please tell us about any observations you want to share," and "In what ways, if any, did this experience in the Great ShakeOut drill support your sense of safety for you and the people around you?" Table 5 summarizes results from all three items, pairing categorical responses (left) with relevant open-ended responses (right).

Table 5. Staff survey responses related to the usefulness of the earthquake drill

The earthquake drill at the museum was useful for me:	Related open-ended responses
To learn about the constraints of the location 	*"Need to evaluate the setup in the planetarium."* *"Allowed us to consider all potential dangers in the turbine hall"* *"It gave me a better understanding of how to protect myself in my office but no experience doing so in public areas around the museum. That is great though because I'm usually at my desk."* *[Multiple comments related to intelligibility of audio; see discussion in text].*
To make a plan with colleagues before the drill 	*"We were able to create a plan and discuss the procedure if an earthquake occurred and have a conversation about what would happen after."*
To practice with the public 	*"The visitor groups in our area (school groups) were ready to go even before the drill. They were in their spaces and excited for the drill to be announced. It was great."* *"For the drill it was nice to be able to pass out information to guests about the drill... School groups were aware of the drill and education did a great job reminding guests that the drill was going to happen soon."*

To exercise my leadership skills with regard to earthquake safety  	*"A lot of people coming in did not know what to do in the event of an earthquake, and particularly how to do it with their young children. I was glad to have the opportunity to show people what to do and to spread awareness."* *"One guest shared the comment 'I'm a grandma, so if I get down on my knees, I'm not getting up anytime soon.' I smiled and shared that she could sit against a wall and cover her head, which she did and encouraged her grandkid to get down on the floor and cover their head."* *"For me this was my very first earthquake drill, so I wasn't really thinking as much about the facilitation components."*
To gain awareness of the feelings expressed by people around me  	*"It was good practice and I think many families appreciated not being surprised or in fear as part of the drill."*
To become more comfortable responding in public  	*[No related open-ended comments]*

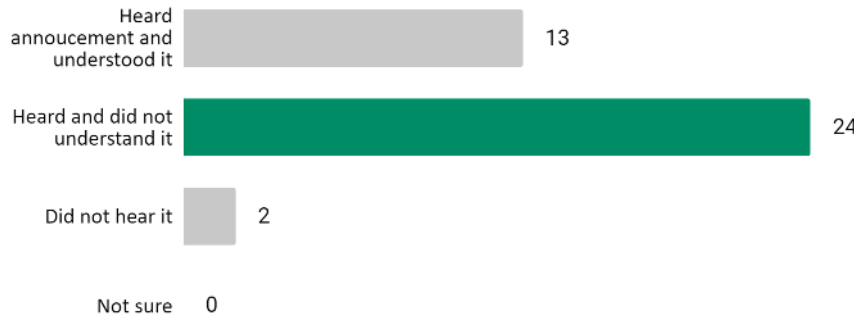
Staff responses indicated that the majority of staff found the drill to be useful in one or more ways. Of the drill's various benefits, staff generally agreed that it was useful to "practice with the public" (30 out of 37 indicating "yes" or "somewhat") and "make a plan with colleagues before the drill" (31 out of 37 indicating "yes" or "somewhat").

In open-ended responses from staff, most of the critiques related to the unintelligibility of the audio announcement. For example:

> *"The PA announcement was earsplitting and unintelligible from the echoing in the lobby, resulting in a traumatic experience. More testing of the emergency PA system should be conducted before any future drills. Ear protection should be provided to guests and staff in these areas."*
>
> *"It was very hard to hear the message through my phone and over the intercom. I couldn't understand anything but I knew what was happening because the 'Emergency' warning popped up on my phone screen."*
>
> *"We all felt it was hard to hear in the part of Pepco where I work. It was transmitting through the phones upstairs and hard to hear."*

The staff survey also asked respondents to report whether they heard and understood the drill, and where in the museum they were located at the time of the drill. These responses indicate widespread challenges with the audio. The majority of staff reported they could hear the ShakeOut drill announcement (37 out of 39), but of those who heard it, most (24 out of 39) reported that they could not understand the message (Figure 1). In a follow-up question, staff who reported not hearing or not understanding the announcement were asked to report where they were at the time of the drill (Table 6).

Figure 1. OMSI Staff – did you hear the drill announcement



n= 39

Table 6. Staff reports related to hearing and understanding the drill audio, according to their location in the museum.

See Appendix D for layout of main museum building

Experience of drill audio, as reported by staff	Specific Location
Heard and understood	• South Mezzanine (reported via open-ended response)
Heard, not understood	• Concierge office • Front desk • Gift shop • Cafe by theater • Theory restaurant • Turbine Hall • Labs: Chemistry and Physics • Teen Tech Center • Science Playground • Natural Science Hall, Staying Alive • Featured Exhibit, Orcas • Upper exhibits shop office • Events office • Exhibit shop (Pepco building) • At the office (not specify what area)
Not heard at all	• Planetarium • Basement chiller room
No data reported	• Empirical Theater • Submarine • Bathrooms (public and staff) • Specific office spaces such as North mezzanine, South Mezzanine, Executive/Finance/Marketing offices, Natural Science offices, Exhibit Experiences spaces, Education wing, Volunteers lounge, Mail room, Facilities spaces, 1800 Building, and meeting rooms. • Kitchen in the Theory restaurant • Freight elevator and loading dock

Some of the staff responses provided very specific information that could be useful for informing possible remediation to PA announcements.

> *"In areas of the museum where the sound has an echo (i.e. the museum lobby, gift shop, turbine hall, and the restaurant) it is difficult to understand what the*

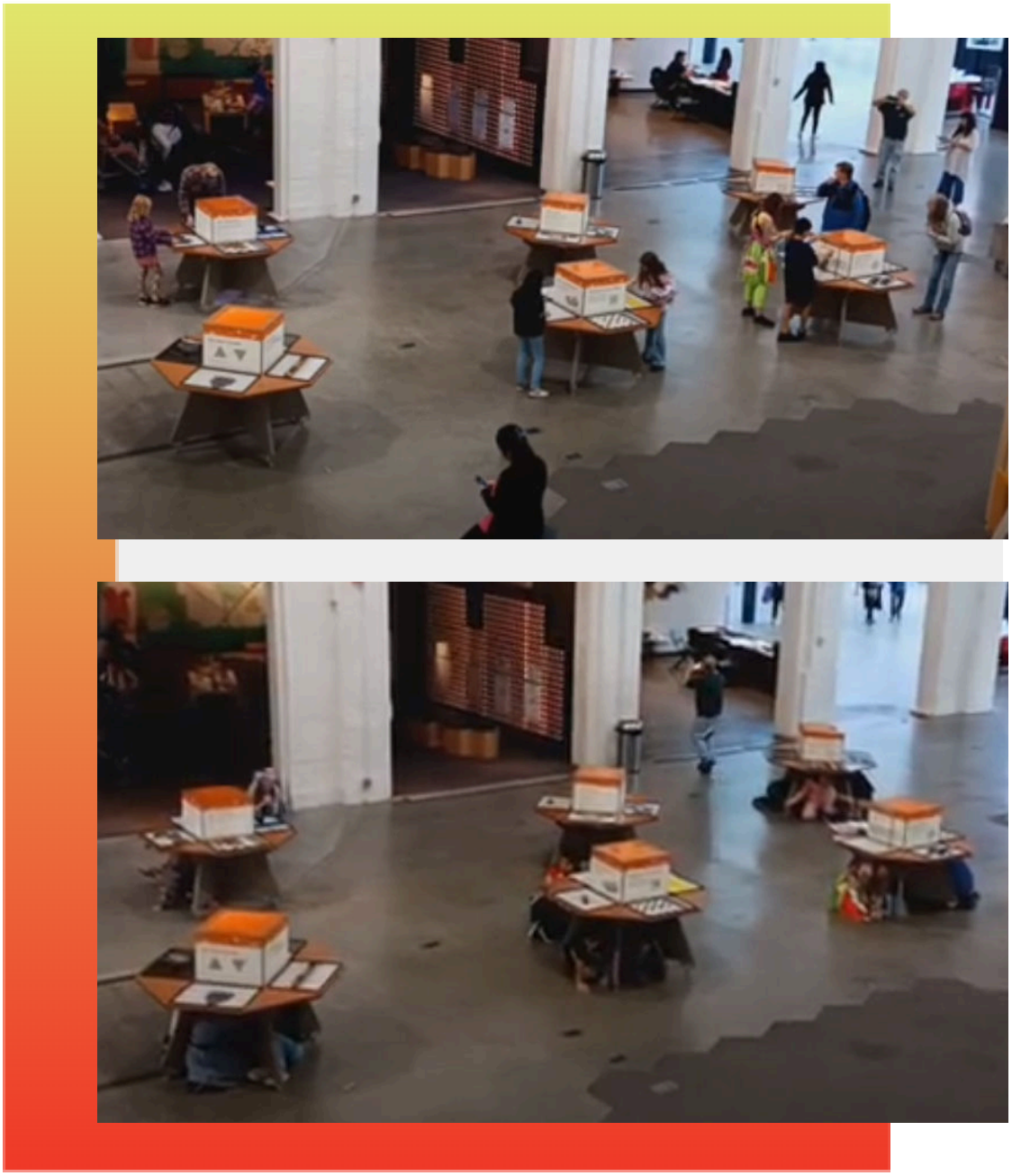
announcement is saying. The announcement is loud enough but it is hard to understand the words being said."

"The announcement before the drill was audible via PA system, but the actual drill was not. It only came through faintly on people's desk phones. Except for mine, because I had seen a message saying, "EMERGENCY." So I hit the speakerphone button thinking there would be a message or other communication, but that just turned OFF the emergency mode, so when the actual drill came around, I didn't hear it except as something hard to hear from someone else's phone."

"Hard to understand the messaging, it seems the system needs some audio equalization to balance the tonal spectrum, also the audio from the phone and the loudspeakers timing was slightly misaligned creating an echo, which also made it difficult to clearly understand the dialogue. The messaging also seemed very long, possibly needs to be more succinct. "

Additional observations: visitor participation

Staff observed that, overall, most museum visitors participated in the drill. In informal conversations following the event, several participating staff reported being pleasantly surprised at how many visitors engaged; they noted that school groups, in particular, participated enthusiastically. Similar feedback came through in open-ended responses to the staff survey. For example, one staff member stationed in the Natural Sciences hall wrote that the "exhibit seemed fairly busy with around 20 guests. Mix of primary school age students and adults. Estimate that about 80% participated in the drill." Similarly, a staff member positioned in Science Playground reported that "Most people did participate," even with the challenges posed by the audio recording.



Museum visitors in the Turbine Hall, moments before the drill (above) and during the drill (below).

Additional observations: structural considerations

In addition to making observations about visitor participation, some staff also made observations about the structural integrity of OMSI's various buildings, particularly the Turbine Hall. Concerns about this space came up in staff surveys and in follow-up conversations with leaders from OMSI's Facilities Team. While the majority of the museum

was built in the last 35 years and meets modern standards for seismic resilience, OMSI's Turbine Hall and Exhibit Shop (Pepco building) are older structures with particular vulnerabilities in the event of an earthquake. Some staff expressed concern that, in these specific locations, Drop Cover, and Hold On may be an insufficient protective action.

Discussion and recommendations

The purpose of the 2023 ShakeOut drill at OMSI was to create a social learning experience that supported participants' knowledge, confidence, and skills related to earthquake safety.

In accordance with this purpose, the goal of evaluation was to better understand:

- Participant learning outcomes, particularly the impact of the drill experience on participants' **sense of safety** related to earthquakes
- **Social dimensions** of participants' drill experience
- The **environmental context**, including audio, visual, tactile, spatial and structural factors that affected participants' drill experience

Learning Outcomes: Participants' Sense of Safety

Learning in informal environments, like OMSI, can take many forms. For participants, a learning experience might lead to cognitive outcomes—such as increased awareness or understanding of a particular topic. Or, it might target affective outcomes, such as awareness, appreciation, or confidence. A learning experience could also support participants in developing particular skills or engaging in particular behaviors (e.g. National Research Council, 2009). In the context of earthquakes, all of these possible learning outcomes have the potential to support individuals' and communities' sense of safety in the face of earthquake hazards. And, in a free-choice learning setting, it is expected that different participants will experience different learning outcomes, based on those participants' diverse goals, identities, interests, and prior experiences.

In terms of knowledge, some participants indicated that the drill provided new or updated information about earthquake protective actions. For example, one museum visitor reported that the experience "taught my 2.5 year old the 'turtle' pose for earthquake safety." One staff member reported that the drill experience helped correct a misconception they had, noting, "I grew up being told to stand under a doorway [during an earthquake], so this was definitely informative for me." For these participants, the learning experience provided information and understanding that could, in turn, lead them to take effective protective actions in the event of an earthquake.

Other participants reported that the drill supported feelings of confidence or self-efficacy related to earthquake response. For example, one staff member noted, "I was pleased to see that people were interested and invested in the drill. It was reassuring that we'll work together in an emergency." Another wrote, "Having drills like this gives me tools to use in a real emergency." For these participants, the drill contributed to their sense of safety by increasing their confidence that they and others could effectively respond to an emergency.

Finally, some participants reported that a primary learning benefit came from physically practicing the skills and behaviors for earthquake safety. Of the 13 museum visitors who completed the survey, four specifically cited the benefit of "practice." Some staff, too, referred to the benefit of physical practice, as with one who noted, "After practicing the response to an alert, I feel like I would respond faster to an actual earthquake or earthquake alert..." These respondents echo the findings of research, which suggest that embodied practice can also support a person's sense of safety, by preparing one to perform a given skill quickly and effectively when needed.

Social Dimensions

Earthquakes are phenomena that affect whole communities; they occur in a social context. With that in mind, the OMSI ShakeOut Drill was designed to engage participants socially, as a path towards deep and relevant learning related to earthquake preparedness.

A key part of the design for this drill was creating opportunities for participants to make a plan, respond, and debrief *with other people*. We found that many participants took advantage of these opportunities; for example, some staff and visitors reported discussing their earthquake response plans with their colleagues immediately before and/or after the drill. Additionally, the event sparked further discussions amongst OMSI staff, as participants brought up particular concerns (e.g. the Turbine Hall) that had not previously been discussed collectively. Some museum visitors, likewise, took the opportunity, when prompted by staff facilitators, to make a plan with their families/groups for how they would respond to earthquake shaking, both during the OMSI drill and in real life. In survey responses, the majority of staff and visitors reported that the social elements of the drill (e.g. planning and responding with other people) were useful and supported their learning experience.

Another design feature for this drill was the intentional placement of staff facilitators, who encouraged participation and modeled protective actions throughout the museum. As described above, we knew from prior research that, in both simulated and real-life emergency situations, people take cues from their social context when determining whether and how to respond. These cues can be direct, as when people look around them and replicate the behavior of others nearby. Other times, the cues are indirect, as when people call on explicit or implicit cultural norms for appropriate behavior. For example, we anticipated that some people may feel awkward or embarrassed about dropping to the

floor and crawling underneath a museum exhibit, as this would be an atypical behavior, particularly in public.

By intentionally positioning OMSI staff facilitators throughout the museum—where they could visibly model and verbally encourage responses such as Drop, Cover, and Hold On—we hoped to create a social environment that normalized these protective actions. Evaluation results suggest that this facilitation element had the intended effect. Not only did the majority of museum visitors participate in the drill, the majority of those who responded to the survey indicated that it was useful to "have OMSI staff support us during the drill." OMSI staff, in turn reflected on their role as leaders and facilitators; of staff survey respondents, 20 out of 37 indicated that it was either useful or somewhat useful to "exercise my leadership with regard to earthquake safety." (Notably, most of the staff who indicated "no" on this item were not with members of the public at the time of the drill, so may not have seen the drill as an opportunity to exercise leadership).

Considering the role of social norms in earthquake response, it is perhaps unsurprising that school groups were particularly organized and enthusiastic in responding to the drill. This was noted observationally and also through survey responses, as with one OMSI staff member who wrote, "The visitor groups in our area (school groups) were ready to go even before the drill. They were in their spaces and excited for the drill to be announced. It was great." Compared to general museum visitors (who typically attend with family or friends), visitors attending the museum as part of a school field trip may bring with them social norms related to their school environment. These norms may relate to roles (e.g. the expectation that students should follow the instructions of a designated teacher or leader) as well as behavior (e.g. the normalization of Drop, Cover, and Hold On, through previous practice in a classroom setting).

Again, this result suggests the value of repeated practice as well as the value of trusted role models and facilitators, whether visitor group members or staff members, in communicating and encouraging protective actions. Future drills and preparedness activities—whether at OMSI, other FCLEs, or other settings—can further leverage the power of social learning through a number of means. These could include:

- Encourage and create more opportunities for participants to make a plan with those around them (e.g. family members, fellow visitors, colleagues), both for how they will respond in the present earthquake drill and how they might respond in a future, real-life earthquake.
- Organizing structured pre-brief or debrief sessions with participants
- Recruiting a wider variety of participants to model protective actions (including participants representing a wider variety of roles, identities, and physical abilities) during the activity.

The Environmental Context

In addition to considering the social context, this event was also designed to learn more about the specific environmental context at OMSI; this includes geographic, audio, visual, tactile, spatial and structural factors that support or hinder safety during a real earthquake, and may support or hinder learning during an earthquake drill.

One salient environmental factor was the PA system, which did not clearly transmit the drill audio. The majority of the staff and public participants could not understand the message and some of them reported not hearing the message at all. For future earthquake drills at OMSI, possible solutions, specific to the PA system, could include:

- Conduct further tests of the PA system, to understand why announcements did not carry into certain locations (both via phone and wall-mounted speaker).
- Consider replacing the pre-recorded drill audio with a live, scripted speech. Because of the way pre-recorded audio is transmitted to OMSI's specific PA system, it has lower fidelity compared to live speech.
- If using a pre-recorded drill audio, consider changing it to include fewer spoken instructions, which were difficult to understand. Instead, initiate the drill with a clear, one-sentence announcement in English and Spanish, then follow with earthquake sound effects and no further spoken instructions until a verbal announcement that the drill is over.

Additionally, future drills at OMSI or other FCLEs could use other alerting mechanisms—in combination with or instead of the PA system—to initiate the drill. These could include in-person, verbal announcements from facilitators; push notifications to mobile devices; radio calls; or visual alerts on digital screens or displays. Including these alternate modalities would have the added benefit of making the drill experience more accessible for participants who are deaf and hard of hearing.

Another salient environmental factor was the spatial arrangement of the museum, which provided few opportunities for cover. The typical recommended action for earthquake protection is "Drop, Cover, Hold On." This recommendation assumes an individual has access to a sturdy table or desk. Knowing that many OMSI staff and visitors would not be near a table, this drill was designed to emphasize other options for self protection, including dropping to the floor and covering one's head with one's arms.

Rather than hindering participants' learning experience, this particular environmental factor may have actually *benefited* participants' learning experience, by helping them develop adaptability as well as situational awareness. As one staff member put it, the drill "Made me view the museum from a new perspective." Another staff member reported, "It was a great practice to see what kinds of cover I would be able to access in the area of the museum I am in most often (including places to avoid, places that offer shelter, etc)." Compared to a school- or office-based drill where tables are readily available, a drill in a "real life" setting like OMSI can help participants develop a habit of noticing site-specific hazards as well as

opportunities for shelter. This situational awareness, in turn, may aid people in safely responding to an earthquake in a variety of settings, whether familiar or unfamiliar.

Lastly, this drill brought up important concerns related to the geographical and structural features of the OMSI campus that should inform future emergency drills and protocols. These include concerns related to specific, older buildings on the OMSI campus, as well as the substrate beneath these buildings and its susceptibility to liquefaction. Specific recommendations for OMSI Leadership, with support from OMSI's Safety Committee, include:

- Review the specific structural features of the Turbine Hall (and possibly other vulnerable locations, including Pepco and the North Parking lot beneath the Marquam Bridge) to identify site-specific hazards as well as site-specific opportunities for protecting oneself (including alternate forms of cover and/or evacuation)
- Based on this review, and weighing the overall benefits and risks of various protective actions, develop updated recommendations for earthquake response in the Turbine Hall
- Develop and implement plans for communicating these updated protective actions to staff
- Incorporate these updated protective actions into activities for ShakeOut 2024

Conclusion

In conclusion, earthquake drills such as the Great ShakeOut are an important part of the "toolbox" of strategies that FCLEs can use to promote earthquake resilience for their staff, their infrastructure, and the broader communities they serve. The 2023 ShakeOut drill at OMSI was designed to engage staff and visitors in social learning that contributed to participants' sense of safety around earthquake response.

The most significant technical challenge that arose from the 2023 drill at OMSI was the unintelligibility of the audio announcement; this experience underscored for us the importance of testing audio and alert systems *before* implementing a drill. This is particularly important considering that the PA system may be used, not only for drills, but in real life emergencies as well—for example, to advise building occupants to evacuate following an earthquake. Additionally, if OMSI were to integrate ShakeAlert Earthquake Early Warning into its campus operations (as many schools, business, and other facilities are beginning to do across the West Coast), the PA system would likely be an integral part of disseminating those alerts.

Even with the audio challenges, however, evaluation results suggest that the drill was a positive experience for most participants, who broadly cited the benefits of planning and practicing protective actions—particularly in a public setting, with other people. FCLEs like OMSI, who wish to meaningfully impact learners' knowledge, confidence, or skills related

to earthquake safety can continue to leverage social learning, whether through drills, hands-on activities, exhibits, or other experiences.

Going forward, FCLEs can build on these efforts by sharing resources, research, and lessons learned, as we work together to collectively impact community resilience in Earthquake Country. To join a community of FCLE professionals sharing in this work, visit the ShakeAlert EPIcenter Partnership at www.shakealert.org/education-and-outreach/epicenter/.

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Appendices

Appendix A – All-Staff ShakeOut Info Sheet

Great ShakeOut Earthquake Drill

On Thurs, Oct 19th, OMSI will participate in The Great ShakeOut earthquake drill. This is the first time OMSI has run a full-scale earthquake drill during open hours and we appreciate your participation, support, and feedback!

- **Who:** All OMSI employees, volunteers, and visitors will be asked to participate, wherever they are (either onstage or offstage). Onstage staff, in particular, can serve as models for visitors, particularly as most visitors will have never practiced an earthquake drill in a museum setting before.
- **When:** Thurs Oct 19 at 10:40am
- **Where**: The entire Water Ave campus, including Pepco, 1800, and Sub
- **Why**: So that we as staff are prepared to protect ourselves and our visitors in the event of a major earthquake in Portland.
- **How:** The drill will be announced on the PA system and radios. You will hear verbal instructions in English and Spanish. When the drill begins, protect yourself as you would during a real earthquake by **Dropping, Covering, and Holding On.** This may look different depending on where you are in the museum and your own physical and mobility factors. (See next page for illustrated examples).

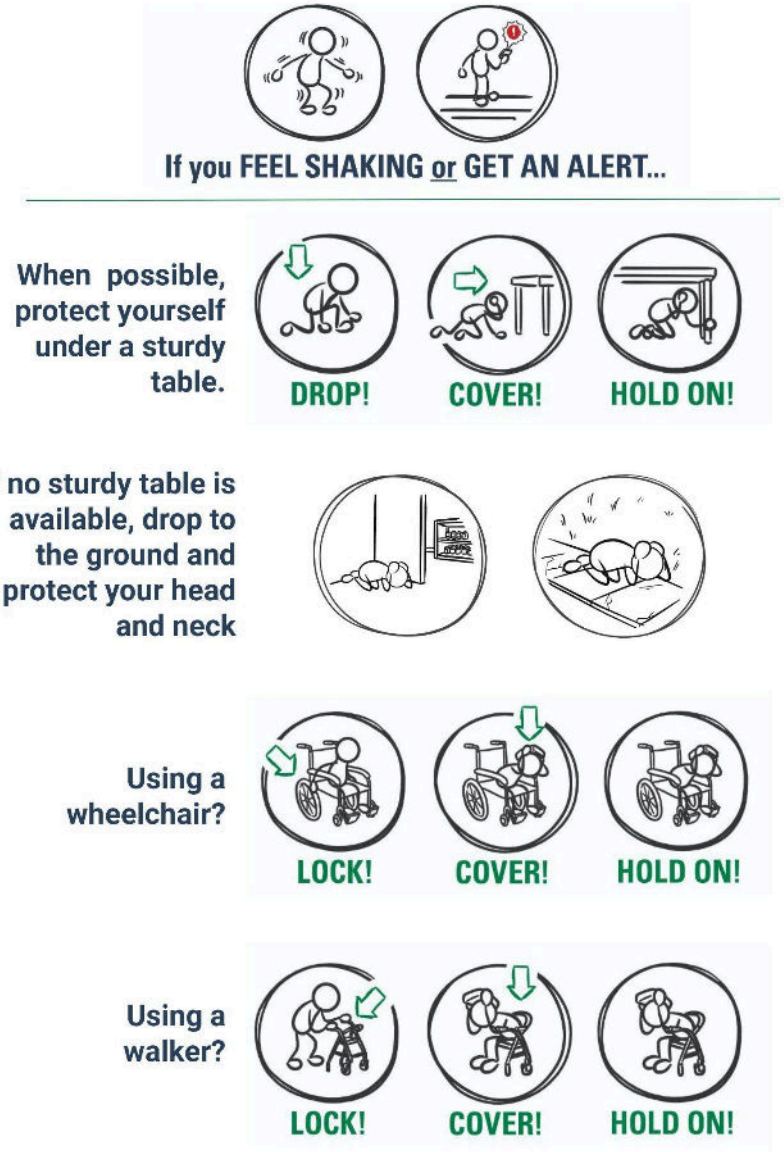
  If you are in an on-stage space during the drill, please encourage guests around you to participate by modeling participation yourself. Provide verbal support and encouragement if you feel comfortable doing so.

  The end of the drill will be announced via PA. There will be *no* building evacuation.

- **More information**: Staff from the ShakeAlert and Security teams will be onsite facilitating the drill. We will also be available both before and after the drill for any staff or visitors who would like more information or support, at ShakeOut stations located at the Welcome Wall and Greenway from 9:30—11:30. If you have questions or concerns in the meantime, please contact [Name] at [email address].

- **How to Drop, Cover, and Hold On:**

  In the US, earthquake injuries are most commonly seen from people attempting to move during shaking, and/or getting hit by falling debris. So, however you Drop, Cover, and Hold On, the key is to get in a position that protects you from falling objects and keeps you from becoming a falling object yourself.



Appendix B – ShakeOut Letter for School Groups

Great ShakeOut Earthquake Drill

Dear teachers, students, and caregivers,

On **Thursday, October 19th, 2023**, OMSI will be participating in the Great ShakeOut, a worldwide earthquake drill and preparedness event. At **10:40 am,** all employees, volunteers, and visitors at OMSI will be invited to participate in an **earthquake drill**. Earthquakes can occur at any time in the Pacific Northwest, and it is important that people of all ages are prepared to protect themselves in the event of shaking!

What to expect during the drill:

- At approximately 10:40 am, you will hear an announcement on OMSI's PA system. It will include instructions in English and Spanish, as well as earthquake sound effects.
- Everyone in the building, including visiting school groups, will be encouraged to participate.
- When the drill begins, protect yourself as you would during a real earthquake by **Dropping, Covering, and Holding On.** This may look different depending on where you are in the museum and your own physical and mobility factors. **See next page of this letter for illustrated examples of how to protect yourself during an earthquake.**
- The drill will last no more than 5 minutes. You may participate from wherever you are in the museum at 10:40.
- You will *not* need to evacuate the building.

What to do after the drill:

- Talk with your students about earthquake preparedness, and encourage them to do the same with their families when they get home!
- For resources you can use in the classroom, visit www.iris.edu/hq/programs/epo/shake_alert
- For more information about the Great ShakeOut, visit ShakeOut.org
- For more information about earthquake hazards in Oregon and steps for emergency preparedness at school and home, visit the Oregon Department of Emergency Preparedness at www.oregon.gov/oem/hazardsprep/pages/earthquakes.aspx

How to protect yourself during an earthquake:

In the US, earthquake injuries are most commonly seen from people attempting to move during shaking, and/or getting hit by falling debris. So, however you Drop, Cover, and Hold On, the key is to get in a position that protects you from falling objects and keeps you from becoming a falling object yourself.

Thank you for joining us in making OMSI and our communities more earthquake-safe! If you have questions about ShakeOut at OMSI, please contact [Name] at [email address].

Sincerely,

OMSI Staff

Appendix C – Info Sheet for Museum Visitors

ShakeOut™

Join Us

In the World's Largest Earthquake Drill

Today at 10:40 am, OMSI will participate in the **Great ShakeOut Earthquake Drill.**

The drill will be broadcast over the PA system. **You will hear instructions and earthquake sound effects.**

We invite you to **Drop, Cover, and Hold On** when you hear the announcement. If you cannot get under a table, that's okay. Simply drop to the ground and protect your head and neck.

The drill will last about 5 minutes. **You will not need to leave the building.**

For questions and more information, please ask an OMSI staff member.

ShakeOut™

Únete

al simulacro de terremoto más grande del mundo

Hoy día a las **10:40 de la mañana**, OMSI participará en **el Gran ShakeOut, un simulacro de terremoto.**

El simulacro se transmitirá por el sistema de altoparlantes. Oirán instrucciones y efectos de sonido de un terremoto.

Te invitamos a **agacharte**, **cubrirte** y **sujetarte** cuando escuches el anuncio. Si no puedes cubrirte debajo de una mesa, no te preocupes. Simplemente agáchate y protege tu cabeza y cuello con tus brazos.

El simulacro durará alrededor de 5 minutos. No necesitarás salir del edificio.

Para preguntas y más información, acércate a un empleado de OMSI.

Appendix D – OMSI Main Building Layout

OMSI™

Oregon Museum of Science and Industry

Appendix E – Drill Audio Script

This is the Great ShakeOut Earthquake Drill.

Este es "El gran ShakeOut," un simulacro de terremoto

Practice now so you can protect yourself during a real earthquake. This is a drill.

Practica ahora para que puedas protegerte durante un terremoto de verdad. Esto es un simulacro.

[Shaking sounds begin now]

Right now: Drop, Cover, and Hold On. During a large earthquake, the ground might jerk strongly and knock you down.

Ahora mismo: agáchate, cúbrete y sujétate. Durante un fuerte terremoto, la tierra podría sacudirse violentamente y lanzarte al suelo.

Drop. Get as low as you can. Drop to the floor if you are able. If there is a sturdy table you can get beneath, do so.

Agáchate. Agáchate lo más que puedas –hasta el piso si es posible. Si hay una mesa firme bajo la cual te puedes cubrir, hazlo.

Cover. During a large earthquake, objects might fly across the room. Protect your head and neck with your arm.

Cúbrete. Durante un fuerte terremoto, los objetos a tu alrededor podrían salir volando. Protege tu cabeza y tu cuello con tu brazo.

Hold on. If you use a wheelchair, lock your wheels. If you are under a table, hold on to the table leg. Stay in your protected position until the shaking stops.

Sujétate. Si usas silla de ruedas, recuerda usar el freno. [If you are under a table, hold on to the table leg.] Mantente en esta posición protegida hasta que pare de temblar.

[Shaking sounds fade out here]

This drill is over. Thank you for participating in the Great ShakeOut. Visit ShakeOut.org for simple steps to help you survive and recover from a major earthquake.

Este simulacro ha terminado. Gracias por tu participación en "El gran ShakeOut". Visita Shakeout.org para ver simples pasos que te ayudarán a sobrevivir y recuperarte luego de un gran terremoto.

Appendix F – Visitor Survey (English)

Thank you for visiting OMSI and participating in the Great ShakeOut drill. Please answer the questions below to help us improve the quality of this experience. The survey takes only a few minutes and your response is anonymous.

1. We want to know about your experience with the ShakeOut drill at OMSI.

Please share your reactions about practicing in the museum.

The earthquake drill at the museum was useful for me:	Yes	Somewhat	No	Not sure
To practice an earthquake drill in a less familiar location	◯	◯	◯	◯
To have OMSI staff support us during the drill	◯	◯	◯	◯
To make a plan with my group before the drill	◯	◯	◯	◯
To respond as part of a group during the drill	◯	◯	◯	◯
To gain awareness of the feelings expressed by my group	◯	◯	◯	◯
To become more comfortable responding in public	◯	◯	◯	◯

2. In what ways, if any, did this experience in the Great ShakeOut drill support your sense of safety for you and your group?

3. Any other comments for us?

Demographic questions

At OMSI we are working on becoming a more inclusive organization. For this, we would like to know more about you.

4. Please write the gender(s) that describe you:

_____

5. Please write the racial or ethnic groups that describe you:

_____

7. Who did you visit OMSI with today? Write the number of adults (including yourself) and minors in your group

# of Adults _____ # of Youth/children _____

Thank you for your feedback!

Appendix G – Visitor Survey (Spanish)

Gracias por visitar OMSI y participar en el simulacro del Gran ShakeOut. Tus respuestas a las preguntas nos ayudarán a mejorar la calidad de esta experiencia. La encuesta toma sólo unos minutos y tu respuesta es anónima.

1. Queremos saber de tu experiencia con el simulacro ShakeOut en OMSI.

Comparte tus reacciones sobre este simulacro en el museo.

El simulacro de terremoto en el museo me resultó útil:	Si	Un poco	No	No estoy segura (o)
Para practicar un simulacro de terremoto en un lugar menos familiar	◯	◯	◯	◯
Para contar con el apoyo del personal de OMSI durante el simulacro.	◯	◯	◯	◯
Para hacer un plan con mi grupo antes del simulacro.	◯	◯	◯	◯
Para responder como un grupo durante el simulacro.	◯	◯	◯	◯
Para darme cuenta de los sentimientos expresados en mi grupo.	◯	◯	◯	◯
Para sentirme más cómoda(o) respondiendo en público.	◯	◯	◯	◯

2¿De qué manera, si la hubo, la experiencia en el simulacro Gran ShakeOut apoyó la sensación de seguridad para tu grupo y tú?

_____

_____

3.¿Cualquier otro comentario para nosotros?

_____

Preguntas demográficas

En OMSI estamos trabajando para convertirnos en una organización más inclusiva. Para ello, nos gustaría saber más sobre usted.

4. Por favor escriba el o los género(s) que lo describe(n):

_____

5. Por favor escriba el o los grupo(s) racial(es) o étnico(s) que lo describe(n):

_____

4. ¿Con quién visitaste OMSI hoy? Escribe el número de adultos (incluyéndote a ti) y menores en tu grupo.

de adultos _____ # niñas (os) or adolescentes _____

¡Gracias por sus comentarios!

Appendix H – Staff Survey

ShakeOut 2023 - Staff Feedback

On Thursday, October 19, 2023 at 10:40am and as part of the Great ShakeOut 2023, OMSI announced an earthquake drill over the PA system for all Water Avenue spaces (public and staff areas).

To help the OMSI Safety Committee and ShakeAlert team improve future earthquake drills, please share your feedback.

Your participation is voluntary and anonymous.

Thank you for your time!

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1) Were you present in any of the Water Avenue spaces at the time of the earthquake drill on Thursday, October 19, 2023 at 10:40am?

- ☐ Yes
- ☐ No

2) Would you like to answer some questions about your experience? As a reminder, your participation is voluntary.

- ☐ Yes
- ☐ No

---

3) Did you hear the drill announcement?

- ☐ Yes, and I understood the message.
- ☐ Yes, but I couldn't understand the message.
- ☐ No, I didn't hear it at all.
- ☐ Not sure

4) (This question had a logic if the response above was either option: *Yes, but I couldn't understand the message* or *No, I didn't hear it at all*) Where were you at the time of the drill on Thursday, October 19, 2023 at 10:40am?

_____

_____

5) During the ShakeOut drill, who were you with at the time? (Check all that apply)

- ☐ Colleagues (staff and volunteers)
- ☐ Museum visitors
- ☐ Alone
- ☐ Other - Write In: _____
- ☐

6) The drill at the museum was useful:

	Yes	Somewhat	No	Not sure
To learn about the constraints of the location	( )	( )	( )	( )
To make a plan with colleagues before the drill	( )	( )	( )	( )
To practice with the public	( )	( )	( )	( )
To exercise my leadership skills with regard to earthquake safety	( )	( )	( )	( )
To gain awareness of the feelings expressed by people around me	( )	( )	( )	( )
To become more comfortable responding in public	( )	( )	( )	( )

7) Please tell us about any observations you want to share.

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_____

8) In what ways, if any, did this experience in the Great ShakeOut drill support your sense of safety for you and the people around you?

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