

Development of an Interactive Escape Room Intervention to Educate College Students about Earthquake Preparedness

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Abstract: Interactive education strategies have been shown to be more effective in increasing knowledge of disaster preparedness than dissemination of written materials and lectures. To educate college students at a university, an earthquake-themed escape room was designed and implemented as part of a campuswide preparedness event. A total of 113 people (96% students) participated in the escape room activity and postgame educational lecture. A single-group postdesign was used to evaluate outcomes (earthquake reaction knowledge, knowledge of mitigation strategies for the home, knowledge of emergency kit supplies, intention to engage in preparedness activities). A majority of participants had not been exposed to a prior disaster preparedness workshop or class. Posttest results showed earthquake reaction knowledge and knowledge of mitigation strategies were high. Most participants attributed their knowledge gained to the interactive escape room. A majority of participants reported intentions of starting or updating an emergency kit. Findings suggest the escape room intervention has potential for increasing disaster preparedness knowledge among college students. DOI: [10.1061/\(ASCE\)NH.1527-6996.0000322](https://doi.org/10.1061/(ASCE)NH.1527-6996.0000322). © 2018 American Society of Civil Engineers.

Introduction

Studies have shown that conventional methods of communicating natural hazards risk through factual information in brochures and lecture-style presentations are not as effective in inspiring preparedness actions as novel, interactive approaches that directly engage participants (Whitney et al. 2004; Mileti and Darlington 1997; Mileti and Fitzpatrick 1993; Glik 2007; McClure et al. 2007; Becker et al. 2012; Wood et al. 2012). Research suggests communication through brochures and lectures is associated with inattentiveness on the part of the learner, lack of comprehension, and poor retention of information (Whitney et al. 2004; Sorensen 1983; Soffer et al. 2010). As such, these passive communication methods are unlikely to provoke a sense of personal relevance to motivate preparedness actions (Sattler et al. 2014).

Various types of interactive formats have been utilized in risk communication campaigns. Glik (2007) found that interpersonal, small group meetings facilitated by community health workers were more effective in encouraging the development of family disaster plans than preparedness education received through print material. A qualitative research study by Becker et al. (2012) found that interactive information such as school, workplace, or community activities and training stimulated thought and discussion more than passive information such as brochures, television, and

websites. These activities spurred people to take a step beyond simply being aware of hazards and to understand the consequences of potential events through interactive discussion. Finally, in a comparative study of educational interventions on schoolchildren's knowledge of earthquake protective behavior, Soffer et al. (2010) found that the combination of lecture and drills yielded the greatest knowledge retention.

Video games have been shown to be another effective interactive method, with Tanes and Cho (2013) demonstrating an increase in preparedness and mitigation knowledge through the study of two earthquake games. Multiple studies have demonstrated a positive shift in perceived self-efficacy to take protective actions against risks through educational video games (Tanes and Cho 2013; Brown et al. 1997; Lieberman 2001). Jenkinson and Macleod (2012) reported positive results when utilizing an interactive in-person game to help students understand vulnerability to extreme events.

The literature also emphasizes the importance of framing preparedness activities as normative or a way of life. Interactive methods that involve discourse between friends, family members, trusted community leaders, and community-based organizations to demonstrate positive reinforcement for taking protective measures have been successful in achieving this outcome (McIvor and Paton 2007; Wood et al. 2012; Becker et al. 2012; Paton 2003; Sattler et al. 2000). Similar to this, methods that demonstrate a distinct, personal relevance for undertaking preparedness have also been shown to be successful (Guion et al. 2007).

Research has shown that older adolescents and young adults with little or no experience with disasters are less likely to undertake preparedness actions (He et al. 2007; Sattler et al. 2011, 2014; Lindell and Perry 2012; Tierney et al. 2001). Students attending college in Southern California, for example, may have a low perception of risk from earthquakes if they are not from the area or have never experienced an earthquake. While a few studies have examined the effectiveness of campus emergency management programs in communicating risk to student populations (Sattler et al. 2011), there is little published information on preparedness programs that are tailored to the college population.

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The purpose of this article is to describe an interactive earthquake preparedness intervention that used an innovative escape room format to engage college students and the impacts on participants' earthquake reaction knowledge, knowledge of mitigation strategies for the home, knowledge of emergency kit supplies, and intention to engage in preparedness activities. An escape room is an increasingly popular live action game format that places a small team (usually four to six people) in a closed room with a themed environment and challenges the team to solve a series of puzzles in order to escape the room or successfully complete the game. This study is exploratory in nature as our purpose is primarily to describe and share the results of a new, innovative preparedness education method.

Methods

Setting

California State University Northridge (CSUN) is located in a dense, urban setting with a history of damage from large earthquakes including the 1994 Northridge earthquake and the 1971 Sylmar earthquake. As one of the nation's largest single-campus universities with more than 42,000 students enrolled in 2015–2016, CSUN is responsible for a large community of young adults. With a majority of the current student population born after 1994, the institutional memory of historic resilience to past earthquakes is beginning to fade. This local earthquake exposure, coupled with the increase in active shooter incidents at universities nationwide (Sattler et al. 2011), necessitates a heightened level of multihazard readiness for all sectors of the campus population.

Beat the Quake Earthquake Preparedness Intervention

The former director of emergency management at the CSUN Department of Police Services (first author) and an assistant professor in the Department of Geological Sciences (second author) designed an earthquake preparedness intervention that utilized the interactive escape room format. The event was 1990s themed to pay tribute to the 1994 Northridge earthquake and create a sense of personal relevance to earthquake hazards. The escape room was designed as a space for personally relevant, experiential learning that replicated a 1994 dorm room occupied by a CSUN student (Fig. 1). Learning outcomes for the intervention included understanding the appropriate actions to take during an earthquake, ability to identify earthquake mitigation strategies, ability to identify appropriate disaster preparedness supplies, and the intention to take preparedness actions.

The escape room challenged groups of 4–5 students to utilize teamwork to solve a series of earthquake-related puzzles before the earthquake hit, simulated by the earthquake early warning sound (Fig. 2). Puzzles included identifying the San Andreas fault on a map, identifying the magnitude of the 1994 Northridge earthquake, utilizing earthquake mitigation techniques to physically secure items in the room, collecting preparedness items to build a kit, and practicing drop, cover, hold on when the earthquake early warning sounded (Fig. 3). While participants played the game, moderators equipped with a scoring rubric evaluated their actions to determine a score for each team. A total of 30 points were available to participants.

After the conclusion of the escape room, students attended a postgame education lecture with the second author and American Red Cross outreach instructors. All students received participation prizes and top scoring teams were awarded grand prizes. The room was also collocated with a resource fair featuring tabling



Fig. 1. Puzzle room setup for the Beat the Quake activity at California State University Northridge, 2016.



Fig. 2. Students engaged in hands-on learning inside the puzzle room at California State University Northridge, 2016.



Fig. 3. Students practicing appropriate earthquake response: drop, cover, and hold on, at California State University Northridge, 2016. (Image courtesy of Sundial and Sarai Henry.)

exhibits from community preparedness partners American Red Cross, CSUN Community Emergency Response Team, Earthquake Country Alliance, CSUN Student Health Center, and Department of Police Services.

The use of the escape room format capitalizes on several of the successful strategies found in the literature, such as interaction, participation with friends and classmates to create a social normative aspect, and creation of a truly actionable environment that directly allowed students to practice protective actions. The addition of the resource fair created an atmosphere where students could hear the same message reinforced through multiple sources and allowed for a dialogue on anything that might have been confusing during the game.

Study Design

The Beat the Quake intervention was designed by campus staff as an event to enhance preparedness and not as a research study. This event was designed as a campus outreach event and, as such, the authors did not have the resources to implement an experimental study. The event was open to the public and people could drop in to participate. The goal of the event was to engage as many participants as possible in the activities in a short amount of time. Given the fluidity of the event with people coming and going, program staff were concerned that administration of a pretest questionnaire would slow down the implementation of the activities and add to the time burden for participants. Given the context of the event, program staff decided that a nonexperimental, posttest design was most practical.

Data Collection

Students were recruited for the event via campus signage, flyers, and CSUN's website and Twitter account. The posttest questionnaire was self-administered online using Google Forms. All participants were emailed a link to the posttest questionnaire the day after the event. All survey participants were entered in a random drawing to win a \$40 campus dining gift card as an incentive for participation. The evaluation study was approved by the CSUN Institutional Review Board.

Measures and Data Analysis

Demographic characteristics assessed on the posttest were affiliation with the university, age, and gender. To assess general earthquake awareness among students who largely reside in the San Fernando Valley surrounding CSUN, participants were asked if they were aware of either the moment magnitude 6.6 1971 San Fernando (Sylmar) earthquake or the moment magnitude 6.7 1994 Northridge earthquake, the latter of which caused heavy damage on the CSUN campus. Earthquake awareness was rated on a 5-point Likert scale with 1 representing unaware and 5 representing highly aware. To measure participants' reaction knowledge prior to the Beat the Quake event, one multiple choice question asked participants to report how they reacted to the strongest earthquake they had ever felt (e.g., I did nothing, I ran to the doorway, I got under a sturdy piece of furniture, and I ran outside).

The posttest included two measures of reaction knowledge that assessed (1) knowledge of the appropriate action to take during an earthquake (i.e., drop, cover, and hold on), and (2) knowledge of what to do during an earthquake in the absence of a safe place to take cover (i.e., drop to the ground and cover your neck and head). Reaction knowledge measures were multiple choice questions. Knowledge of home mitigation strategies was defined as the ability to identify two correct strategies to secure one's home and was measured with an open-ended question. Knowledge of appropriate

supplies for an emergency kit was defined as correctly identifying five out of nine items on a checklist, e.g., water, whistle, and flashlight.

Participants' intentions to engage in preparedness action after the event were measured with a checklist that listed six possible actions, including start or update a disaster kit, move or secure heavy objects at home, and take a class or workshop on disaster preparedness. Separate binary variables were created for each type of action. Finally, to assess the impact of the event on participant knowledge of two home mitigation strategies, two yes or no questions were included that ask whether the strategy they reported learning was attained through the game or the educational presentation.

Satisfaction of the event was assessed with five content-related questions that asked to what extent the event was fun, challenging, educational, motivating, and creative. The five content questions used a 5-point Likert scale with 1 being very low and 5 being very high. Two binary questions asked if participants would recommend the event to their friends and if they would like to see the event take place on an annual basis on campus. To evaluate recruitment strategies, a question was included that asked how participants heard about the event using a multiple choice format. Univariate results are presented for all variables.

Limitations

The results of this evaluation must be understood within the context of certain limitations. First, the study used a single-group evaluation design, which precluded examination of the intervention's efficacy. Second, the study did not collect pretest data on reaction knowledge and mitigation knowledge. As such, the authors were unable to determine whether knowledge was increased as a result of exposure to the event. Third, the sample size was small, which precluded analysis to identify predictors of positive outcomes such as reaction knowledge, mitigation knowledge, and intentions to engage in preparedness actions. The limitation to online surveys, however, is the potential for attrition.

Results

Sample Characteristics

A total of 113 students on 22 teams played the escape room and all students attended the postgame educational lecture. Sixty-nine of these participants (61%) completed an online posttest. Out of these 69, all but five were students. Four participants were CSUN staff members and one was a visitor. The vast majority (84.1%) of participants were in the 18–25 age range, with the remaining 15.9% being above the age of 25. Most participants (62.3%) were female.

All participants reported at least some awareness of prior earthquakes in the San Fernando Valley. Slightly more than a third (36.2%) of participants reported a high level of awareness. All but seven participants reported having experienced an earthquake in their lifetime. Among participants who had experienced a strong earthquake in the past, 40% reported doing nothing during the earthquake, 12.3% ran to the doorway, 15.4% got under a sturdy piece of furniture, 10.8% ran outside, and 10.8% got between two pieces of furniture (triangle of life approach). Prior exposure to a disaster preparedness educational workshop was very low (27.5%). However, a majority of participants reported some earthquake preparedness because 58% of participants reported having an emergency kit at their home, apartment, or dorm room.

Table 1. Summary of posttest outcomes, Beat the Quake event, 2016 ($N = 69$)

Posttest results	Percentage or mean (standard deviation)
Knowledge of earthquake preparedness	
Correct knowledge of the appropriate action to take during an earthquake (drop, cover, and hold on)	98.6%
Correct knowledge of what to do during an earthquake in the absence of a place to take cover	84.1%
Correct knowledge of home mitigation strategies	75.4%
Intentions to become prepared	
Likely to start or update a disaster kit	94.2%
Likely to take a class or workshop on disaster preparedness	39.1%
Likely to read more about earthquakes or natural disasters	52.2%
Participant satisfaction	
Event was fun	4.6 (0.71)
Event was challenging	3.7 (0.98)
Event was educational	4.6 (0.72)
Event was motivating	4.3 (0.87)
Event was creative	4.6 (0.78)
Would recommend event to one's friends	98.6%
Would like to see the event annually	72.5%

Outcomes

Reaction Knowledge

Nearly all (98.6%) participants reported at the posttest that the appropriate action during an earthquake is to drop, cover, and hold on. After the event, 69.3% of participants were able to list two home mitigation strategies. When asked how many of those strategies came directly from the Beat the Quake escape room game, 77.3% of participants reported that their first mitigation strategy came from the game. Additionally, 73.7% of participants attributed learning the second strategy they listed to the game.

Participants' intentions to engage in preparedness actions after the event were assessed. When asked if they had a disaster kit of any kind prior to the event, 58% of participants said yes. However, 94% of participants said they would start or update their kit as a direct result of the event. The likelihood of taking a workshop on disaster preparedness after the event was endorsed by 39.1% of participants. Slightly more than half of participants (52.2%) said they would read more about earthquakes or other natural disasters as a result of the game. See Table 1 for results.

Satisfaction

Participants were asked to rate the Beat the Quake event in regards to how fun, educational, challenging, motivating, and creative it was. Mean scores for all categories except for challenging were above 4.0 on a 5-point scale. The mean score for challenging was 3.7. All but one of the participants reported that they would recommend Beat the Quake to a friend, and all participants agreed that they would like to see the Beat the Quake event or something similar become an annual event at CSUN. See Table 1 for results.

Recruitment Strategies

The most effective methods for advertising the event and drawing in participants based on participant reports were announcements and promises of extra credit from professors (42%), large signs on lawns across campus (30.4%), and word of mouth from friends (27.5%). Emails, social media, and small fliers each reached less than 15% of participants.

Discussion

The Beat the Quake event was successfully piloted with 113 students. Despite the small sample size, results from the posttest suggest that the escape room and educational booths may be

effective strategies for disseminating knowledge of earthquake preparedness and intentions to engage in actual preparation activities. Less than one-third (27.5%) of participants said they had taken any sort of disaster preparedness class or workshop prior to the Beat the Quake event. This clearly shows that the event reached a population in need of disaster preparedness intervention and education.

Results from the posttest indicate a high level of earthquake reaction knowledge. While only 15% of respondents reported using the drop, cover, and hold on strategy during the last strong earthquake they experienced, all but one respondent demonstrated knowledge of drop, cover, and hold on as the most appropriate action to take during an earthquake. Additionally, the vast majority of participants correctly answered the question on the posttest that tested their knowledge of what to do during an earthquake if there is no safe place to take cover, which can be attributed to knowledge learned directly from the game.

Participants demonstrated knowledge of home mitigation strategies. Three-fourths of participants were able to list two or more strategies to secure their homes against earthquakes. More participants attributed their knowledge of mitigation strategies to their participation in the escape room game versus the educational session. The Beat the Quake event appeared to inspire participants to consider taking actions to prepare for earthquakes and other disasters. These findings corroborate prior research that found interactive learning methods to emergency preparedness to be more effective than written materials and lecture-based methods (Becker et al. 2012; Soffer et al. 2010; Glik 2007).

Participants were overwhelming very satisfied with the Beat the Quake event. Participants gave the event high ratings on being fun, creative, educational, and motivational. The domain with the lowest rating was challenging, but the score was still at the higher end of the scale (mean of 3.7, range 1–5). The feedback from the participants suggests that the event was somewhat challenging, but feasible, which is a useful finding for future research. Despite the limitations of small sample size and lack of a pretest to document prior knowledge, the authors believe that this evaluation provides evidence of feasibility and acceptability of the intervention as well as promising results.

Conclusion

The Beat the Quake event was the first risk communication intervention to our knowledge to use an escape room format to educate participants. Findings from the event posttest suggest that this

intervention has some promise in educating young adults and, in particular, college students about disaster preparedness. Future research should test the intervention in an experimental trial to determine its efficacy. The authors recommend utilizing both a pretest and a posttest in future iterations of the intervention and expanding the sample size by growing the number and diversity of participants. It is also recommended that the puzzle room method of intervention be tested with different preparedness and public health messages to determine efficacy as a general education method.

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Supplemental Data

Video S1, video footage of the Beat the Quake activity, is available online in the ASCE Library (www.ascelibrary.org).

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