Online learning during post-earthquake school closures

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Abstract
Purpose – The purpose of this paper is to describe the impacts of earthquakes on schools and education services and demonstrate the critical role that information and communication technologies (ICTs) can play in supporting the continuity of education delivery during temporary school closures after seismic events.

Design/methodology/approach – This paper relies on a conceptual analysis that shows the potential role of the online educational environment during post-earthquake school closures by relying on the available ICT tools.

Findings – This paper proposes a pro-active strategy for schools that transforms traditional education into an online learning environment to restore education delivery during school closures after earthquake which disrupts face-to-face teaching and denies students and staffs access to schools.

Originality/value – The sustainability of education delivery in the aftermath of earthquakes presents a challenge to governments, schools, people and communities. This paper contributes to the literature by demonstrating the role of online learning in sustaining educational delivery services after moderate earthquakes.

Keywords Online learning, Earthquake disasters, Educational delivery, Emergency education, School closures

Paper type Conceptual paper

Introduction
In the aftermath of natural hazards such as earthquakes, hurricanes or floods, maintaining the educational delivery services becomes a challenge. In fact, disasters affect schools and educational processes in many ways. However, closure of schools and disruption of educational processes have been traditionally among the most severe consequences of natural hazards on education, particularly in seismically vulnerable regions. Such events may lead to the deprivation of millions of children’s fundamental right to education and place their future at risk. Previous disasters have left severe effects on children, both physically and psychologically. Disruption of education can leave children at risk of child labor, early marriage, exploitation and recruitment into armed forces. The longer children are out of school, the less likely they are to return. As such, in Pakistan, children in the affected areas remained out of school for 700 days after the floods in 2010. One year after the 2011 Typhoon Washi in the Philippines, 23 percent of families revealed that their children had permanently dropped out of school. Also, six months after the 2013 Typhoon Haiyan in the Philippines, an average of 13 percent decline in school attendance was recorded in the affected areas. The recent hurricanes Harvey and Irma that hit the USA in 2017 are clear evidence of the impacts of natural hazards on the school system and children education. They led to temporary school closure that deprived 1.7 million children from attending schools for weeks. Other examples are provided in Table I showing numbers of schools and students affected by natural hazards and how education was covered up (Save the children, 2014, 2015, 2017).

Earthquakes are one of the most powerful and deadliest disasters on earth, threatening infrastructure, populations and economies (Baytiyeh and Naja, 2013). Worldwide, the occurrence of moderate earthquakes is much higher in number than strong earthquakes. During a moderate earthquake (5.0-6.5 on Richter scale; UGS, 2008), schools may suffer minor to major structural damages depending on their structural resilience capabilities, whereas in strong earthquakes, school buildings may collapse. In general, earthquake disasters have had severe physical and psychological effects and detrimental
impacts on their educational and social development, posing major challenges to people, communities and governments. In the aftermath of such tragedies, education can play a highly important role in healing the affected children.

Amid increasing awareness and preparedness measures, these barriers can be addressed by the development of temporary learning centers to provide educational services in affected communities. However, the extensive damage, limited supplies and resources and challenging geographical context might result in long delays before education resumes even in temporary learning centers, resulting in children losing long months of schooling. In this context, the use of technology to restore the delivery of education services during temporary, short-term school closure after moderate earthquakes becomes an educational need, a social necessity and a national priority.

Technology plays crucial roles in all stages of disasters, connecting and informing people and even saving lives. Technology can provide access to education for learners who often cannot gather in traditional school settings after disasters. Online learning can be a potential approach to continue education during school closures, offering students substantial benefits and learning opportunities, including convenience of time and place. Researchers have established the benefits of online learning for people who have disabilities, hold full-time jobs or live in remote areas (Pierre, 1998), but its potential role in supporting children’s education after earthquakes or other disasters has not been emphasized or investigated. This paper describes the severe impacts of earthquakes on education, schools and students and demonstrates the potential of online learning to provide continuity of education during short-term post-earthquake school closures when formal, face-to-face
education cannot be delivered. School administrators in earthquake-prone region are called upon to develop emergency plans to deliver online learning to mitigate the disruption of education delivery and the impacts on students and schools after disasters.

**Impacts of earthquakes on students, schools and education**

The impact of disasters on students goes beyond damage to schools and disruption of education. Children constitute a major population segment which can suffer highly devastating consequences from disasters (Peek, 2008). Older children remain at risk for injury or death and can develop serious psychological trauma or developmental concerns. These negative effects of earthquake disasters may have severe consequences on children’s physical health, emotional growth and academic performance. Students are often subjected to psychological distress following disasters which affect their ability to learn. As such, it was revealed that some children, after five years of the Black Saturday bushfires in Australia, were suffering developmental delays of between one and five years. Consequently, some schools in the affected areas have reallocated the received support from the government to enable affected students to special services such as speech pathology and psychiatry. Also, six months after typhoon Haiyan in the Philippines, almost a quarter of all schools reported that children’s psychological distress presented a barrier to learning. School systems and educators should address these potential physical harms and emotional strains to protect children’s well-being. Disasters disturb their daily lives, including education, leading to poor academic progress and exposure to destructive behaviors (Silverman and Greca, 2002). Research has shown that children who are out of school for long periods risk falling into child labor, child marriage, sexual exploitation, violence, rape and recruitment into fighting, prostitution and other life-threatening, often criminal activities (Anderson, 2006). Many will simply never return to the classroom.

The destruction of seismically vulnerable school buildings has been documented during many earthquakes around the world. In recent earthquakes, students and teachers have been trapped or crushed to death by concrete blocks in collapsed school buildings, leading to mass-casualty events (Wisner et al., 2004). When an earthquake hit the Spitak area of northern Armenia during school hours in 1988, many children died in collapsed school buildings. Nearly two-thirds of the total deaths (25,000) in the Armenian earthquake of 1988 were children and adolescents. More than 10,000 school buildings collapsed in the 2005 Pakistan earthquake (Hewitt, 2007), leaving the surviving children without access to education. The 1995 Kobe earthquake caused extensive, varied damage to approximately 4,500 educational facilities, but there were no fatalities as the quake struck early in the morning (Nakano, 2004). The 1999 Chi-Chi earthquake destroyed 700 schools in Taiwan, the 2001 Gujarat earthquake damaged more than 11,600 schools in India (World Bank, 2000), while a 2004 earthquake damaged or destroyed as many as 1,150 schools in Indonesia (UNICEF, 2006). In the Sichuan earthquake of May 2008, approximately 10,000 students were crushed in more than 7,000 collapsed school buildings (UNISDR, 2007). The 2010 earthquake in Haiti killed approximately 38,000 students, along with 1,300 teachers and school other personnel (Bhuwanee, 2010), and destroyed the Ministry of Education offices, along with 4,000 schools – close to 80 percent of the educational sector in the Port-au-Prince area.

Such repeated tragedies speak for themselves and should not be accepted, underestimated or ignored. Clearly, seismically vulnerable communities must prioritize the safety of school buildings to minimize school closures after the occurrence of earthquakes. For instance, after the 2011 Christchurch earthquake in New Zealand, school closures contributed to an unprecedented displacement of students; 11,077 students, or 14.9 percent of Christchurch students, were transferred to other schools, including 8,458 students who transferred to schools outside the Christchurch area (Love, 2011).
In summary, earthquakes destroy vulnerable school buildings, put children at risk and affect the functional capacity of the educational system, disturbing the educational processes and denying children access to education (Naja and Baytiyeh, 2014, 2015). Earthquakes have destroyed schools, caused the tragic deaths of tens of thousands of students and triggered school closures, interrupting the delivery of education services. The main reasons for post-earthquake school closures include power outages, burst water pipes, road failure, damage to non-structural components and sanitation systems and loss of furniture and equipment. Students were absent due to displacement, injuries and emotional and physical distress. School building collapse, interruption of main utility services, such as water and electricity, and the use of school buildings as shelters for displaced victims interrupt educational delivery, rendering schools unoperational and prolonging school closures and children’s suffering.

Theoretical background
Children and adolescents are among the vulnerable populations that require special attention (Hoven et al., 2003). However, there are wide variances in how individuals cope over time with disaster-related stressful experiences and traumatic events (Pfefferbaum et al., 2006). It is important for educators to understand human stress responses, appraisal, and coping in order to practically apply knowledge when dealing with students while using information and communication technologies (ICTs) after a disaster, and therefore to mitigate negative effects on students’ educational attainment as well as their overall well-being.

Selye (1956) stated the stress theory by linking the stressful life events to the onset of distress or disorders. The stress response begins with a stressor, which is defined as any real or imagined event, condition or situation. Lewis and Roberts (2001) believe that a crisis can be assessed through the stimulus of the crisis as well as people’s perception of the stressor and their coping efficacy. Coping is seen as an interaction between one’s internal resources and the external environment (Lazarus and Folkman, 1984). As such, a study conducted regarding the response of academic institutions after the disaster of the World Trade Center in New York city revealed that the personal time devoted with students to processing the events and their coping strategies either alone, with peers, in a group, or with their field instructor, were supportive to these students (Matthieu et al., 2007). Another study revealed that children who survived hurricane Katrina spent several years before noticing some decrease in the post-traumatic stress and depression. It was also found that the most helpful way for children to recover was through building and maintaining supportive relationships (Strauss, 2017).

It was shown that children around the world react similarly to disaster despite differences in cultures and resources. It was also suggested that there are four main channels through which natural hazards may impact education: psychological impact, shifts in child labor, infrastructure damage and poverty. In fact, the psychological impact of disasters can hamper students’ performance in school (Center on Conflict and Development, 2016). After a natural hazard, it was revealed that survivors exhibit symptoms of post-traumatic stress disorder (PTSD) that can last up to five years following the disaster which decrease the academic performance. Researchers believe that most individuals can cope with ordinary stress. However, human beings do not possess the ability to confront traumatic stressors. Natural hazards and man-made disasters are considered as being traumatic events, leading to PTSD, that are different from the other painful events in life such as divorce, illness or failure (Friedman, 2016).

The social cognitive theory suggests that people need to believe that they can deal effectively with potential environmental stressors. Bandura (1997) defined people’s perceived self-efficacy as being the beliefs in their capabilities to control their own behavior
during events that affect their lives. These beliefs in personal efficacy would affect life choices as well as resilience to adversity and vulnerability to stress and depression.

Educational researchers have investigated the role of self-efficacy concept in the academic lives of students and have confirmed that their self-efficacy beliefs affect their academic performance (Bandura, 1977; Pajares, 1997). Self-efficacy determines individuals’ perseverance in the face of obstacles, their resilience to adversity and the amount of stress or depression they may experience in coping within the environmental context (Bandura). Students’ self-efficacy beliefs influence their persistence and resilience and therefore determine their self-regulated learning strategies (Bandura, 1977). Students with high self-efficacy use more cognitive and metacognitive strategies and persevere in the face of adversities (Pajares, 2002). Zimmerman and Bandura (1994) demonstrated that students’ self-efficacy increases confidence in their self-regulated learning which affects their achievements and increases their grades.

The use of ICTs is tremendously essential in supporting students during temporary school closures after seismic events by promoting self-regulated learning. This type of learning emphasizes students’ autonomy and control of the learning environment as they become responsible for information acquisition and other learning outcomes (Paris and Paris, 2001; Zimmerman, 1990). Researchers have showed that using ICTs provide students with an engaging learning experience to effectively learn the content and increase their sense of self-efficacy and ability to learn independently (Enfield, 2013; Fulton, 2012). Other researchers have demonstrated that self-efficacy increases the self-regulated learning strategies and equip students with perseverance, persistence and resiliency to engage in lifelong learning (Baytiyeh, 2017; Baytiyeh and Naja, 2017).

Online delivery methods
Online learning, a form of distance education in which learning materials are delivered via technological tools using the internet, has served as an alternative method for educating students unable to attend traditional, face-to-face classes. Online learning relies on a variety of innovative tools to deliver learning materials and instruction, including multimedia applications, social media tools, print materials, e-mail, the internet, computer software and audio- and video-conferencing. Technology has raised the quality of individualized instruction synchronously and asynchronously. The use of various electronic media increases time effectiveness and improves the delivery of information (Baytiyeh and Naja, 2010).

Providing instruction to students in an online environment is not solely the responsibility of the instructor. Collaboration between instructors and educational technologists is necessary for the development and dissemination of instructional materials (Brinkley et al., 1991; Collins and Murphy, 1987; Kelly, 1990). Educational technologists provide expertise in areas where the instructor lacks experience (Kelly, 1990) and include computer specialists, instructional designers and educational video producers who possess the production expertise to assist in the technical development of subject matter materials (Smith, 1991).

Maintaining education during disasters
This paper proposes online education as a solution to restore education delivery during school closures after earthquake which disrupts traditional, face-to-face teaching and denies students and staffs access to schools. Such weeks- or months-long interruptions pose a crucial challenge to educators and administrators, particularly when damages to schools require an undetermined period of rehabilitation. Transforming traditional schools in earthquake-affected areas into online educational environments can become a valuable intervention to address these challenges.
The availability of a reliable internet connection is always fundamental to use technology in educational contexts. In case of disasters in general and specifically earthquakes, it is more likely that the internet connection becomes not reliable to assist in communication and in educational materials delivery. Therefore, the following solutions can be taken into consideration:

- Project Loon launched by Google X company (Google X, 2017; Muoio, 2016) is a network of balloons designed to extend internet connectivity to people in rural and remote areas worldwide. This option can be used as well to connect people to the internet in disaster zones. As such, project Loon was successfully implemented to connect tens of thousands of people in Peru for seven weeks where flooding has destroyed homes and roads (Larson, 2017b).

- Another project offered by facebook (Larson, 2017a) aims at connecting rural regions around the world to the internet by building a prototype helicopter antenna that can provide internet to areas during disasters.

Once the internet connection is available, three essential components are requested to be maintained for online education after an earthquake as shown in Figure 1: data storage, instant communication capabilities and learning materials.

Maintaining instant communication
Maintaining communication among students, parents, teachers and administrators is essential in disasters. Phones are a basic tool for groups of students, teachers and staff to stay in touch. Creating call trees, which are essential in every disaster preparedness plan, is helpful to keep groups connected and notify key personnel of any problems. Landline phones, e-mail, pagers, cell phones and short message services (SMS) can be used with a specific-software program to automate call trees.

SMS are an ideal option for teachers to communicate with students. Instant messaging (IM) allows high school students to ask questions during the learning process after school hours (Hrastinski et al., 2014). In another study, students whose university provided an internal SMS tended to participate and ask more questions during and after lessons (Scornavacca et al., 2009). Other researchers have reported that the use of IM as a communication tool for faculty and students promotes student learning (Smit, 2012),

Figure 1. Main components to maintain online education during disasters
active learning (Cifuentes and Lents, 2011), informal communication between students (Cifuentes and Lents, 2011; Smit, 2012), in-person interaction between students and faculty related to course content (Cifuentes and Lents, 2011), a sense of belonging and community (Doering et al., 2008; Sweeny, 2010), the breakdown of social barriers between teachers and students (Doering et al., 2008) and students’ attentiveness and serious attitudes toward assignments (Sweeny, 2010).

WhatsApp messenger is another alternative tool for communication. This cross-platform, mobile messaging application enables users to exchange messages, phone calls, images, videos and audio using the same data plan as for e-mails and web browsing (WhatsApp, 2016). Church and De-Oliveira (2013) found that users adopt WhatsApp as their main communication channel rather than other platforms due to its immediacy, cost effectiveness, the desire to be a part of a trend and the constant interaction with friends and family. WhatsApp also enables users to send an unlimited number of messages and simultaneously conduct conversations with many friends. WhatsApp provides a free solution for students and teachers to communicate during disasters; teachers can create a WhatsApp group for classes and notify them of any updates or news.

Maintaining access to learning materials
A digital platform is one solution to provide students with learning materials and help parents stay continuously informed of their children’s academic performance. Parents can download school reports and materials and receive important links, notifications and automated alerts sent by the school through digital platforms. If schools cannot afford the design, implementation and maintenance of a private digital platform, they can use some online tools for free such as MoodleCloud. Another tool is Google Drive, a free solution for schools providing online word-processing documents, spreadsheets, slides, surveys, drawings and databases. Teachers and students can share content and collaborate synchronously and asynchronously. Also, Google Apps for Education (GAFE) are cost-free offerings for educational institutions of the suite of Google applications (Gmail, Calendar, Drive, Docs and Sites) that can be used to deliver education during emergencies. Once registered for GAFE, the school will be assigned a domain where teachers and students can collaborate and save their work on the cloud. Edmodo is also a free online tool that allows teachers and students to share files and resources while providing real-time communication tool and unlimited storage. In the case of disasters, these applications are easy to manage and can be accessed from any computer or mobile device, allowing users to communicate and collaborate with others.

Maintaining data access
Maintaining access to data is essential to saving official documents. Cloud storage is an ideal solution that educational institutions are urged to adopt as a proactive measure for disaster situations. Cloud computing enables ubiquitous access to shared computing resources, such as computer networks, servers and applications, with minimal management effort. Cloud computing provides data storage in third-party data centers located far from the user, from across a city to across the world. Data centers typically are located far from the region of disasters, which allows users with an internet connection to access the servers and services needed.

Implementation of the proposed approach
All members of a school have critical roles in the backup emergency plan for a disaster by maintaining instant communication and access to data and to the learning materials. The following explains the steps that should be taken to implement this online learning approach.
A post-disaster scenario will start by an essential task performed by the IT staff which is to ensure the functionality of the designed infrastructure after the disaster. A reliable internet connection is the major requirement to secure the performance of the proposed approach. Depending on the vulnerability of the regions, some schools may have to implement the project Loon launched by Google X company or the project offered by Facebook, as explained above, to extend internet connectivity to people.

The second task is to be performed by the administration and to launch the communication between staff, students and teachers to announce that the designed disaster approach is under action. This communication can be either through phone calls, e-mails or WhatsApp messages, depending on the availability of the tools.

Once all the groups of classes are in contact, teachers can start using the application adopted by the school as a learning management system/course management system. Teachers need to update the online materials as needed, and create discussion forums for questions and answers to maintain class interaction. Meanwhile, it is very essential to maintain communication between classmates and their teachers. For that purpose, several free online are available where teachers can create groups and invite their students to keep communication and interaction within the group. As such, blogs serve as an excellent communication tool and can provide an intellectual cyberspace where students and teachers can have conversations, post comments on specific posts, reply to others’ comments and encourage readers to respond to each other. Wikis can be also be used as repositories for learning materials or for students to collaborate on projects both synchronously and asynchronously. All types of files, including images and videos, can be attached to wikis. Teachers can also use Facebook by inviting their students to share materials, communicate through messages and replies and receive notifications of any updates. Twitter is another online social networking tool that students and teachers can use to converse in a peer-to-peer discussion.

Although teachers have an essential role in the educational processes, parental involvement can be critical for effective student learning achievement in online teaching environments. Parental involvement influences student academic performance (Anderson and Minke, 2007). Due to the lack of the teacher’s physical presence in online learning modes, Russell (2004) believed that parents’ role in keeping learners focused on the assigned tasks could be more important than in traditional school environments.

Recently, education during disasters has gained high priority due to its critical role in protecting children and preserving their right to education. After disasters, emotional and social issues can interfere with educational processes that require a safe learning environment to be effective. Consequently, in these situations, the psycho-social well-being of students must be considered, along with their cognitive development. Exposure to violence and trauma has been shown to have negative impacts on learning and information processing (Delaney-Black et al., 2002). To mitigate these impacts, online educational environments seem to be a promising interventional approach that can empower students, provide a positive learning environment and generate positive learning experiences. Furthermore, this approach can encourage students to communicate with friends and teachers and release some of the stress they feel due to the emergency. ICTs can offer alternative ways of delivering mental health support to disasters’ survivors. These ICT applications are becoming ubiquitous for a variety of daily tasks, such as shopping and banking, and their integration into mental health services is available through video-teleconferencing, mobile phone and smartphone-based interventions. The penetration of social media platforms connects large numbers of users and facilitates rapid communication. The use of ICTs to provide mental health support in the disaster-affected communities is essential due to the fact that these technologies can reach rural areas and regions that have a shortage of mental health clinicians while accommodating a large
number of users (Brian and Ben-Zeev, 2014; Kanuri et al., 2015). Researchers believe that ICTs assist mental health professionals by providing peer mental health support and by increasing active self-management of problems among disaster survivors (Aggarwal, 2012). It was found that internet interventions for PTSD are significantly more effective than passive controls (Kuester et al., 2016). As such, it was noticed that PTSD Coach, a mobile application that has been downloaded over 243,000 times in 96 countries, has helped in reducing distress for those who use at least one symptom management tool (Owen et al., 2015). In Iraq, researchers who tested the efficacy of a cognitive-behavioral internet-based intervention for war-traumatized residents found that PTSD symptoms were significantly reduced, and it was suggested that using ICTs entirely to provide cognitive-behavioral treatment may help trauma survivors (Knaevelsrud et al., 2016). Also, in the USA, web-based interventions have successfully reduced PTSD symptoms and depression for combat veterans experiencing stress difficulties (Hobfoll et al., 2016). In politically unstable countries, areas that are affected by disasters and lacking basic necessities where mental health providers are not available to provide in-person support, the use of ICTs becomes an ideal solution for communications and interventions with people experiencing PTSD symptoms (Acar and Muraki, 2011). The available ICTs are a great solution for extensive mental health needs in both Western countries where mental health infrastructures are well established and in low- and middle-income countries that lack such infrastructures.

**Challenges faced through the proposed approach**

Research has indicated that student achievement in online educational setting is as effective as in face-to-face instruction (Cavanaugh et al., 2004; Cavanaugh, 2005; Means et al., 2009). This finding has motivated greater acceptance of online learning as a feasible educational alternative (Hawkins et al., 2012). However, transforming the traditional educational processes during emergencies into an electronic or online environment is a challenging task that requires teachers to establish the needed interaction with their students. The success of the temporary shift to electronic schools during short emergencies requires involved teachers to play a devoted role (Mackey et al., 2012). The features that make teachers successful in the traditional classroom must be sustained in online teaching. Guiding students through the online learning materials, responding to questions and maintaining live interaction among students amid conflicts is a new approach that requires teachers be well prepared and have the experience and skills to accomplish this task. Also, a main challenging task is the continuous and unlimited support needed from the IT staff to the teachers. In such circumstances, teachers should be supported by the technical team as well as by the instructional designers who are needed to assist teachers in performing their teaching practices through the available online tools and applications. Moreover, parental involvement has a critical role. In addition to affecting academic performance, parents have been recognized as the most important source of social support for children during disasters (Prinstein et al., 1996), offering a sense of physical safety while giving emotional support, comfort and nurturance.

**Conclusion**

Past earthquakes have had devastating impacts on the education sector that should motivate school administrators in seismically active regions to have backup emergency management plans to deliver education online during temporary school closures caused by earthquakes. Although improving school building safety in earthquake-prone regions through the implementation of seismic structural strengthening techniques can increase the safety of students and teachers, prevent the structural collapse of schools during strong earthquakes and eliminate fear and anxiety among students and parents, it remains insufficient to ensure the operation of schools and continuity of education after an earthquake.
This paper proposes the transformation of face-to-face education into an online learning model during temporary school closures after moderate earthquakes and provides a pre- and post-earthquake framework for online learning. When combined with structural strengthening of school buildings, this emergency backup approach presents a sufficient, proactive preventive measure that can effectively increase the resilience of education and mitigate the impacts of future earthquakes on schools and students. Education leaders and school administrators in earthquake-prone countries should be aware of the risks of earthquakes for schools, students and education. They are urged to devise emergency management plans that build teachers’ and students’ online teaching and learning capabilities to prevent the interruption of education delivery in the aftermath of moderate earthquakes.

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