The 2010 Haiti earthquake: Real-time disaster inquiry in the classroom

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Abstract

Civil engineering education commonly has classroom instructional strategies that include synchronous engagements between the instructor and the learner, but seldom has synchronous experiences between the learner and real-time external phenomena. As a consequence, student learning has historical sensibilities that may inhibit formulating opinions and conclusions from live events. This paper explores a natural disaster as a real-time course inquiry and its semester long immersion into the structures classroom at a private liberal arts university. A qualitative research design was deployed with a teacher's story and participant observation study to document forty-four third-year architecture students studying an unfolding disaster event. The disaster was the 2010 Haiti earthquake. The findings indicate that students envision earthquake events as either a structural phenomenon with cultural implications or a cultural phenomenon with structural implications. The lessons learned from implementing a real-time disaster inquiry in the classroom are provided.

Introduction

"From birth, man carries the weight of gravity on his shoulders. He is bolted to earth. But man has only to sink beneath the surface and he is free." wrote Jacques-Yves Cousteau.[1] Cousteau bypassed the gravity constraints and co-developed the first aqua lung device. His approach redefined the problem. Cousteau's solution now made the invisible visible as he charted new frontier. This is a metaphor for educators continually confronted by the weight of prescriptive curricula in need of alternative innovation.

The top eleven undergraduate engineering programs ranked in 2010 by the US News and World Report were investigated by the author and two trends were found. The curricula are very doctrinaire and the course descriptions are indicative of synchronous engagements between the instructor and the learner. Conversely, none of the eleven schools appear to dedicate a course that has a synchronous engagement between the learner and live content. A semester long course devoted to a single real-time dramatic event that has broad impacts in engineering. Educators may identify a significant event as the Kansas City Hyatt walkway collapse. Although this became a learning moment in engineering education, its discussion or laboratory reenactment exhibits synchronicity between the instructor and the learner and not the learner and the event. This asynchronous experience has the students learning about the event with a historical sensibility. All of the relevant conclusions from academia and practice are available in the public domain. When engineering programs lack courses engaging real-time phenomena, they may inhibit students from thinking critically and formulating their own opinions and conclusions from live events. A need exists for exploring synchronous, or real-time, student engagement between a significant event, such as a disaster phenomenon, and the academic experience.

In response to this need, undergraduate students were immersed inside one disaster event in the structures classroom to explore, “What is the nature of synchronous engagements between the learner and the disaster event?” To examine this condition, a qualitative study was instituted to document a course devoted to studying a natural disaster that evolves concurrently within the course timeframe. The primary purpose is to understand the nature of disaster inquiry in the classroom through student immersion. The paper addresses persons interested in integrating engineering, education, and disasters.

The 2010 Haiti Earthquake

On January 12, 2010, one of the world’s worst natural disasters took place. The Caribbean and the North America tectonic plates adjusted and released energy that had a 474 kt [2 pj] TNT explosive equivalent. The earthquake epicenter was positioned near Porte-au-Prince, Haiti. The earthquake measured a 7.0 on the moment magnitude scale (M_W). Although, the 7.0 M_W is comparable to the energy release of the Loma Prieta earthquake (6.9 M_W), it produced over 3,500 times the fatalities. The 2010 Haiti earthquake has the largest death toll of any previously recorded 7.0 earthquake event.[2] When Loma Prieta occurred in 1989, I was beginning my graduate education in structural engineering. My enthusiasm for gaining knowledge grew when this real-time topic was introduced into an earthquake engineering lecture. Some twenty years later and being teacher, one realizes that the Haiti earthquake is a unique learning opportunity for students. An opportunity suited not for an isolated lecture, but rather its immersion into a course.

Implementing Disaster

Drury University is a private school that offers higher education rooted in the liberal arts tradition. Although the university houses the Hammons School of Architecture, it does not have an engineering program. The department offers three computational-based structures courses. The first course introduces the fundamental principles of statics and mechanics of materials, while the second course includes structural steel and timber design. The third course became the immersion setting. There were forty-four architecture students enrolled in the junior-level structures course during the spring semester of 2010. This third course is in flux as our program transitions from a five-year bachelor to a five-year master’s program. The master’s curriculum is sunsetting reinforced masonry and concrete design topical content in the third course in favor of a new research-based course. The upcoming course description reads, “Application of engineering principles and analytical methods, as presented in the earlier technology coursework. Beginning team scientific research into implications and development of these systems through the collection of empirical data using methods of science. Students will write up research results in the form of a professional publication and present their work in a forum open to the full campus.” Of the two courses, the research course is more suitable for immersing a natural disaster, but it has its weaknesses. The students have not been exposed to lateral forces or reinforced concrete design. These are two important components of earthquake engineering. In spite of this deficiency, the master’s curriculum has greater adaptability for a disaster intervention due to the research directive. With uniform student consensus, they chose to engage the new master’s course a couple of years early.

Procedure

A qualitative research design[3] was deployed with a teacher's story[4] and an embedded participant observation study.[5] The rationale is to provide a holistic interpretation of the course through the perspectives of the teacher and the students. The teachers' story method is founded upon personal portrayals by teachers concerning their classroom experiences. This approach follows the narrative tradition and captures the author's storied knowledge. This is presented in a storytelling format. The participant observation study describes the student perspective. The data are composed of artifacts that were acquired in an unobtrusive manner. The artifacts include raw field notes and evaluations of student outcomes. The notes represent context and actions from the shared experience in group and class discussions. The student outcomes include literature reviews, scholarly papers, posters, and their first impressions captured immediately after viewing topical content. The data are analyzed to discover relationships, make interpretations, and develop explanations. This interpretive analysis is presented in a findings format interwoven with the teacher's story. The narrative follows a chronological journey with embedded participant observation themes characterized in a *bon mot*, light-hearted anecdotal hyperboles, or idiomatic expressions.

Findings

The course was configured into two stages (see Figure 1). The first stage was an introduction to earthquake principles and the Haiti earthquake, while the second stage was the research inquiry. The two stages were separated by the instructor development and student selection of the research questions. The questions were informed by the student outcomes from the first stage activities. The outcomes are shown inside the parentheses of Figure 1.

The first stage was about one-quarter of the semester. The instruction was an instructor-centered lecture methodology which included a sprinkling of multimedia encounters. The topical areas were associated with the historical development of earthquake principles. The principles expressed how US model building codes and lateral force procedures evolved. The historical traces paralleled industry's knowledge progression regarding plate tectonics, quantifying earthquake events, building construction materials, and architectural form and configuration. The multimedia engagements included silent footage of San Francisco's Market Street prior to and after the 1906 earthquake, the 1908 Messina, Italy, earthquake, earthquake preparedness for the New Madrid fault region, architectural and engineering collaborations, and footage of the Haiti earthquake. The student outcomes were in the form of first impression journaling of the aforementioned artifacts and recorded immediately after their initial exposure.

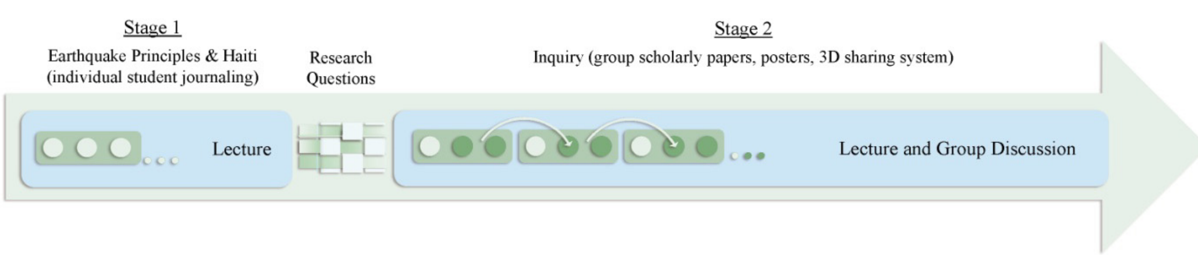

Figure 1. Course configuration.

The student impressions revealed that earthquake events were either a structural phenomenon with cultural implications or a cultural phenomenon with structural implications. This content breadth was unanticipated when the course was first orchestrated. Therefore, the research questions were developed from the expanded topical areas of earthquake engineering and Haiti where each topic allowed the other to act as a backdrop condition. Five research questions were created by weaving a topical area and its backdrop within the timeline parameters of pre-earthquake, earthquake, or post-earthquake. The timeline was established to provide a holistic viewpoint of the disaster event. The student research questions are shown in Figure 2. Each question was classified as Haitian culture, earthquakes v. buildings, survivor stories, the built environment, and Haitian utopia.

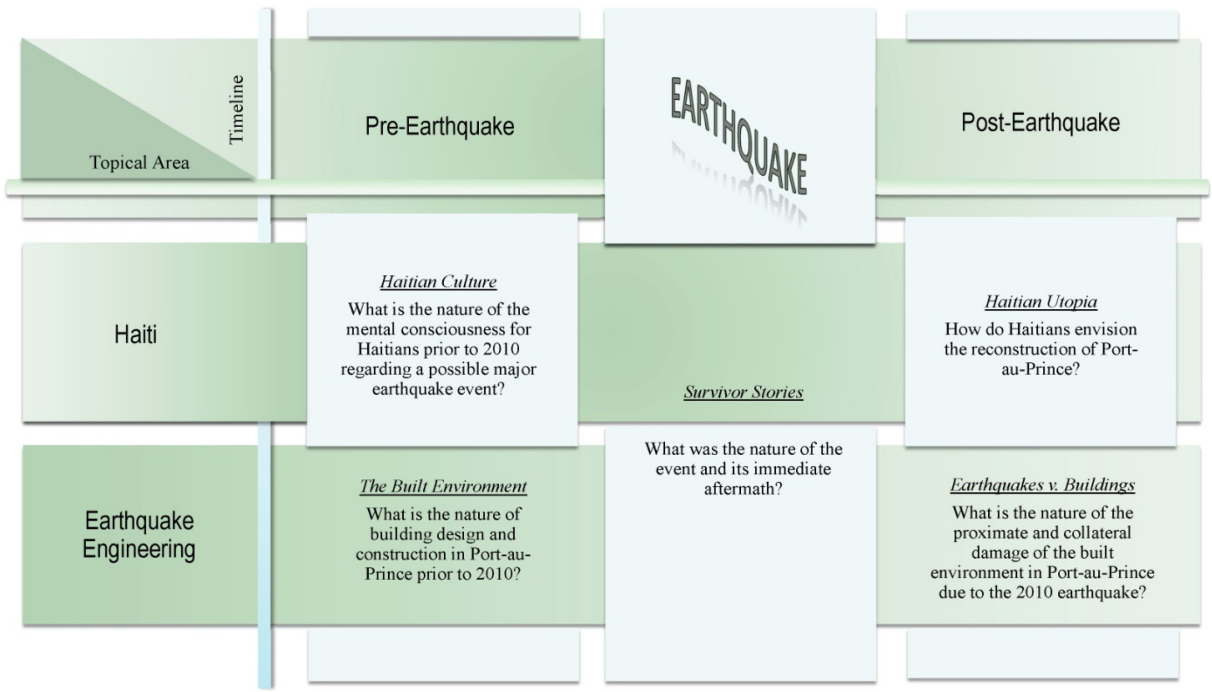

Figure 2. Student research questions.

The second stage was about three-quarters of the semester. The instruction was a hybrid of weekly lectures on Mondays and group discussions on Wednesdays and Fridays. The group discussions were coordinated with the group research questions. Each group was assigned one research question. The lectures were informed by the outcomes of the group discussions from the previous week. This stage was fluid and integrated student discovery. The groups were asked to collect artifacts concerning their research question. The artifacts were in the form of traces, documents, personal communications, records, photographs, videos, and archives. These were indicators of group or individual life and the built environment. The students performed an artifact analysis by recognizing patterns and making generalizations. This research process and group discussions culminated in a scholarly paper, poster, and an on-line interactive 3D information sharing system. The student outcomes and engagements from the entire course revealed several interesting findings. The findings represent the interpretations of the relationships inside the student outcomes. A reduced summary is provided in Table 1.

Table 1. Common Student Themes.

Theme	Description
Whole lotta of shakin' goin on	The students discovered that the Earth's tectonic plates were under constant strain and constantly inducing ground motion all over the world. During the semester, the Chilean earthquake registered an 8.8 M_W. The students noticed that Haiti had significantly more damage through a much weaker shake.
No shoes, no shirt, no code	The students discovered that design and construction practices in Haiti were not consistent with standards in the US. The students recognized that even the National Palace (see Figure 3), the most important Haitian building that houses the president, was not earthquake resistance.
What's the frequency, Kenneth?	The students discovered that the last relevant earthquake in Port-au-Prince was almost two and a half centuries ago. This infrequency, lead the Haitians to become more concerned about annual hurricanes and heavy rains.
Hey bar-tender	The students found that the construction materials were frequently inconsistent. There were several conditions were concrete beams and columns neglected reinforcement or when implemented used smooth bars.
Let the games begin (On-line interactive 3D)	Some student teams pursued using interoperable BIM and on-line interactive 3D visualization to share project data. This was a user-friendly means of allowing novice BIM users an opportunity to access information. This may have industry potential for integrated design procedures.
Standing on your own two feet	Some student inquiries did not uncover enough data due to the newness of the earthquake event. When this occurred, the students sought representative examples to draw their own conclusions.

Discussion

To offer meaning from the student findings, I collapsed the themes into four educational lessons learned. These are my reflections from the real-time disaster inquiries in the areas of course instruction, content, and student outcomes.

Eureka!

The instructor's need for minimum topical content and the lack of a controlled discussion are the two major obstacles confronting educators in pursuing classroom discussions as an instructional strategy.[6] Topical content is best attained through lectures. As discussions increase, the content progressively decreases, but this facilitates an increase in learning comprehension and critical thinking. A hybrid lecture and discussion format was chosen in an effort to include content during the inquiry stage. The daily ASEE briefings regarding the Haiti earthquake were deployed to provide balance and to initiate discussion.[7] These were distributed as a tool to initiate discussions relevant to a group's research question. The students experienced *Eureka!* moments during inquiry. A lesson learned was that the *Eureka!* moments bridged the class lectures and the group discussions. For example, the Built Environment group discovered in *Hey bar-tender* that the National Palace (see Figure 3) was built with concrete columns that contained four thin and smooth vertical reinforcement bars. The students instinctively knew that this was incorrect, but did not have the technical knowledge to understand why. This was an opportunity to discuss the significance of stirrups, bar deformations, and development lengths with the smaller group and extend to the larger class lecture the following Monday. This was knowledge strengthening for the discovery group and knowledge acquisition for the remaining students. Each group had individual discoveries that occurred at different points in time and informed subsequent lectures. This lesson learned conveniently deals with structural concerns, and does not address the non-technical or cultural issues.

Figure 3. National Palace, Port-au-Prince: (a) August 7, 2006;[8] and (b) January 14, 2010.[9]

Who Let the Dogs Out?

Expanding research questions to include a cultural emphasis is a slippery slope in an engineering course. *Who let the dogs out?* refers to a breadth of content associated with disasters that seems to go on forever. Unusual topics arose during the discussions such as economics, politics, anthropology, sociology, foreign language, history, violent crime, and even food science, etc . This was, in part, due to our liberal arts general education experience at Drury. The expanded inquiry was integral in recognizing themes such as the *No shoes, no shirt, no code* regarding Haitian design and construction practices. One lesson learned was to redirect some of the non-technical cultural themes back into the structural domain. For example, discussions of economy were transformed into concrete failure conditions for unreinforced, under-reinforced, balanced, and over-reinforced members. This was relevant due to the amount of reinforcement a client could afford to purchase. When topics were too difficult to navigate through, the students were encouraged to share their reflections with the whole class during the lecture sessions. Permitting cultural journeys fostered critical thinking. This lesson learned also offers an opportunity for team teaching outside of the design discipline. An instructor in the humanities area might be the most appropriate collaborator. Please keep in mind that if the dogs are not let out occasionally, we may arrive at the final destination without making stops along the way.

Pit Stops

An engineer with formal training may view the images of the earthquake aftermath and conclude that the building construction was grossly inadequate for the applied loads. This may import a rush to judgment where the final solution is to educate and provide the Haitians with the most current model building code. Not so fast. An inquiry of the structural phenomenon may not provide an implementable solution in the short-term. The Haitians taught us that finding shelter prior to the rainy season and securing basic sustenance have a greater sense of urgency than addressing the design and construction processes of permanent structures. Furthermore, from *What's the frequency, Kenneth?* the Haitians must overcome a few centuries of having a false sense of security that large earthquakes rarely strike Haiti. The lesson learned from real-time inquiry is that incremental inquiries or pit stops of the cultural phenomenon are needed along the way before a long-term solution is reached based exclusively upon the structural phenomenon.

Flirtin' with Disaster

The *Whole lotta shakin' goin on* brings to light the disasters around us and the suitability of disasters. When selecting a disaster, one should define what constitutes a disaster, examine the recent history, and align the course in real-time with the event. Most Americans live in areas that are exposed to hazards whether occurring naturally or through the involvement with humankind. Natural hazards may be in the form of tornadoes, earthquakes, or hurricanes and may impact the Midwest, West Coast, and Gulf States, respectively. Hazards occurring from human involvement may be oil drilling rigs, physical neglect of buildings and infrastructure, or acts of terrorism. Hazards are the initial sources of the phenomena. The selected phenomenon should have broad implications and significance, and subsequently be classified as a disaster to warrant a classroom inquiry. Broad implications exist when there is harm to human life, its shelter, or to ecosystems. The significance is the degree of harm such as human lives lost, reconstruction costs of buildings and infrastructure, or the corresponding loss of fauna and flora. A disaster exists when a hazard achieves the aforementioned harm.

The past decade witnessed the 2000 Carlsbad pipeline explosion, 2001 September 11 attacks, 2002 Hayman Fire disaster, 2003 Midwest tornado outbreak sequence, 2004 Indian Ocean tsunami, 2005 Hurricane Katrina, 2006 North American heat wave, 2007 I-35W Mississippi River bridge collapse, 2008 Bihar India flood, and the 2009 Typhoon Ketsana. Most recently, the Deepwater Horizon oil drilling platform explosion occurred in the Gulf of Mexico. Recent disaster history illustrates the breadth of sources. Since most regions have some adverse risk, everyone is potentially connected to a disaster situation. Select a disaster that has geographic proximity and relevance. This will increase the potential of student travel and possible access.

Real-time is the synchronicity between the disaster phenomenon and the academic experience. Inquiry is the student investigation of the event. When too much time passes between the event and the inquiry, professionals and academics may have their conclusions available in the public domain. Disaster events will not conveniently reveal themselves during the first week of class. Therefore, one may conclude that a real-time engagement would pragmatically be the semester immediately following an event. Ideally, the event and the academic experience are concurrent and the recent events are still under active investigation and remediation by industry. The research questions should not yet to be fully explored by others.

"Disasters Teach more than Successes"[10]

In conclusion, consider real-time disaster inquiries as an opportunity for broader implications where, "Education is for improving the lives of others and for leaving your community and world better than what you found it."[11]

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Keith Hedges is an Assistant Professor of Architecture at Drury University. His research interests are to bridge the disciplinary knowledge gap between architecture and engineering students in higher education. Keith has taught sixteen various courses from architecture courses at ABET accredited institutions to engineering courses at NAAB accredited institutions. He has presented educational themed papers in six countries.