

A Perfect Storm: Examining Natural Disasters by Combining Traditional Teaching Methods with Service-Learning and Innovative Technology*

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In spring 2006, Duke University piloted a new, interdisciplinary, service-learning course, in which undergraduate, graduate, and professional students conducted a life cycle analysis of natural disasters. Invited experts discussed: the range of meteorologic, hydrologic and geologic factors that cause disasters; explored how societies plan for and/or respond to the immediate and long-term physical, social, emotional and spiritual issues associated with survival; and presented case studies of response, recovery and reconstruction efforts. Students had the option to participate in either a service-learning exercise in an area ravaged by a natural disaster or to research a topic related to natural disasters. All students attended the lecture component of the course and completed on-line quizzes to demonstrate understanding of the material presented. Students who elected to undertake the service-learning experience participated in a trip over spring break to assist residents of St. Bernard Parish, Louisiana. During their time in Louisiana, they kept journals (audio and written) of their activities and upon their return wrote a brief synopsis, and made a group oral presentation of their experience. Students not participating in a service-learning project prepared one individual paper on a relevant topic and one group paper, the results of which were presented to the class. Additionally, as part of the Duke Digital Initiative, the course also relied on technology to enhance student learning. Twice-weekly lectures were recorded and provided in the form of Webcasts for future reference and students completed online quizzes based on these lectures. Also, students recorded interviews with hurricane survivors and volunteers on Duke issued iPods and used that audio content, interwoven with their own thoughts and experiences, to create audio journals about their service-learning experiences.

Keywords: service-learning; instructional technology; natural disasters

INTRODUCTION

KATRINA. MOUNT ST. HELENS. Southeast Asia Tsunami. Bird Flu. Northridge Earthquake. All of these conjure images of catastrophic infrastructure failure, tragic loss of life, and crisis moments for communities, nations and in some

cases global regions. Natural disasters reveal inadequacies in social, psychological, and physical support networks, but they also crystallize what is best about humanity with stories of courage, sacrifice, and united effort to overcome adversity. Following the ravages of Hurricane Katrina, many individuals and agencies pondered how best to use their resources to assist the survivors of the gulf coast in rebuilding their communities. Academic

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institutions also examined how they could support the effort. Recognizing the wealth of intellectual capital in the academy, Duke University piloted a service-learning course to not only explore the aftermath of Katrina, but also to analyze the life-cycle of natural disasters from an interdisciplinary vantage point. The purpose was to engage students in examining the science behind disasters, learn how societies (and subset groups within societies) cope with the immediate aftermath of catastrophes, and explore long-term strategies for rebuilding and restoring a good quality of life to a community.

MOTIVATION FOR CLASS, SELECTION OF PRESENTED MATERIAL AND PAST WORK BY OTHERS IN THIS AREA

With the human interest associated with Katrina and other recent catastrophes, the topic of natural disasters provides a rich and engaging intellectual environment in which to address multi-faceted problems, all of which must be approached from interdisciplinary standpoints. By tapping the diverse expertise available at Duke, the course provided students with exposure to all aspects of these complex problems. Specifically, experts in the sciences, engineering, and medicine described: the science behind weather patterns; tectonic movement; biological pathogen mutation, exposure, and infection; and a host of other ever-present disaster scenarios. Others representing distinct and overlapping professional sub-specialties in the humanities, public policy, law school, divinity school, and medical center—who represented both first responders and long term partners detailed issues related to the immediate and the extended recovery process. To facilitate the learning process, the course was divided into four major sections: the causes of natural disasters, surviving the unimaginable/first responses, rebuilding from ruins/process of recovery, and student presentations on student-selected topics. Academic course content was coupled with an optional service-learning engagement in the Gulf Coast over the spring break, which gave students the opportunity for experiential learning within the context of civic engagement.

Thomas Ehrlich defines service-learning as ‘the various pedagogies that link some form of community service with academic study so that both parts symbiotically strengthen one another’ (Jacoby, 1996). Other educators have applied service-learning in both engineering and in educational situations in responding to disasters (Steiner and Sands, 2000; Pearce, 2006). However, this pedagogical approach is rather new, noting that the Engineering Projects in Community Service (EPICS) program was launched at Purdue University in 1995 and the establishment of the International Journal for Service Learning in Engineering occurred in 2006. Educators have used specific

practical experiences to combine learning and intellectual engagement (Endreny, 2004; Hrabowski, Lee, and Martello, 1999), couple engineering and service-learning (Coyle, Jamieson, and Oakes, 2005; Goldberg, 2004; Jeffers, Safferman, and Safferman, 2004; Pearce, 2006; Tsang *et al.*, 2001), work with graduate students (Talbert *et al.*, 2003) and integrate service-learning within the context of sustainability (Al-Khafaji and Morse, 2006; McCarthy, 2003; Sandekian, Amadei, and Pinnell, 2005). While this past work has advanced the state of the art as well as the state of the practice of service-learning, the reviewed literature still leaves areas to expand the current knowledge basis related to the method as well as to define alternative applications for innovative student experiences. Specifically, many traditional service-learning experiences tend to focus students of similar skill sets or academic preparation toward working on common topics. In the experience that is the focus of this paper, the multi-disciplinary nature will be discussed and lessons learned will be highlighted. Additionally, learning objectives and measurable outcomes, especially those related to quantifying reflections are discussed. The course discussed here expands on the past work and integrates innovative applications of service-learning and instructional technology, to form the ‘Perfect Storm’ of educational techniques and experiences interwoven with issues of ethics, graduate education and student engagement.

COURSE LEARNING OBJECTIVES, STRUCTURE AND ASSIGNMENTS

When the course was first conceptualized, it was thought that there would be significant student interest from across the University. This was indeed the case as the final course enrollment was 174 students, including undergraduate, graduate and professional students representing 22 different majors and/or departments. Figure 1 displays the breakdown of students based on major as both the numeric enrollment and percentage of the total students in the class. Engineering students comprised approximately 38% of the total, with the remainder coming primarily from Public Policy (14%) and Masters of Environmental Management (13%). Also, as displayed in Fig. 2, the course had a broad appeal with all four graduating classes of undergraduates as well as professional and graduate students. In order to engage such a diverse group of students, the pedagogical themes of the class were woven together with experiential learning. With such a diverse group, defining learning objectives that would be meaningful and rigorous proved to be challenging. However, in order to frame the questions and direct the learning, the following objectives were proposed.

1. Understand the meteorologic, hydrologic and geologic factors that cause disasters.
2. Understand the range of environmental, regulatory, social, emotional, design, operation and maintenance issues that are involved in disaster mitigation and recovery projects.
3. Explore how societies plan for and/or respond to the immediate and long-term physical, social, emotional and spiritual issues associated with survival.

In order to convey these objectives, the course used traditional lecture-based instruction, with opportunities for student questions and discussions, and was enhanced by the integration of instructional technology. Technological tools offered a particular advantage in dealing with the large course enrollment. Each of the lectures was captured in both video and audio formats using the Lectopia software tool. The students could then refer back to these recorded lectures throughout the semester. The learning was also reinforced with on-line, lecture specific quizzes that each student had to complete as part of their course grade. These twice weekly exams were randomly generated from an instructor prepared bank of multiple choice, ordering, or matching questions using Blackboard software. Quizzes were then automatically graded and entered into the course grade book, providing real-time feedback to the students as well as reduced grading time for the instructors.

The course grading structure was differentiated between students participating in the spring break service-learning experience and those electing to complete a research project. For those engaged in experiential learning, the submitted documents which earned a grade were: written and audio journals and a trip synopsis of the service-learning experience, a final team presentation of lessons learned during the civic engagement, and a research proposal for potential future service-learning projects. For the students opting for the research project track, two written reports (one individual report and one group paper) investigating topics related to a natural disaster along with a group presentation were required. The following discussion expands on the salient features of the class summarized above (both technological enhancements and submitted assignments) and attempts to elaborate on their role in the class, the usefulness of their implementation, lessons learned by the students (and instructors) and feedback mechanisms from the students in the process.

MEASURABLE OUTCOMES

In order to determine whether the students were grasping the information provided, as well as the gravity of the issues being faced in the midst of a disaster, measurable outcomes were established to evaluate their learning. Different evaluation tools

were used to assess the following measurable outcomes.

1. Demonstrate comprehension of the scientific principles underlying the occurrence of natural disasters. This included understanding theoretical principles, physical processes and governing mechanics, as well as the terminology used to describe the phenomena. This outcome was measured using on-line quizzes and research papers.
2. Demonstrate understanding of the responses to natural disasters, including the individual, communal, and societal reactions. This included recognizing issues and interplay of economics, governance, infrastructure, race, environment, etc. This outcome was measured using on-line quizzes, research papers, group reflections, journals (both audio and written), trip synopsis reports, oral presentations, and research proposals.
3. Demonstrate an awareness of what can be done to prepare for and respond to future natural disasters. This included demonstrating an understanding of the issues associated with planning, mitigation, response, and recovery as well as the infrastructure limitations of our current system. This outcome was measured using on-line quizzes, research papers, group reflections, journals (both audio and written), trip synopsis reports, oral presentations, and research proposals.

The following discusses the techniques used to teach and/or measure the understanding of the students with respect to these learned lessons.

INNOVATIVE TECHNOLOGY

Recorded/Captured lectures (Webcasts)

With the ability for streaming audio and video, and the prevalence of distance learning, the use of 'capture software' to record lectures for future reference was a logical step in the genesis of this course. Since there was broad appeal to students from across the University, providing a lecture that could be referred to ensure that all students had equal access (and ample opportunity) to comprehend the presented material. Additionally, alumni or other interested individuals were able to 'virtually' take part in the class. To facilitate this, a Web link was sent to alumni as part of a short article about the course in their Alumni magazine. One aspect of recording lectures is the importance of respecting the intellectual property of the presenter. This concern was dealt with by obtaining written permission on a standard form from each presenter prior to Webcasting his or her material. Figure 3 displays the recorded downloads for the captured class Webcasts.

As demonstrated in that figure, students and others accessed the first two Webcasts at a much higher rate than those from the remainder of the

semester. Omitting these first two lectures, the average download rate for the remainder of the Webcasts was 108 per lecture. With a course enrollment of 174 students, it appears that as many as 60% of the students on average re-visited the presented lectures at a later point in the semester. Unfortunately, the Webcast access data are only total 'hits', so it is not possible to determine if there is a positive correlation between learning objectives (i.e., retention of presented material, performance on quizzes) and reviewing lectures. It is also entirely possible that the Website received multiple hits from one student, thus biasing the data. Independent of documented proof of effectiveness, the fact that the access is relatively

consistent throughout the course indicates that the students found the captured lectures useful enough that a majority of the students appear to have watched at least portions of the presented material a second time. In order to encourage students to attend class and not simply view the Webcasts (in lieu of coming to class), students were required to register their presence in class and attend at least 75% of the lectures.

Blackboard quizzes

To facilitate the learning process, as well as to formulate a meaningful way to evaluate the retention of material for a class of 174 students, twice-weekly online quizzes were used to reinforce learn-

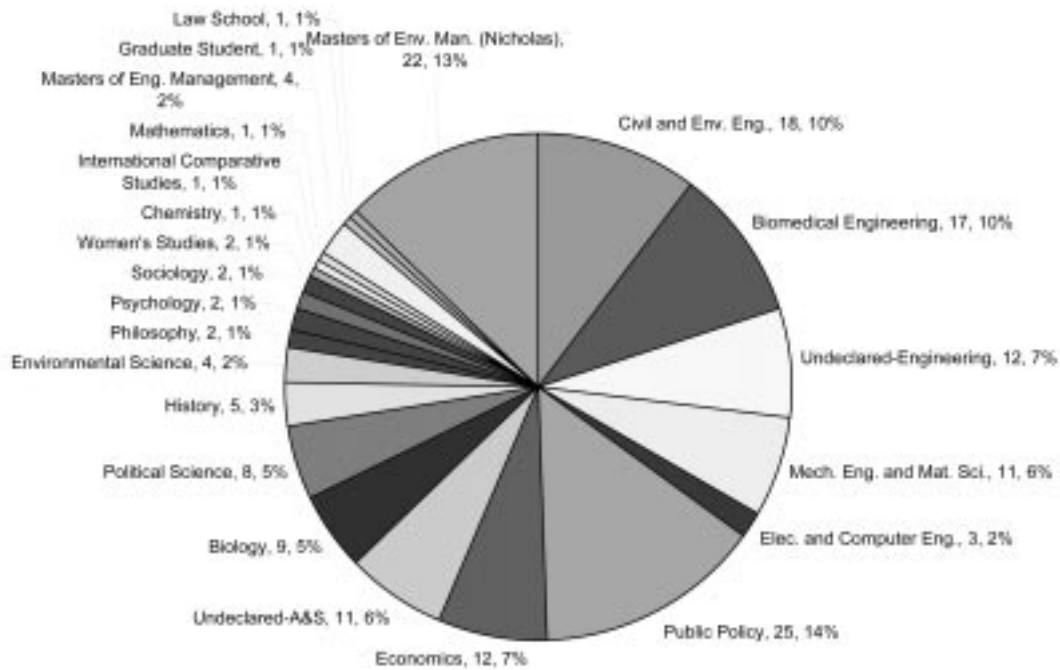


Fig. 1. Distribution of majors.

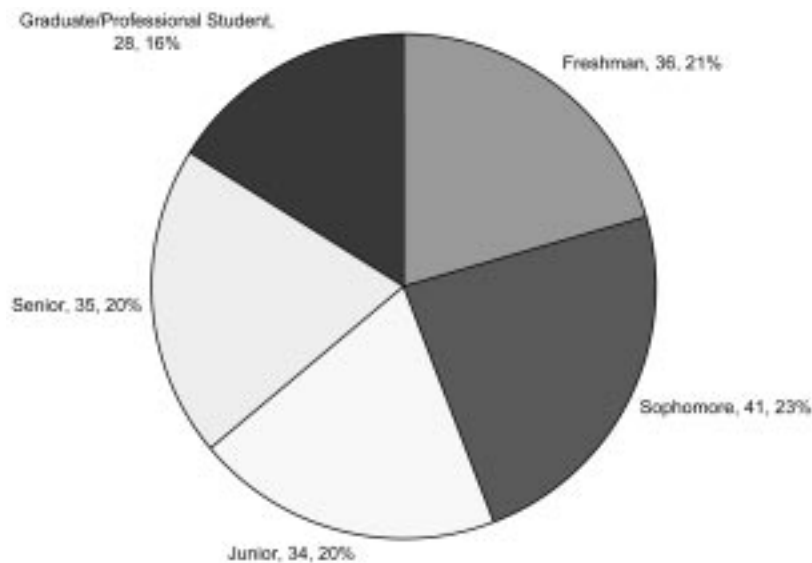


Fig. 2. Distribution of students.

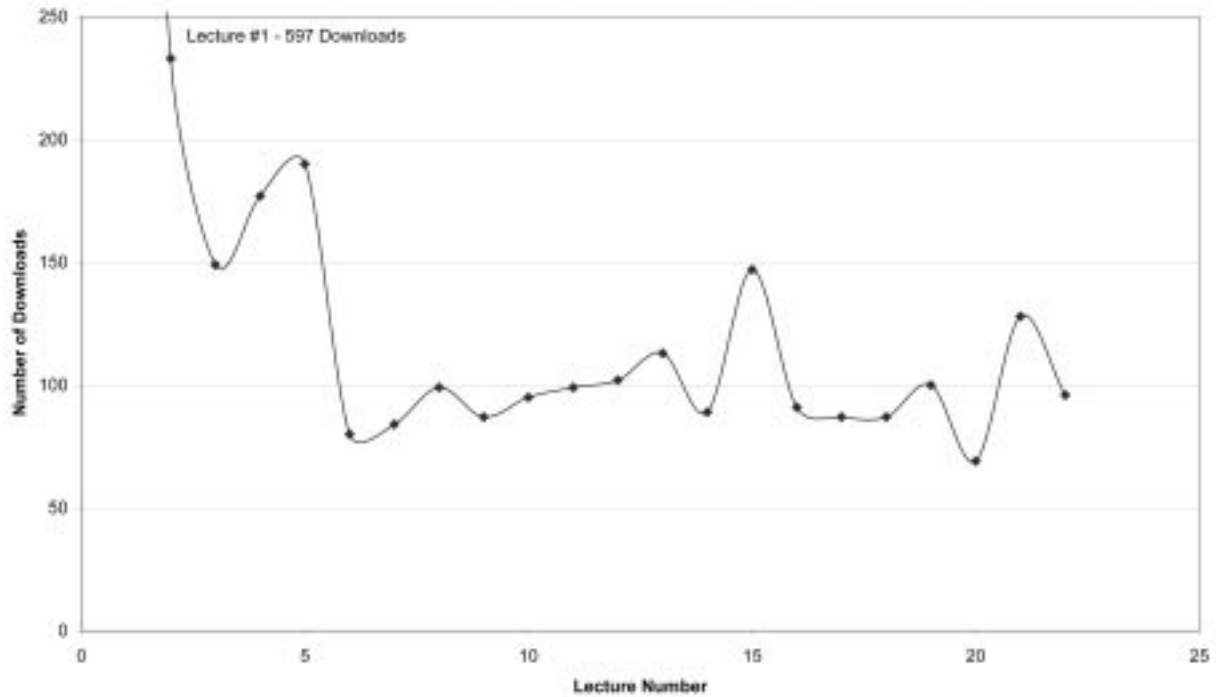


Fig. 3. Webcast downloads.

Fig. 4. Debris pile associated with 1200 ft² house.

Fig. 6. Students interviewing St. Bernard Parish firefighter.



Fig. 5. Collapsed home in the Ninth Ward due to levee failure.

ing throughout the semester. Each quiz given to the students was approximately fifteen (multiple choice, matching or ordering) questions focused on the particular lecture topic. To prevent academic honesty temptations, a number of ‘pools’ of questions were developed. To maintain rigor and fairness in the exams, some of the pools were simply one question asked a number of different ways, or a group of questions related to one specific aspect of the lecture. When a student launched his or her online quiz, the Blackboard software would randomly select from the specific pools to generate a unique (or nearly unique) test for each individual. This means that two students sitting next to each other at computer terminals would most likely have very different questions when launching the same exam. Additionally, since the quizzes

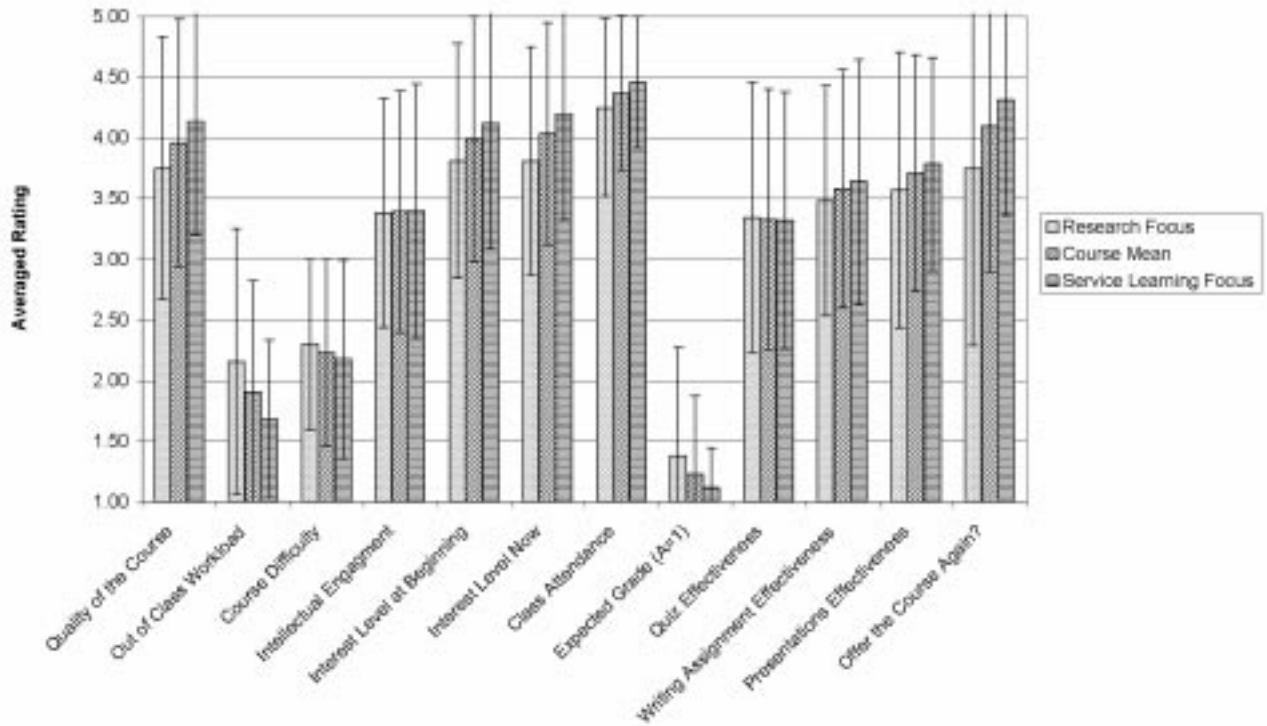


Fig. 7. End of course student evaluations.

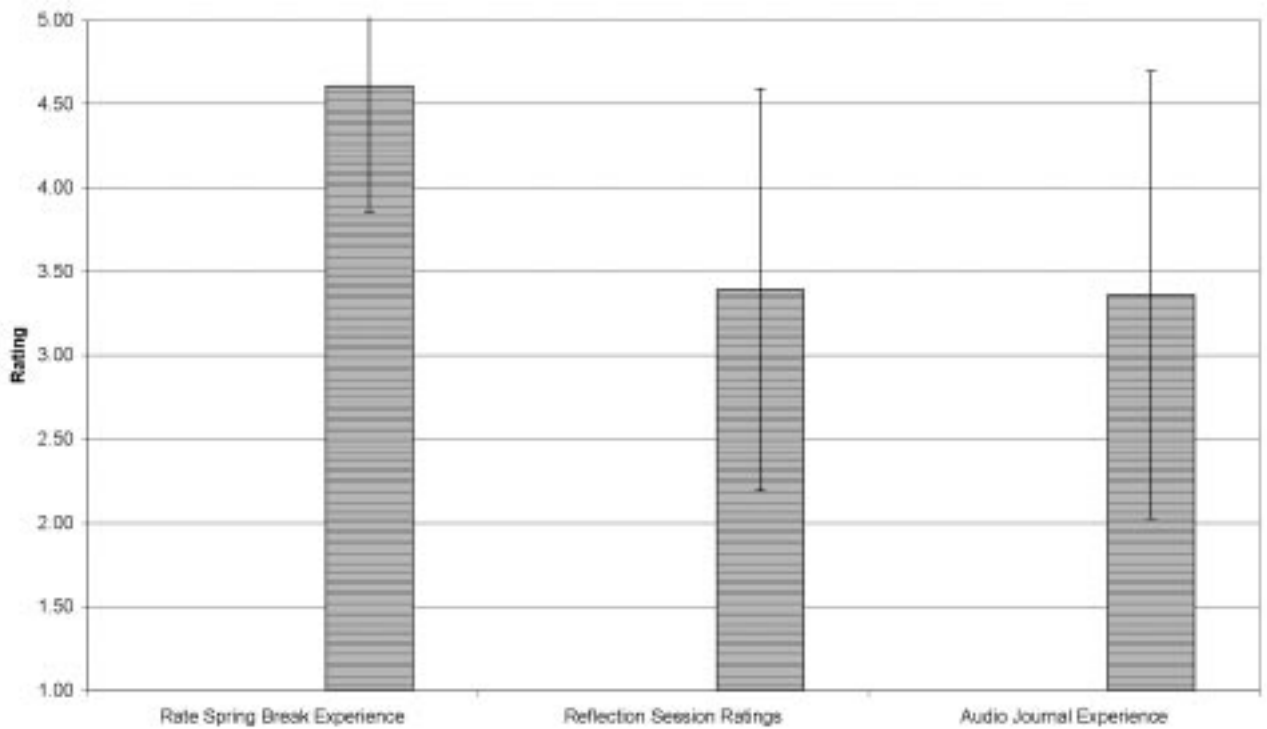


Fig. 8. Student ratings on aspects of the service learning experience.

were primarily designed to reinforce learning, the students were permitted to refer back to notes, Webcasts, etc. while taking the exam.

Over the course of the semester 81 question pools were developed (and contained a total of 575 questions). The pools were distributed in 21

quizzes so that each student answered approximately 280 questions (or 49% of the total developed questions). With each student answering 280 questions related to the topics covered in the course, it was possible to measure their mastery of the presented material related to the science

behind the disasters as well as the societal response (both immediate and long-term). The mean value for the quiz grades was 89.07% with a maximum value of 99.37% and a minimum value of 64.96%. The standard deviation of the grades on the quizzes was 5.09%. These statistics indicate that approximately 95% of the students correctly answered approximately 80% of the questions related to the issues evaluated in class.

'Real-time' student feedback

In addition to using Blackboard for on-line quizzes, students were able to provide almost immediate feedback on the presented lectures. Once the students completed their twice weekly quizzes, they were also asked to provide survey feedback on the individual presenter for a given lecture. Again, using the Blackboard software tool, students were asked three questions related to the speaker, content, and applicability of the material to the course, and were provided with five answers. The students were able to select the response that best described their opinions regarding the speaker and the presented material. The data for each lecture were reported by Blackboard as a class aggregate rating, and while it is possible to confirm that individual students have completed their surveys, their individual responses are anonymous. By tabulating the data, it is possible to evaluate what topics were ranked the most and least important, as well as which presenters or topics the students found the most engaging. Table 1 presents the questions asked of the students and the average rankings for all of the lectures (as well as the standard deviation, maximum and minimum values for each category). Table 2 shows the individual lectures ranked from highest to lowest based on weighting factors for each of the student answers. Based on Table 1, over 55% of the students ranked the speaker/content/material applicability in the top two categories, with 90% of the students ranking the same items in the top three categories. These rankings will also be used in the future to assist instructors in determining what material should be included in future course offerings, as well as which speakers to invite to present the content.

Use of iPods as a learning tool

The final instructional technology innovation implemented in the course was the use of Apple Computer Corporation iPod[®] digital media players issued to the students as part of the Duke Digital Initiative, a multi-year program of experimentation, development, and implementation of new and emerging technologies to explore their effective use in support of the University's mission. With the audio feed from the class captured (as described in a previous section), it was possible to download that file as a podcast. Unfortunately, the total 'hit' rate for the content download does not differentiate between Webcast versus audio only (podcast) downloads, so the use of the iPods for

this application cannot be quantified. Additionally, students were assigned various 'listening' exercises specifically related to discussions of the role of the media in response to disasters. A content sharing arrangement between Public Radio International (PRI) and Duke University provided students with access to media coverage related to disasters spanning back almost a decade (to Hurricane Mitch, 1998) that could be downloaded onto their iPods. While listening to content was an excellent opportunity for learning, perhaps the greatest benefit and application of the iPods was the production of audio journals of the service-learning experience, which is discussed in greater detail in the following section.

SERVICE-LEARNING

One of the integral experiences for the majority of course participants was the opportunity to engage in service-learning in an area ravaged by a natural disaster, specifically in the Gulf Coast region after the recent Hurricane Katrina of 2005. By combining the lessons learned from the academic material with their application through participation in the rebuilding process, students were engaged in both intellectual and personal ways beyond the classroom with the process of rebuilding and the people impacted by the disaster. To maximize the experience and to help integrate it with the classroom material, the students participated in reflection sessions before and after the service-learning engagement in St. Bernard Parish, Louisiana, and processed their learning experiences further through journaling and writing exercises.

Service-learning is the integration of direct service and structured, guided reflection on service, intentionally linking the experience back to the classroom material. Various studies have demonstrated the pedagogical value of service-learning, including students' self-reported achievement in the course and their application of principles learned in the course (Markus, Howard and King, 1993; Eyler, Giles and Braxton, 1997).

Duke University developed a service-learning program in support of an element of the university's 1994 mission statement to help develop undergraduates to have 'full participation as leaders in their communities.' Now called Research Service-Learning (RSL) at Duke (<http://rsl.duke.mc.duke.edu>), the program offers approximately ten courses each semester in a variety of fields, primarily in the humanities and social sciences including psychology, education, and public policy. Research service-learning refines the concept of service-learning by combining inquiry and analysis with service and reflection. In practice students are not simply engaged in civic activities aimed at societal improvement, but use research techniques to identify an issue, examine options for solving the problem, and then evaluate or test those

Table 1. Tabulation of student feedback on individual lectures

	Category average	Standard deviation	Maximum category ranking	Minimum category ranking
Question 1:				
How would you rate the person giving the lecture?				
Answers				
Excellent, one of the best lectures I've had at Duke...they kept me on the edge of my seat the entire time.	14.30%	10.93%	40.72%	1.24%
Good, definitely better than a typical lecture. It was easy for me to stay engaged in the presentation.	40.60%	10.42%	53.09%	13.04%
Average, enjoyed hearing them speak and would welcome the chance to have them lecture in the course again.	30.44%	8.39%	42.47%	10.78%
Fair, I did learn something, but would recommend trying to tap another expert in the field if this topic needs to be presented somewhere else.	11.53%	10.29%	40.99%	0.60%
Poor do I really have to say more?	2.39%	3.67%	13.75%	0.00%
<i>Unanswered</i>	0.75%	0.69%	2.48%	0.00%
Question 2:				
How much did you learn from the lecture?				
Answers				
Everything was new to me and I learned more than I expected about the subject.	15.44%	7.74%	33.12%	4.97%
Most of what I heard was new and I was satisfied with what I learned today.	45.25%	10.54%	60.48%	20.65%
A few new concepts were introduced and some interesting information was shared today.	31.46%	9.18%	51.55%	12.58%
The lecture was a good reinforcement of what I had previously been taught about the subject.	5.71%	5.45%	21.29%	0.63%
I learned this stuff years ago.	1.54%	2.86%	11.25%	0.00%
<i>Unanswered</i>	0.60%	0.68%	2.48%	0.00%
Question 3:				
How relevant was this topic to the course?				
Answers				
Definitely a must have topic the course wouldn't be complete without considering this issue.	24.81%	13.52%	55.84%	11.61%
The topic fit well within the context of the class glad it was included.	39.75%	6.80%	48.72%	23.87%
Seems appropriate to include this topic in the course.	27.39%	7.55%	37.27%	11.95%
Not sure of the relevance of this topic might suggest substituting some other lecture the next time the course is presented.	6.34%	6.37%	29.68%	0.00%
This is a course about Recovery/Rebuilding from Natural Catastrophes? I thought I came to the wrong class today.	1.11%	1.53%	5.81%	0.00%
<i>Unanswered</i>	0.60%	0.68%	2.48%	0.00%

proposed solutions. This is a valuable approach for research universities as it synthesizes service-learning and civic engagement with the university's research mission.

The Rebuilding from Ruins course is a 'gateway course' to the RSL program because students considered, but did not engage in research inquiry during the course of service. The course varied from previous service-learning courses offered at Duke both because of its offering in the Pratt School of Engineering and because the service was done over the 9-day spring break period as opposed to weekly during the entire semester. Both of these differences presented challenges as well as opportunities. While the importance of under-

standing the social context of science is central to the educational mission of the undergraduate program, developing reflection materials that captured scientific and engineering concerns in relation to the service was not a trivial exercise.

Students had the option of registering for the course as a gateway service-learning course, or as a non-RSL course. If a student chose the service-learning option, he or she then registered for an additional zero-credit hour discussion section that was used for reflections. The reflection sessions consisted of two one-hour long meetings before the trip and two post-trip sessions. These sessions were designed and led by two trained service-learning staff members.

Table 2. Individually Rankings by Students of Speakers, Lecture Content, and Applicability of the Subject to the Course

Ranking by Speaker	Ranking by Lecture Content	Ranking by Applicability to Course
Disease Outbreaks	Earthquakes	Possible Futures of New Orleans
Case Study: Rebuilding After the Tsunami	Possible Futures of New Orleans	Disease Outbreaks
Possible Futures of New Orleans	Disease Outbreaks	Hurricanes
Health Epidemics and Hist. Gov. Response	Health Epidemics and Hist. Gov. Response	Case Study: Rebuilding After the Tsunami
Transportation and Sustainability	Case Study: Rebuilding After the Tsunami	Earthquakes
Earthquakes	Transportation and Sustainability	Floods
Leadership During Crisis	Architecture and Building Systems	Health Epidemics and Hist. Gov. Response
Architecture and Building Systems	Droughts—Speaker A	Droughts—Speaker A
Community Planning	Floods	Case Study: Hospital Disaster Preparation
Droughts—Speaker A	Droughts—Speaker B	Transportation and Sustainability
Case Study: Hospital Disaster Preparation	Community Planning	Coastal Development and Katrina
Emotional Toll of Disasters	Case Study: Hospital Disaster Preparation	Emotional Toll of Disasters
Infect. Disease Surv. and Epidemiology	Toxic Mold	Leadership During Crisis
Coastal Development and Katrina	Political Management of Disasters	Architecture and Building Systems
Toxic Mold	Infect. Disease Surv. and Epidemiology	Floods (Global Warming)
Political Management of Disasters	Hurricanes	Community Planning
Droughts—Speaker B	Coastal Development and Katrina	Political Management of Disasters
Floods	Leadership During Crisis	Case Study: Red Cross
Hurricanes	Emotional Toll of Disasters	Infect. Disease Surv. and Epidemiology
Role of Faith Communities in Response	Floods (Global Warming)	Droughts—Speaker B
Case Study: Red Cross	Case Study: Red Cross	Toxic Mold
Floods (Global Warming)	Role of Faith Communities in Response	Role of Faith Communities in Response

Note:

1. Rankings were determined by weighting the top category with a multiplier of 0.9, the next category with a 0.7, the third category with a 0.5, the fourth with a 0.3, and the final category with a 0.1 and then adding the result.
2. "Media Coverage during Disasters" and "Racism and the Response to Katrina" were not ranked by the students.

Pre-trip sessions

The service-learning reflection sessions provided the opportunity for students to learn from one another, as well as through exploring their own thoughts more deeply. To engage students with many different learning styles, each session was generally structured to consist of a group activity, guided discussion facilitated by service-learning staff, and a short individual written reflection. These short written reflections provided the ability for students to assess how their views changed over the course of the semester.

The objectives of the first reflection session were to understand the meaning of service and how service can intersect with academia. The students discussed how service can take on many forms, and what one person may believe is service another may not. As a starting-ground for the discussion, the students took part in an activity in which they were to rank potential activities that could be considered service. Some of these activities were: 'attending a protest,' 'donating money to a charity,' 'adopting an eight-year-old child,' and 'joining the armed forces.' Themes of commitment, time involvement, regularity, difficulty, and sacrifice were all brought up in the following discussions.

The definition and discussion of service-learning was then developed through brainstorming based on the group discussion of service. The goal of the service-learning reflection sessions was to create a means for students to enhance both what they

were learning in the classroom and the service they were doing outside of the classroom. Discussions focused on how coursework can help increase awareness and understanding of a situation in which a person may be providing service, how participating in service can help bring a new perspective to the coursework, and how continued reflection can bring the two together.

A third component of the first reflection session was to discuss the initial reactions to the 2004 Tsunami and Hurricane Katrina. Emotions ranged from shock and disbelief, to anger and helplessness. Many of the students were encouraged by the prospect that they could potentially make a difference for the people of the Gulf Coast.

After developing an understanding of service and service-learning, the objective of the second reflection session was to discuss the ethical issues related to service and disaster response, and what our obligations as citizens are. The session began with a group activity, this one being a 'triage' activity, in which students had to decide who they would take on a lifeboat in a shipwreck. The activity opened the discussion of how we choose to help people when there are limited resources, and how these resources were used in the response in New Orleans. Students considered the obligations of the government, the residents of New Orleans, and college students and their role in the recovery of Hurricane Katrina.

As this was the last reflection session before the service trip, one of the most important components of the session was goal setting. Students wrote down their individual goals and group goals for the trip, and then shared them with the group. Goals included very practical things; including rebuilding a house and learning what caused the levees to breach, to the less tangible, such as listening to the stories of residents and showing the residents that people around the country care about them. Nearly all of the students commented that they wanted to help the residents of New Orleans in the recovery process, and particularly wanted to see physical results of their efforts.

Some suggested enhancements to the reflection process that were successfully employed as part of this effort were: 1) the proactive facilitation of each discussion, including 'going around' each group (thus inciting each student to speak), which paved the way for a larger number of ideas and voices; 2) structuring the reflection sessions to start with some sort of motivation activity (the ranking/spectrum of service activity, the ship-wreck activity), then an initial oral presentation of each student's ideas, thoughts, and reflections, then a structured writing activity, and then further guided reflection and discussion. This follows a number of different reflection models that exist; and 3) analyzing the short written reflections, which served as a partial source of evidence for the quality of the reflection and the outcomes.

Rebuilding St. Bernard Parish

During Spring Break 2006, approximately 92 students from the course (and 40 others from outside the class) traveled by charter bus to St. Bernard Parish, which is located just southeast of New Orleans, Louisiana to assist Habitat for Humanity (Habitat), an international non-governmental agency, with gutting home interiors that were flooded when Hurricane Katrina blew through the gulf coast in late August 2005. Students' individual goals for the trip may have differed, but each obtained first hand knowledge of the emotional turmoil experienced by those who survived the disaster, the political will of the community leadership, the complexities of infrastructure reconstruction, and the application of lessons originally learned in a traditional academic setting.

The trip itself was not dissimilar from many others discussed in the popular media, hordes of volunteers converging on the Gulf Coast to make a difference. With many of the logistical details (i.e., feeding and sheltering the students) being handled in cooperation with Habitat for Humanity, the students were free to engage in experiential learning. During the week long stay at Camp Premier, a FEMA-run tent village with facilities for 1300 volunteers, students were provided with comfortable yet Spartan living arrangements to support their learning experience. Upon arrival at camp, the students witnessed the logistical difficulties of

coordinating the efforts of multiple people. In class they had learned about different managerial styles and response synchronization, but in reality just 'checking in' to the camp became a large exercise in patience. Additionally, instructing all of the students in the mandatory safety training demonstrated additional coordination issues and problems with making sure response teams have a common baseline understanding of preparation. To effectively coordinate and manage the student teams, Habitat divided the group into 12-person teams, with approximately four teams supervised by one AmeriCorps volunteer. The task of each team was to work in a home, stripping everything out of houses down to the studs. In the process of debris removal, Habitat coordinates with homeowners who have elected to rebuild their home, but need assistance in removing the flood damaged material from the home. In many instances, the homeowners were present at the home to watch the progress of the removal, which afforded the students the opportunity to hear from them and experience the impact their efforts were making in the lives of Katrina survivors.

The work was challenging and difficult. With the flood water rising to a reported elevation of 11 feet above ground level inside the houses, and 14 feet outside, many of the first floor ceilings had collapsed onto the contents below. Additionally, with the flow of water into the homes, approximately 3–5 inches of mud coated everything in the house. With many of the homes untouched for 7 months, all of their contents remained in the precarious positions within the structure in which the floodwaters left them. Refrigerators (still with their contents), obviously without power, created a particularly noxious problem, but all the contents of the home needed to be removed. Working with the Parish, Habitat instructed students to stack the debris in four distinct piles: one of household chemical wastes, a 'white goods' pile that contained the refrigerators and other appliances, other household debris (by far the largest pile containing drywall, carpet, furniture, etc.) and finally a 'memorabilia pile' of personal keepsakes including photos and trinkets, which was placed back in the houses for the homeowners. Required safety gear for the students included steel-toed boots, hard hats, safety glasses/goggles, gloves and N95 respirators. Figure 4 displays a debris pile for an approximately 1200 ft² house.

While the week of work was arduous but rewarding, one aspect that certainly stands out was the thoughtfulness and gratitude of the area residents. Specifically, one such incident that all of the students were able to experience was the appreciation expressed by the local Parish government. Immediately following dinner on the next to last evening in camp, representatives from the Parish Council formally thanked the assembled volunteers for their participation in helping to rebuild St. Bernard. They shared their personal stories about how much the outpouring of support

had impacted and provided hope for them, and the emotional display visibly moved the students.

As an additional part of the learning experience, field trips were arranged and invited speakers were brought in to speak to the students. Specifically, the students visited a local pumping station that is used to lift storm water from behind the levee system out into the Mississippi River during storm events. Also, as part of a presentation by the Army Corps of Engineers, students were informed about the area's 300 miles of levees, which were designed and constructed in the 1960s in response to Hurricane Betsy. As part of this same presentation, students visited two of the failed levee sites, one adjacent to the Mississippi River—Gulf Outlet Canal and one adjacent to the Lower Ninth Ward. The students' experience of these failures demonstrated the complex issues involved with engineering for extreme events. When the levees broke in the Ninth Ward, for example, the first row of houses were ripped from their foundations and rammed into the next row, generating a series of cascading failures. After the storm, the streets in this area were impassable, covered in 30 feet of debris. Although the roads had been cleared, the remnants of houses, overturned vehicles and snapped trees remained, leaving an indelible imprint in the minds of the students who witnessed the destruction. Figure 5 displays a photo of a home collapsed following a levee failure in the Ninth Ward.

While the students who participated in the service-learning trip to St. Bernard Parish did engage in community involvement by clearing some 25 houses, the tangible learning came from becoming better acquainted with the very human realities of disaster in the process. From speaking with and interviewing hurricane survivors, AmeriCorps volunteers, other students from around the country, and fire department workers currently living in the Parish, the students became involved in a very experiential way with the issues impacting the lives of those touched by the disaster. Figure 6 shows a photo of students interviewing/talking with Katrina survivors. The first-hand experience gained by participating in the recovery and rebuilding effort crystallized many of the academic lessons being taught in the class. Students witnessed the issues, felt the hope and despair, and shared in the successes and failures of the actual reconstruction effort. These lessons reinforced the service-learning objectives for the class by drawing a clear connection between the academic issues deposited in the students during the semester and the life lessons learned in the week-long service trip. While solutions to many of the problems still faced in New Orleans remained enigmatic, the student's first-hand experience of the storm's aftermath and the steps taken on the long path to rebuilding at least led them to ask many of the right questions, and gave them a newfound appreciation for the complexity of the answers.

Post-trip reflections

Two reflection sessions were also held after the spring break service trip. These sessions were noticeably different from the first two, in that the students were much more talkative and engaged in the discussion, and the content shifted from a theoretical context to being more real or applied. These final reflection sessions focused on the value of the service, what people found most surprising about the trip, how opinions of the rebuilding process in New Orleans have changed, how to allocate recovery funds, and what can and should be done for the future of New Orleans.

Students generally noted their surprise at the amount of destruction that still existed even months after the hurricane. They felt that their contribution during the service trip was minor relative to the huge amount of work to be done. Most people also felt that they likely gained more from the trip personally than they gave to the community. However, despite the vastness of the wreckage and the knowledge the students had learned about the flood-prone region, after hearing the stories of the residents of St. Bernard Parish, most people felt that they should not deny anyone the right to rebuild their home, and that they understood the reasons that someone would want to.

Much of the final reflection session focused on what students can do to continue to work on the issues discussed in the course. Many felt that by going on the service-trip, they now had a way to share the stories of the people of the Gulf Coast and to encourage others to help. A goal of service-learning is also to incorporate research into service. In the final session, students developed a focused research question based on their broad experience in the course and exposure to course material. The development of a research plan was a requirement for the course, and several students may choose to carry out their research project.

Written journals, trip synopsis and presentations

One of the main ways that students processed their service-learning experience was by the thoughtful production of written journals. In general, the students were expected to write reflective and introspective journals rather than simply reporting the facts of the trip. The students were instructed to examine personal issues related to their own physical, emotional, psychological and spiritual state, as well as those of residents of the area, and of other people that are included in the journal. One of the requirements of the journals was to reflect on the totality of the issues facing the citizens trying to rebuild their lives. This caused students to examine the issues in a multidisciplinary fashion, where they examined not only the traditional economic and societal impacts of the disaster, but the engineering and scientific aspects of the failures as well. Many of the students specifically addressed the trip to visit the levees and the Ninth Ward as a poignant part of the trip that crystallized their appreciation of the wonders

and limitations of science and engineering. Feedback was provided to the students about their journals regarding their reflection—both with respect to their feelings about their impacts on the community, their lessons learned academically, and how the process was introspective and formative in their educational and personal progression. Additionally, the journal was ‘graded’ with respect to the learning objectives and measurable outcomes, further quantifying the student’s retention and application of the acquired knowledge.

In addition to the introspective journal, students wrote a trip synopsis of their experience, which was a succinct summary of what happened, what they did, and what they accomplished while in St. Bernard Parish. While the synopsis captured the emotion/weight of the trip, the goal was to include observations that provided a broad overview of what was accomplished/experienced as well as detailed mechanics of the trip.

The final aspect of the assignment for the students was a retelling of their experience to their colleagues as part of a group presentation to the class. In the presentation, they wove together the thoughts from their journals and the factual accounts of their trip to convey both a succinct summary of the major trip experiences as well as attempting to capture the emotion and weight of the trip. Both of these were graded with respect to a rubric provided to the students. Specifically incorporated as part of the rubric was examining the multidisciplinary aspects of the experience and the accomplishment of the measurable outcomes associated with the class.

Audio journals

One of the most innovative and exciting components of the course was the use of iPods as an instructional enhancement for the class. Audio journals produced by the students were extremely creative, as well as being reflective and engaged. In the audio journal, the submitted audio file from each student was approximately five minutes long, with the feel of a radio interview/story. Some students spliced in their own thoughts recorded from the trip with interviews conducted while in New Orleans, audio content from class lectures, audio files of media reports obtained through PRI, downloaded speeches from political leaders, music files of jazz musicians displaced by Katrina, etc. Some students relayed their thoughts using video technology interwoven with actual video of their time in New Orleans. Whatever the form, the written, audio and video presentations of the student experiences were thoughtful, heartfelt, and very insightful, with student expressions of the impact of experiences indelibly written on their lives.

INDIVIDUAL AND GROUP PROJECTS AND PRESENTATIONS

Instead of participating in the service-learning component of the course, 69 students elected to

complete research projects focused on various aspects of disasters. Students were required to complete an individual assignment and a group assignment. The group assignment was then presented to their colleagues in the course. Table 3 presents a listing of the individual student assignments submitted by the class. As demonstrated from this list, the student’s interests were wide ranging, and the body of knowledge they engaged was fairly comprehensive, shaping their thoughts and directions moving forward from the course with this more in depth understanding about the science and policy behind disasters. As part of the assignments, students were required to frame the problem, its gravity/relevance, historical context and the object of their research. Similarly, they were asked to demonstrate their understanding of the current issues related to the topic, demonstrate their thoughts regarding the issue and describe the options or approaches that could be used to solve the problem/issue. Finally, they were instructed to determine the future implications/directions of the issue by clearly defining their thoughts, suggestions, and contributions to resolving the issues related to the problem definition and providing critical data to support their position (or explained why such data is not needed/relevant). Students also identified roadblocks or challenges to resolving the issues and either suggested methods for overcoming those obstacles or defined the practical limitations preventing their removal. These papers and presentations were evaluated to ascertain the student’s grasp of the material and their comprehension of the learning objectives.

RESEARCH PROPOSALS

Following the service-learning experience, all the students who went to Louisiana were required to submit a research proposal related to a potential future service-learning project. Specifically, the students were asked to propose: an idea for a class they would like to see offered with a service-learning component; a research service-learning project stemming from their experiences in New Orleans; a local project associated with the local community; or any other proposed option that interested them. As part of the assignment, students were supposed to answer or address the following issues:

1. What is their research question?
2. Why do they think this is important?
3. Describe a proposed methodology for researching/testing/evaluating data related to this question?
4. What is a possible schedule?
5. Discuss how reflective learning would be incorporated into the service-learning?
6. What will be the beneficial outcome/delivered product that would benefit a community as part of this research?

Table 3. Topics of papers

Impending Famine in Ethiopia: What Can Be Done?
A Cascade of Failures
A Costly Opportunity: Rebuilding New Orleans
A Great American Tragedy: The Levee Lifeline of New Orleans
A Serious Strain of Terrorism: Use of Chemicals and Biological Engineering for Terrorist Purposes
Advances in Seismic Retrofitting of Bridges and Highway Infrastructure
After Disaster: An Argument for the Privatization of Natural Disaster Relief Response
Alleviating Potential Disaster: An Analysis of Katrina's Evacuation Policy
An Evaluation of China's Response to a Chemical Spill on the Songhua River
Anthrax: Bringing Bioterrorism Close to Home
Avalanches: Prediction, Prevention and Rescue Techniques
Building on Shaky Ground: Constructing Multistory Buildings in Earthquake Prone Areas
Contagious Diseases and Their Effects on Human Society
Controlling a Future Outbreak of Pandemic Influenza
Dangerous Doses of Water: The Perils of Floods in China
Designing for Disaster: The Design of Techniques and Materials Utilized to Withstand Tornado Devastation
Developing a New Paradigm for Evaluating the Health Risks of Mold Exposure Following Flooding
Disabling Infectious Diseases
Disaster Relief: The Role of Mental Health Response Efforts
Don't Politicize the Disaster—Or Should You?
Earthquakes and Sports: Avoiding the Worst
Economic Impact of Some Large Gulf Coast Hurricanes
Emerging infectious diseases in Asia—SARS and Avian Flu Pandemic
Exploring Natural Disaster—Conflict Interfaces in Light of Continued Sustainable Development Challenges
Forest Fire Suppression and Biodiversity Loss: How we traded a natural “disaster” for a man-made catastrophe
Global Warming: Science, Dangers, Solutions
Going in Blind: Preparing to See Beyond the Symptoms to the Prevention of the Newest Emerging Diseases
HIV and Infectious Diseases in Africa
Hurricane Andrew: The Aftermath
Hurricanes and the Problems they Present to America
Infectious Disease in Africa: A Look at Outbreaks and Responses on the Continent
Infectious Diseases and the 21st Century
Ivory Towers of Hope: The Role of Colleges and Universities in Rebuilding New Orleans
Lessons Learned from Galveston in National and Local Policy
Levees, Keeping New Orleans Dry
Limiting Loss: What Kentucky Should Learn from the Ohio River Valley Flood of 1997
Natural and Spiritual Destruction: Restoring Lost Faith in a Hopeless Time
Natural Disasters and the human factor: what services people need after a disaster and who provides them
Power Failure
Psychological and Behavioral Change in Children after Natural Disasters
Psychological Impact of Natural Disasters
Public Health Implications of Natural Disaster: Moving Beyond Katrina
Public Health Response Following Natural Disasters
Rebuilding of Homes
Smallpox: The Past, the Present, and the Future
Supervolcano
Technology for Natural Disaster Prevention and Management
The 2005 South Asian Earthquake: Causes and Response
The Achilles' Heel of Wonder Drugs: <i>Will our antibiotics keep up with evolving infectious diseases?</i>
The current risk of disease epidemics due to contaminated drinking water, inherent or related to bio-warfare plausibility
The Developed World's Private Disaster: Blackouts
The Disease that Never Sleeps: The Reemergence of African <i>Trypanosomiasis</i>
The Effectiveness of Emergency Response Teams in the Post-9/11 Era
The Emotional Aftermath
The Great Johnstown Flood of 1889: The tragedy that exposed the need to understand, manage, and avoid natural disasters
The Impacts of the Galveston Hurricane in 1900
The Recurring Bengali Floods
The Revelation: Hurricane Katrina & the Way America Treats Our Poor
Tornadoes: Nature's Most Ferocious Storms
Tsunamis in North America
Unstable Ground: Hurricane Stan, Guatemala, and the Mayans
Volcanic Eruptions
Waiting For the Big One: An Investigation into the Preparedness for a Large Earthquake in Western Canada As Well As Its Effects
Wildfire: Nature's Napalm
Wildfires of Southern California in October 2003/Fires: Study on Current Fuel Management Actions

This exercise also served to help students reflect on their experience responding to a disaster and synthesized their thinking by reflecting on how they could contribute to solving the problem through the development of a research proposal. This exercise was both introspective in tying together their experiences from the class, while uniting their passions with a shared sense of responsibility for putting together an idea to change the future.

COURSE EVALUATIONS

For an initial offering the course was uniformly praised by the students for the academic content, relevance, integration of service-learning and use of instructional technology. As displayed on Figures 7 and 8, which are depictions of the averaged course evaluations for the class, the students generally viewed the individual components of the course

favorably. Figure 7 differentiates the opinions of the total course from those of the students who did and who did not participate in the service-learning component of the class, as well as displaying bars depicting the standard deviation of the ratings (1 to 5, 5 being the highest). Referencing the figure, the mean ranking for students who participated in the service-learning component was universally higher than for those who did not travel to Louisiana. Additionally, the standard deviation is generally smaller for the rankings from the service-learning students as well. As displayed on Figure 8, which is strictly related to the service-learning experience, the trip itself was very well received by the students.

EXPENDED EFFORT

While the measurable outcomes (quizzes, papers, etc.) successfully demonstrated achievement of the learning objectives for the course, the

Table 4. Course tasks and required investment

Task	Time invested	Person making the investment	Required equipment	Financial cost (\$)
Recruiting speakers/ Arranging lectures	~1/hr/lecture	Faculty	None	0
Capturing the Webcast	~2 hr/semester to set-up	Support Staff	Lectopia software and associated hardware	3000
Prepare and post quizzes	~3hr/lecture	Faculty		0
Pre-trip small group reflections	~40 h (8 groups of 15 students met 3 times prior to the service-learning experience)	Service-learning support staff	None	0
Planning service learning trip (including travel and accommodations, as well as obtaining requisite waiver and health forms from each student)	~30 h	Faculty	None	0
Service learning trip	8 days	Faculty and Staff	Transportation by bus, sleeping in a tent village, personal protective equipment, and food.	\$200/student (the University subsidized participation so that each student only had to invest \$75)
Post-trip small group reflections	~25 h (8 groups of 15 students met twice following the service-learning experience)	Service-learning support staff	None	0
Review written submissions (papers, journals, etc.)	~150 h	Faculty	None	0
Review audio submissions	~50 h	Faculty	iPod	0
Review presentations	~15 h	Faculty	None	0
Administrative effort (including course management and assigning grades)	~100 h	Faculty	None	0

amount of effort expended by the team of faculty and support staff was significant. Simply responding to e-mails from students could take hours (i.e., if it takes one minute to respond to an e-mail, and all 177 students inquire about different topics, then the time invested is the better part of three hours). Table 4 provides a summary of the individual tasks required to offer the course, and the approximate amount of investment (both time and money) required to accomplish each adequately. Additionally, managing the multidisciplinary nature of the students provided challenges in balancing academic preparation. This manifested itself initially in lower than expected quiz grades, but quickly turned into an asset as students from different backgrounds were able to work together in interdisciplinary groups, and encouraged learning from a variety of perspectives not normally associated with a homogeneous course.

MODIFICATIONS FOR THE FUTURE

Based on the ranking and the anecdotal experience of the instructors, the course difficulty and out of class workload could be increased. The timing of the service-learning proposals will be moved and, based on Table 2, some topics that were presented in 2006 may be replaced in future course offerings (and possibly other presenters will be asked to give the lectures). Based on the feedback from the students, the demonstrated achievement of the learning objectives, and the performance on the measured outcomes, the instructional technology and service-learning components were successful in engaging students and enhancing the learning process. Another enhancement for the class would be the addition of more assigned readings to better equip and prepare the students ahead of time with background (or enhancement) knowledge of subject areas addressed in class. This addition should result in an increase in dialogue between student

participants and guest lecturers, thereby increasing the interactivity of the lecture component.

CONCLUSIONS

The new course offering discussed in this paper addressed an interdisciplinary life cycle analysis of natural disasters. Invited experts discussed the range of meteorologic, hydrologic and geologic factors that cause disasters; explored how societies plan for and/or respond to the immediate and long-term physical, social, emotional and spiritual issues associated with survival; and presented case studies of response, recovery and reconstruction efforts. The intersection of service-learning and instructional technology, and how the students engaged with these innovative teaching tools was discussed. The course itself represented a confluence of connected and complementary teaching avenues. From the use of service-learning and instructional technology to the civic engagement and broad interdisciplinary aspect of the course, students, both engineers and non-engineers, were catapulted into a new learning experience, which represented a 'Perfect Storm' of learning.

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All of the authors count this experience as one of the highlights of their careers, and enjoyed being part of the Spring Break trip to New Orleans.

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