AC 2011-2148: LESSONS LEARNED FROM A DISTANCE LEARNING RESEARCH METHODS COURSE CO-TAUGHT BY CLEMSON, UNIVERSITY OF PITTSBURGH, AND VIRGINIA TECH

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Lessons learned from a Distance Learning Research Methods Course co-taught by Clemson, University of Pittsburgh, and Virginia Tech

Abstract

A cross-institution research methods course was developed to provide students conducting thesis projects with an introduction to research development and many different types of qualitative and quantitative research methods. The course draws on the experiences of a diverse group of young faculty to present students with a broad range of best practices and experiences in research methods. Unique to this distance-learning course is the incorporation of team-based active learning activities in every lecture. In this active learning course, students learn quantitative research methods by practicing the set of procedures in class. Students are expected to incorporate their research topics as examples throughout the class. Topics in research methods include: defining research problems, conducting a literature review, qualitative and quantitative data analysis, developing experimental designs, survey design, visual presentation of results, research ethics, and the process of writing a peer-reviewed journal article. The course culminates in students’ research proposal.

This paper discusses the lessons learned from a cross-institution course collaboration and presents the findings from student assessments and surveys. We discuss the effectiveness of the cross-university course on different types of students, from new to senior PhD students conducting thesis research to masters students conducting term projects on a wide range of civil, environmental, sustainability, and construction research topics. We also examine the effectiveness of distance active learning and peer-teaching during the course. Half of the students at the Pitt location are in their second or third year of graduate studies, and they take an active role in mentoring and teaching.

Introduction

A cross-institution, distance learning research methods course was developed and piloted in Fall 2010. The vision for the course was to provide research-track students with the fundamental knowledge of the research process and several research methods. One motivation for developing and offering the course from the instructors’ perspective is the observation that many graduate students were struggling with understanding the process to achieving their desired degree. The instructors hypothesized that providing a formal course-based structure to understanding research process would be more effective than individual or group research meetings, ultimately enhancing not only the students’ productivity but also the quality of their graduate experience. Another motivation for the course was that the instructors - as young faculty members – were learning new techniques for research methods, along with providing the students a peer-to-peer network. The assignments with firm deadlines corresponded with typical stages in the research process were both instructor and peer reviewed, enhancing the ultimate quality of their research projects. Finally, the instructors strongly believe in creating a collaborative environment since true innovation and discovery is more likely to happen in unexpected and serendipitous settings.
Many if not most technical graduate degree programs incorporate independent research as a requirement for advanced degrees at the masters level, and demonstrating the ability to conduct independent research is an essential pillar of the doctoral process. Rigorous independent research at the undergraduate level is still relatively uncommon in the U.S.; is typically limited to the strongest students or students in specifically targeted populations\(^1,2,3\); is most common in fields involving laboratory science; and is least common in non-laboratory social sciences and humanities, with engineering fields somewhere in between. Ultimately, this means that students entering graduate engineering or construction-related programs of study typically do not have significant prior exposure to or experience with the means and methods for designing and implementing independent research.

In response to this knowledge gap, faculty responsible for supervising or advising graduate students in their independent research face a significant challenge of how to effectively communicate both tacit and explicit knowledge about the design of inquiry to multiple students working on distinctly different projects. Faculty who supervise a number of students working in a common research area may use informal approaches tailored to their domain of specialty such as regular research team meetings or senior students mentoring junior students. Some programs include formal for-credit courses or seminars to introduce students to the basics of research, either taught by the student’s home department or selected from courses offered in other domains such as sociology, education, or science.

Beyond what can be learned in generic research methods courses, a significant amount of additional knowledge is required to successfully carry out independent research in a technical domain. General courses are typically followed up by individual supervision of the students by advisors and/or faculty advisory committees as students complete their work. Faculty advisors often spend considerable time advising individual students, repeating the same advice and guidance to student after student, even though this type of activity is not rewarded as much as other faculty activities.\(^4\) This individual research apprenticeship has historically been the way in which students are guided through the process of learning how to do independent research\(^5,6\). However, it represents a large time investment on the part of faculty and does not encourage peer-to-peer learning that might otherwise occur in a classroom or seminar environment.\(^6\) It also does not take advantage of the emergent benefits offered by faculty collaboration.\(^7\)

Although research methods courses or seminars taught within a department offer opportunities for students to learn from each other and from faculty within that department, new technologies for distance learning now offer the possibility of creating communities of practice within specialty areas.\(^8\) The faculty participating in the course described in this paper all specialize in sustainability-related research, and they collaborate on faculty research as well as on the course itself. This approach offers significant promise for students interested in sustainability-related research, since they will get to meet not only leading faculty researchers in this domain through the partnership, but also their peers who will be the faculty of the future in this area. This type of integration into the discipline may contribute to greater retention and successful completion of graduate study.\(^9\)
Previous, individual course instruction

**Clemson:** The “Research Processes in Civil Engineering” course was offered once prior to the collaborative distance learning course discussed in this paper. The course is aimed at students beginning thesis research. The instructor is in his third year of teaching and also developed and taught the initial offering of the course. This course was originally developed as a one credit seminar type course and the basic content remained the same for the co-taught distance learning version. The only significant changes were related to the course delivery.

**Pitt:** This was the first offering of a research methods course in the Department of Civil and Environmental Engineering at Pitt. Prior instruction has entirely been on a one-on-one advisor to student basis.

**Virginia Tech:** As part of its unique joint graduate curriculum for degrees in construction from the Colleges of Engineering and Architecture at Virginia Tech, the Myers-Lawson School of Construction (MLSoC) developed a new graduate course in research methods for construction students offered for the first time in Fall 2007. The purpose of the course was to introduce the means and methods of research to graduate students in supporting their definition and selection of an exit option for their course of study. One of the key challenges of the course was to appeal to both students interested in pursuing further academic study and students pursuing a more practice-based career path. Prior to 2007, students in construction-related degree programs were encouraged to take research methods courses offered by other departments such as urban planning, education, statistics, and others on an as-needed basis to support their specific areas of inquiry. No specific course was required of all students.

The “Methods in Construction Research” course was initially designed and offered as a mechanism to conduct preliminary research on team-based learning and performance while teaching graduate students how to frame, design, and execute a research project focused on a subject with both research-based and practical interest for the construction industry: team performance and behavior. Over the four times the course has been offered, different mixes of research-based and industry-oriented students have participated, and the course has evolved to have a greater focus on developing and refining individual student topics of interest, with less focus on faculty research. After the first two offerings, limited faculty resources led to the course being taught by a single faculty member rather than team-taught. It remains a requirement for all graduate students in the Department of Building Construction, but has been listed as an elective for students in the Department of Civil & Environmental Engineering due to the number of students pursuing a practice-oriented degree in this department as opposed to a research-oriented degree. In the most recent offering, the course was offered as a 3 credit hour course with meetings twice per week. Only one meeting per week was collaborative with the other institutions. The other meeting was used for guest lectures, exercises on special topics such as speed-reading, and discussions between students and the instructor.

Collaborative course description

All four instructors collaboratively designed the course content. The instructors held weekly Skype meetings to plan for the course implementation; one faculty member was assigned
lead for delivering each weekly module. However the module implementation was collaborative; faculty shared resources and ideas for most of the lectures. During the semester, the instructors continued to meet via Skype on a weekly basis to update and evaluate the progress of the course. The course was conducted using Adobe Connect, hosted by Pitt.

There were two main differences between the different universities: 1) the distance learning technologies varied widely and 2) the students’ experience and goals were drastically different.

A variety of distance learning technologies and resources exist at the three universities. However, one of the aims of the faculty in participating in this course was to experiment with off-the-shelf technologies available outside specialized classrooms. The goal was to determine the extent to which distance learning could be offered in a space not specially equipped for that purposes, and without significant investment in additional equipment. Clemson and Virginia Tech utilized off-the-shelf distance learning equipment, while Pitt utilized a state-of-the-art distance-learning classroom.

*Clemson:* The distance learning technology included a basic webcam, which was run through the instructor’s laptop and displayed on a projection screen. This was adequate for sharing information between institutions but required additional set up and troubleshooting each class for the instructor at Clemson. It also limited video and audio quality.

*Pitt:* Pitt’s SSOE distance learning classroom was equipped with two video cameras to capture both the instructor and the students, two hanging in room microphones to capture student comments, an instructor microphone, touch sensitive mats that enable the camera to track the instructors’ movement, a SmartBoard, a TV at the back of the classroom (so that the instructor can see the students’ online views), and a projector, instructor monitor, and whiteboard at the front of the class. The distance learning staff at Pitt provided one assistant who aided in initial set-up, monitored and trouble-shot during the class, and managed the audio and video (e.g. the technician ensured that the camera followed the instructor when she walked around the classroom and switched the video to students when they were speaking).

*Virginia Tech:* The room initially assigned for the course is equipped with an in-room PC, LCD projector, and speakers. Instructors can also connect their personal laptops in lieu of the in-room PC, and the instructor’s MacBook Pro was used in this case to provide a microphone and camera for the VT class. After the first few classes, the course was moved to a small conference room to facilitate better interaction among students. The equipment in the conference room was similar to the large room, with the instructor’s laptop providing video camera and microphone for the class and a wall-mounted TV mirroring the laptop monitor.

The students in each class were at different levels of the education, were in slightly different programs, and had different final outcomes. The *Clemson* classroom had a total of 9 students enrolled, all in the beginning phases of their thesis research (5 Ph.D., 4 M.S.). Students’ research topics covered the range of Civil Engineering, from transportation to materials to structures. The *Pitt* classroom had a total of 15 students enrolled. Since this was the first offering of a research methods class in the department, students from every year of their degree enrolled. However, only students from the Sustainability and Green Design group (i.e. students working with Drs.
Landis and Bilec) were enrolled in the class. The Virginia Tech classroom had one Ph.D. student and four M.S. students (3 Building Construction; 1 Civil & Environmental Engineering). Student research topics in the VT section of the course covered a variety of construction-related areas, including market valuation of green development, the effectiveness of interventions in increasing safety and occupational health among drywall workers, design of multi-generational housing, techniques for pond remediation, and sustainability lessons learned across institutionally-owned capital projects at Virginia Tech. All participating students will be engaged in independent research for their exit options, but M.S. students had not yet chosen whether they would pursue a thesis or project and report exit option. All but one of the students in the VT group were in their first semester of graduate study.

Course goals and modules

The course goals and objectives – in conjunction with the motivation of the course – promote process based research objectives, definitive deadlines, and enhancing oral and written communication. The specific course goals and objectives are the following:

- To learn qualitative and quantitative research methods by practicing the set of procedures.
- To learn to collaborate with colleagues at Pitt as well as colleagues in remote settings
- To encourage critical thinking of the present state of the built environment and engineering decisions that led to this environment
- To define research problems
- To conduct a literature review
- To develop experimental designs and survey designs
- To develop visual presentation of results
- To learn the process of writing and reviewing peer-reviewed journal articles.

One of Pitt’s goals for the course that was different from Clemson and Virginia Tech was to enable peer mentoring by having students take the course twice (1.5 credits each offering): first at the beginning of their study and then again at the end of their study. First year graduate students would participate in the course applying their newly defined research projects to class assignments. Senior students were encouraged to utilize the course and assignments to develop new research ideas, for example to aid them in writing their statement of research interests for academic or post-doctoral positions.

Generally, each class began with a mini-lecture, ranging between 15 to 30 minutes, led by one instructor to introduce the main content for the day. Following the mini-lecture, we typically incorporated some type of active learning activity to engage the students and reinforce the main learning objectives for that class. The course schedule is presented in Table 1.

<table>
<thead>
<tr>
<th>Module Number</th>
<th>Content and Activity</th>
<th>General description of assignments</th>
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<tbody>
<tr>
<td>1</td>
<td>Orientation</td>
<td></td>
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<tr>
<td>2</td>
<td>Lecture: Finding a good problem</td>
<td>Bring something that &quot;makes</td>
</tr>
<tr>
<td>In-class exercise (candy)</td>
<td>your blood boil&quot;</td>
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<tr>
<td>Report back</td>
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<tr>
<td>3</td>
<td>Lecture: Instructor's paths</td>
<td>Connect your interests to your research</td>
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<tr>
<td></td>
<td>Lecture: Finding your research interests</td>
<td></td>
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<tr>
<td>4</td>
<td>Lecture: How to conduct a literature review</td>
<td>Create a concept map; begin literature database</td>
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<tr>
<td></td>
<td>In-class exercise: Concept Mapping</td>
<td></td>
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<tr>
<td>5</td>
<td>Lecture: Technical part of literature review</td>
<td>Complete literature review database</td>
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<tr>
<td></td>
<td>In-class exercise: Literature review</td>
<td></td>
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<tr>
<td>6</td>
<td>Lecture: Building your research case/motivation</td>
<td>Write your research motivation, goals, and objectives</td>
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<td></td>
<td>In-class activity: Post-it activity</td>
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<tr>
<td>7</td>
<td>Lecture: Defining your research questions and hypothesis driven research</td>
<td>Create your research questions</td>
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<tr>
<td></td>
<td>In-class activity: Post-it activity</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Lecture: Data collection methods: Qualitative</td>
<td>Using the table presented in class, complete the table related to your research</td>
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<td></td>
<td>In-class activity: Discuss survey perspectives</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Lecture: Data collection methods: Quantitative</td>
<td>Begin to write your research method and approach</td>
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<tr>
<td>10</td>
<td>In-class Activity: Student driven</td>
<td>Collect all approaches, discuss pros/cons</td>
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<tr>
<td></td>
<td>Collect all approaches, discuss pros/cons</td>
<td></td>
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<tr>
<td>11</td>
<td>Lecture: Data analysis, validation, sensitivity</td>
<td>Find good and poor figures related to your research</td>
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<tr>
<td></td>
<td>In-class activity: Discuss good vs. poor figures</td>
<td></td>
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<tr>
<td>12</td>
<td>Lecture: Pulling it together; circle back to the motivation; making your key figures and tables</td>
<td>Sketch what you think your major figures will be</td>
</tr>
<tr>
<td></td>
<td>Lecture: Pulling it together; circle back to the motivation; making your key figures and tables</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Lecture: Review NSF proposal and calls</td>
<td>Review NSF website, indentify calls in your research area</td>
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<tr>
<td></td>
<td>Lecture: Wrap up and discussion</td>
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Often, this active learning activity was aimed at enabling students to apply concepts from the mini-lecture to their own research topic and then discuss their efforts with students and faculty at their location. For example, when literature reviews were the class topic, the instructor’s introduction of various methods to structure a literature review was followed by students outlining a structure for their own literature review. Other active learning activities were more creative. During the initial class describing the overall research process, students were broken into small groups and given a pack of candy (e.g. skittles, M&M’s). Students were then challenged to ask and answer a compelling research question about their candy. This activity helped illustrate the basic steps of the research process and one group even found that skittles can be used to test for colorblindness.
The good graph/bad graph activity engaged them in developing effective graphs. Students were asked to bring a graph or figure to class that they located from their literature review. The class then voted on whether or not the graph was ‘good’ or ‘bad’ by giving a thumbs up or thumbs down. Students then identified the ‘good’ and ‘bad’ aspects of each of the graphs to assemble a list of best practices in graphing and presentation of figures.

The Home Depot survey activity engaged the students in effective survey design and implementation. Following a lecture on different types of data collection methods, students were asked to work in small groups to identify various ways to test the hypothesis that purchase of green building materials correlates positively with socioeconomic status. Students were asked to collect data for both the dependent (purchase of green building materials) and independent (socioeconomic status) variables at a hypothetical survey for Home Depot. Students were charged with developing three different approaches to collecting data for these variables and then to evaluate the pros and cons of each from the standpoint of the researcher, the research subjects/sampled population, and Home Depot, the host for the experiment. Ideas ranged from the conventional (for example, written surveys distributed at point of purchase to customers asking about their demographics and purchases) to unconventional (for example, inferring customer socioeconomic status by observing the car they drove to the store or the shoes they wear). The aim of the exercise was to introduce students to the wide variety of methods available to them for data collection and to encourage them to think outside the box when selecting metrics and designing data collection protocols.

At Pitt, the assignments were geared towards different levels of the students, dependent upon where they were in their research. For example, students that were close to graduating were working on developing research plans for their academic careers. Students at Pitt also participated in peer-reviewing certain assignments; students exchanged assignments with someone at a different state in their studies and provided feedback to one another. At Clemson and Virginia Tech, the assignments were the same for all first-year graduate students.

Lessons Learned

The faculty distributed an anonymous web-based follow up survey to the students to evaluate the student perceptions of the collaborative, distance-learning research methods class. Student response rates were as follows: 5/9 responded from Clemson, 13/15 responded from Pitt, and 5/5 responded from Virginia Tech.

In general, students agreed that the collaborative course that drew on expertise from instructors from different universities was valuable (see Figure 1). Despite having weekly homework assignments, presentations, and activities, students overwhelmingly agreed that the amount of these elements was ‘just right’ for the class (see Figure 2). However, 60% of students said that they would like to see fewer cross-university student interactions.
In a facilitated discussion at the end of the semester, students expressed frustration with the “report back” parts of exercises. This is reflected in the student feedback in Figure 2 where students wanted to see fewer instances of cross-university student interactions. The large number of groups among the three universities made it difficult to maintain attention during informal report backs, especially since audio and video feeds were difficult to hear and see. Students recommended that future reporting from active learning activities incorporate visuals such as slides so that students at other sites could clearly make out what was being shown.

Even though Pitt was the only university to employ a peer-review process on three assignments, all students were asked if they would like to see more peer reviewing. There was no
distinguishable difference between Pitt responses and Clemson or Virginia Tech: 65% of students from all universities would liked to have had more peer reviewing in the class (Figure 2). Figure 3 depicts Pitt students’ responses related to the peer mentoring; Pitt students of all experience levels (first through final year graduate students) attended the class. One hundred percent of senior students in their last year at Pitt agreed that their involvement in the class to work on future research ideas was a good experience. The first year students felt more strongly about the benefits of peer mentoring: 3 out of 4 strongly agreed, while 1 agreed with this statement. Interestingly, students in the middle of their career were the only group to disagree. In a follow-up discussion, these students primarily felt that the timing of the course was not right for them.

Finally, when asked about the distance-learning technology; “Please respond to the next question ONLY as it pertains to the mechanics of your distance learning experience (this includes the audio and video). The distance learning experience... needed improvement, was adequate, or was exceptional”, over half of the students thought that the distance learning technology was adequate (Figure 4). Pitt students who were in a dedicated distance learning classroom gave a slightly higher adequate to exceptional rating of the technology than students at the other universities. However, about half of Clemson and Virginia Tech students found the off-the-shelf technology adequate.

At Clemson, lessons learned related to technology for the distance-learning format were network problems as opposed to hardware problems. A few times during this semester, Clemson lost the connection when listening to an instructor at another institution. This led to short gaps in the mini-lecture. The small group of graduate students was patient with these glitches and able to recover quickly. A second issue related to a distance learning technology was the difficulty in transitioning from one institution to another. For example, if the instructor at the Virginia Tech was leading the micro lecture, the instructors at Pittsburgh or Clemson were not able to chime in with additional points without the audio delay interrupting the primary instructor. To accommodate, we designed classes to minimize transitions between institutions. Using dedicated distance learning facilities at all institutions in future versions of this class will help address these technical issues.
From a Virginia Tech perspective, students reported becoming more comfortable with the distance learning aspect of the course over time. One student remarked that even though the Adobe Connect medium was sometimes frustrating, the course provided a good experience in making everyone more comfortable with this venue that will undoubtedly be used more and more frequently in the workplace.

Since all but one of the VT students were in their first semester of study, they described feeling less knowledgeable than students at the other two institutions during discussions. Students at Virginia Tech were focusing on a broad variety of research areas, not just sustainability, and so they did not necessarily benefit as much as others from the sustainability community of practice that emerged over time. Overall, they found the lecture portions of the collaborative sessions to be most useful, especially when accompanied by slides that could be easily seen, followed by on-
site discussion of concepts during and after active learning exercises. Students at VT also benefitted from guest lectures by more senior students at Pitt and Clemson during their Thursday class sessions, where they had the opportunity to ask frank questions of their peers about what those students’ experiences had been like.

From the instructors’ perspective, one of the best parts of this class was the opportunity to learn from peers at other institutions. Offering this co-taught distance learning class made collaborating part of our regular job responsibilities. We had an incentive each week to talk to each other to setup that week’s class. The time this took was no longer than individual class preparation, but we heard different perspectives and approaches to teaching the course material.

Bibliography


