Teaching Social Sustainability in Sustainable Construction and Infrastructure Courses: A Collaborative Approach

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ABSTRACT

This paper addresses the implementation of a teaching module related to social sustainability, focusing on the planning and design phases of construction projects. The target population for this study included 74 seniors and 40 graduate students in Sustainable Construction and Infrastructure courses offered by three first-tier academic institutions during the Fall of 2011. The module proposed here provides the foundation for discussing four social sustainability conceptual areas: community involvement, corporate social responsibility, social sustainability, and safety through design. The implementation requires four steps. The first step uses a survey to assess the students’ previous knowledge of social sustainability. The second step focuses on learning about social sustainability through a mini-lecture and a class discussion, emphasizing that this construct involves multiple perspectives. During the lecture, the students then provide specific social sustainability examples for each of these four conceptual areas. The third step involves students learning how to create concept maps based on Novak’s technique. Finally, the students create individual concept maps that are subsequently used as post-assessment tools, identifying the knowledge they have gained. The preliminary results indicate that the module provides a platform for increasing student awareness that sustainability involves more than the green features of a facility.

INTRODUCTION

Sustainability is a topic of growing importance that should be covered in technical degree programs for several reasons, one of the most important being that prominent accreditation organizations require that these concepts be included in the curricula for accredited degrees. In addition, employers increasingly expect students to have an awareness of sustainability as such skills are necessary to address problems of global significance. Traditionally, when teaching or discussing issues surrounding sustainability in the classroom, the focus is placed on environmental topics, and the social sustainability construct receives little attention. Classes often lack a comprehensive framework for defining social sustainability, and the topic is frequently omitted from discussion. Two of the strategies for covering this topic
include service learning or community service projects. However, both of these strategies provide only a partial view of social sustainability to the students. The authors chose to implement the teaching module discussed here as a method for including and facilitating discussions regarding social sustainability in their existing courses.

Although there are many ways to cover sustainability in a curriculum, integrating social sustainability across existing courses allows related concepts to be presented in a way that reinforces their broader applicability. In this paradigm, current sustainable courses serve as an integration point for teaching social sustainability concepts to future planners, designers and construction managers by using a systems thinking approach. In addition, traditional classes can provide related material in the form of case studies or specific implementation examples. Such a pedagogy can help students learn to consider how early decisions can eliminate or minimize social impacts of hazards on the community, on the construction workforce, and on the final users. In addition, the discussion of this construct can help them expand their perspectives about sustainability beyond green products/materials or construction practices.

To accomplish this goal, this paper describes the implementation of a teaching module based on social sustainability concepts. In this module, social sustainability is defined as a series of processes that improves safety, health, and well-being during the life cycle of projects, including those for both current and future generations (Mihelcic et al. 2003, Herd-Smith and Fewings 2008, Dillard et al. 2009). Specifically, this module was developed to help students consider social sustainability during the planning and design of construction projects by focusing on the following conceptual areas: community involvement, corporate social responsibility, safety through design, and social design (Valdes-Vasquez and Klotz 2010). Each category is described briefly below:

- Community involvement emphasizes public constituencies in governmental and private decisions.
- Corporate social responsibility considers the accountability of an organization in caring for all of the stakeholders affected by its operations.
- Safety through design ensures worker safety by eliminating potential construction/operation safety hazards during the design phase.
- Social design focuses on improving the decision-making process of the design team and the intended use of the project by the final users.

The learning outcomes of these four social categories are assessed using Novak’s concept mapping technique (1990, 2010). This technique promotes shared understanding and learning by looking at broader wholes and their parts, especially important in teaching abstract concepts such as social sustainability.

IMPLEMENTATION

The social sustainability module reported here was taught in Sustainable Construction and Infrastructure courses offered by three first-tier academic institutions. These courses are electives for seniors and graduates students in the Civil Engineering, Building Construction, and Construction Management programs at Clemson University, Colorado State University, and Virginia Tech, respectively.
At Clemson University, the module was part of Sustainable Construction (CE 456/656), a technical elective for Civil Engineering majors at the senior or graduate level. This course also welcomes graduate students from the Construction Science and Management major. During Fall 2011, this class was composed of 74 students, 59 undergraduates and 16 graduate students. This course provides an opportunity for students to gain an understanding of how to minimize the negative impact of construction projects such as buildings, emphasizing collaboration and the interdisciplinary aspects of design, construction, and maintenance. One of the primary learning objectives of this course is to develop skills for life-long learning in relation to the three main sustainability pillars (social, environmental, and economics) in the built environment as the field evolves.

At Colorado State University, the module was taught as part of introductory lectures in Sustainable Design and Construction (CON 476). During the Fall 2011 semester, the course enrollment was 16 undergraduate and 4 graduate students. The principle components of this course include such topics as community planning, passive design, resource conservation, healthy buildings, and natural construction. The course was developed to foster an understanding of these concepts by placing them within the context of social, environmental, and economic sustainability. Students are primarily Construction Management and Interior Design majors; however, in 2011 majors in Historic Preservation and Business were also enrolled. This course focuses on the breadth of sustainable design and construction, assisting each student in developing an understanding of the scope and complexity of sustainable principles as applied in their professional practice.

At Virginia Tech, the module was included as part of Sustainable Civil Infrastructure Systems (BC 5144), an interdisciplinary graduate course composed of 20 students in Fall 2011. This course included students from Building Construction and Civil Engineering with an emphasis on Infrastructure Systems or Construction Engineering and Management as well as Architecture, and Urban Affairs and Planning majors. The course is organized with the first half being devoted to sustainability theory, tools, and techniques for analysis, and the second half focusing on specific types of alternative infrastructure systems that improve sustainability and reduce vulnerability. The social sustainability module reported here was included as part of the first half of the course focusing on sustainability theory.

The teaching module was implemented in these three courses by coordinating with the instructors of record about the best time to accommodate it in their syllabus. Several face-to-face communications, phone calls and e-mails established the best means and methods for implementing the module. This module was taught in each course by an outside facilitator who was not the instructor of record, so all the students received the same information and interaction from the same facilitator. The implementation of the teaching module was coordinated by the outside facilitator following the general plan presented in Table 1:
Table 1. Implementation Plan for the Social Sustainability Teaching Module

<table>
<thead>
<tr>
<th>Phase</th>
<th>General description of the content</th>
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| 1. Pre-assessment (before the lecture) | a. Students are assigned to respond to an on-line survey concerning what social sustainability means and to provide two examples of social considerations that are included during the planning and design phases of a construction project.  
b. Students are assigned to watch the “Refugees of Boom and Bust” by Cameron Sinclair, which is part of the TED video library http://www.ted.com/talks/cameron_sinclair_the_refugees_of_boom_and_bust.html. Also, students are required to respond to the following question: What, if any, responsibility do you think engineering and construction companies have in preventing or addressing situations like this one? |
b. Organized discussion (class activity) - 25 min  
c. Social sustainability framework - 10 min  
d. Concluding remarks and reflections by the students - 10 min |
| 3. Learning about concept mapping | a. Students are assigned to watch the following video http://youtu.be/A625Yh6v6uQ.  
b. Students create a concept map related to the class content or their midterm project/final project  
c. Concept maps are collected and feedback is provided |
| 4. Post-assessment | a. In class, students spend 20 to 30 minutes creating a concept map of the social processes of sustainability that need to be considered during the planning and design of a construction project.  
b. Students are assigned to respond to an on-line survey related to their experience about the teaching module. |

**Phase 1: Pre-assessment**

This first phase assesses the students’ previous knowledge of social sustainability through an on-line questionnaire. This preliminary assessment asks students to provide their definition of social sustainability and two examples that describe processes during the planning and design phases of construction projects. In addition, students are asked to provide their opinions about the TED video “The Refugees of Boom and Bust” by Cameron Sinclair, an activity that prepares them for next class period. The information collected from the students helps the facilitator to assess their previous knowledge and select a range of opinions that should be highlighted during the lecture. This strategy also helps engage the students during the lecture.
Phase 2: Social sustainability lecture

The second phase provides the primary instruction time related to social sustainability. The class begins with the introduction of the facilitator and then moves to a discussion of the comments posted on the discussion forum about the TED video. The goal of this discussion is to lead into a mini-lecture on the construct of social sustainability and its four conceptual areas. During the mini-lecture, examples about how to integrate safety considerations during the design phase of construction projects and in corporate social sustainability practices are provided. The aim of this mini-lecture is to emphasize that the social sustainability concept involves multiple perspectives represented by various conceptual areas, which should be integrated.

The students are then asked to form groups of 3 to 8, depending on the size of the class; they are challenged to share an example of one these conceptual areas with the rest of the class. To facilitate this in-class activity, students are provided with four handouts that describe each of the conceptual areas. This learning activity gives students an opportunity to build and convey knowledge through a cooperative team effort. The combination of providing and receiving information from peers enhances the learning process since peer-feedback provides a different perspective and allows students to incorporate and internalize these new concepts (Nilson 2003).

The class session concludes with a general discussion to help students clarify concepts and view different perspectives of the topic, with special emphasis on the fundamental concepts behind each social conceptual area. Then, students are asked to articulate three lessons learned about social sustainability based on the lecture. Finally, students are given instructions for incorporating the different categories of social sustainability in a midterm project or final project.

Phase 3: Learning about concept mapping

This phase focuses on learning about Novak’s concept mapping technique, which is used to assess the knowledge gained by each student (Novak and Cañas 2008). In Novak’s approach, the student writes ideas in boxes using lines to connect related concepts, often including labels, to show the type of connection needed to build meaning among a given set of concepts. This concept mapping technique has been successfully applied in other programs to measure understanding of sustainability (Borrego et al. 2009, Lourdel et al. 2007).

To practice this technique, students develop individual concept maps based on their understanding of the topics covered in the course to date, such as energy modeling or their proposal for their final projects. The main purpose of creating the maps is to allow students to practice using Novak concept mapping so that they become familiar with the technique. After creating the maps, students then share their maps, reinforcing how to create them. As discussed by Wiezel (2006), this technique is also a useful tool for understanding how students connect related information as well as determining the information they are missing at a specific point in time.

Phase 4: Post-assessment of student understanding

The last phase of the module involves assessing the knowledge gained by the students a couple of weeks after practicing concept mapping. During a subsequent class period, the students are required to construct individual concept maps of the
social processes of sustainability that need to be considered during the design of construction project.

A grading matrix for assessing these concept maps was adapted from Martinson (2004) and Besterfield-Sacre et al. (2004). Since one concern when using this type of rubric is the validation of the assessment tool, two independent evaluators are asked to assess a stratified random sample of the concept maps collected. These maps are given to the evaluators without the names of the students on them, and they are randomly arranged to eliminate any individual bias. In general, having two additional evaluators is important for the assessment of the maps because this process needs to be unbiased, especially when assessing the more abstract topics related to social sustainability.

Finally, the facilitator distributes an anonymous Web-based follow-up survey to the students to evaluate their perceptions of the teaching module and the social sustainability construct. Some of the open-ended questions that can be asked include a) What do you think social sustainability means? b) Can you explain how your understanding of social sustainability has changed? If it has, was it a result of the teaching module? and c) Do you think it is important that social aspects are taught in this class? Why or why not?

PRELIMINARY RESULTS

This research is currently underway, and at this point in the semester the assessment of the concept maps has not yet been completed for the three courses. However, the lessons learned from the students after the lecture and general observations from the instructors of record are presented below.

Lessons learned from students

Student response rates were as follows: 62/74 responded from Clemson, 20/20 responded from Colorado State University, and 18/20 responded from Virginia Tech. The lessons learned obtained from the students provided preliminary results that the module was successful in increasing awareness about social sustainability. The most frequent three responses from Clemson focused on having a better understanding of safety through design, community involvement, and the importance of human rights. Below are few representative student opinions:

- “One thing I did not know about social sustainability was the community impact. After today's lecture, I realize that the community needs to be involved, not only after the project is complete, but during the planning and design phase too.”

- “It wasn't until after I watched the video when he brought forward the question: 'Is building a green building sustainable when the workers used during construction were not being treated well?' I then realized how important the treatment of workers is to social sustainability.”

- “I really enjoyed seeing the examples of safety through design. I was surprised that there are so many small changes that could be made in the design phase of a project, without extra expense, that would increase the safety of the construction.”
Colorado State University students also mentioned safety, community involvement, and human rights considerations as important lessons learned. The following is a sample of the comments from these students:

- “In Safety through design, the example of the skylight and the snow perfectly showed how safety through design could be implemented.”
- “Community involvement…, I never considered that getting the communities’ input before designing the project would relate to social sustainability.”
- “Social sustainability also has a lot to do with the way people in that part of the world view human rights and living standards.”

The students from Virginia Tech reported having a better understanding of the construct of social sustainability as whole as well as community involvement and safety through design. Below are remarks representing some of their lessons learned:

- “Social sustainability is probably less well-defined than the other aspects of sustainability. I liked the depiction of social sustainability inside the ecological [sphere] and its integration with economics.”
- “I have learned that it is important to bring the community into the planning stages of the project to get buy-ins and keep them informed and involved during and after the projects ends.”
- “Prevention through design methods are social sustainability considerations that could have effects on workers, citizens, and indirect participants.”

In general, this anecdotal feedback provided by the students suggests that the lectures provided the opportunity to better define social sustainability in relation to the delivery of construction projects.

Observations from the instructors of record

The three instructors of record have also provided feedback about the impact of the teaching module in their classes. The instructor from Clemson believes that his students now see the social pillar as part of the big picture of sustainability, carrying with them the idea that sustainability is not only about being green. Before this module was part of the class, fewer instances of social sustainability were used as examples ones during class discussions.

From the Virginia Tech perspective, the content of the module was a beneficial complement to issues of resource consumption and ecosystem impact discussed in the rest of the course. Specifically, the construct of social sustainability presented in the course provided a way to interrelate many of the social issues that came up during the semester. For instance, while students were aware of the need for community involvement in projects to facilitate project implementation and reduce resistance, they had not explicitly thought about this as a criterion for sustainability. Likewise, safety during project implementation, safety through design, and active involvement of stakeholders in solution design were concepts touched upon elsewhere in the course; however, they were not actively included in students' understanding of sustainability until the social sustainability module. The framework of practical considerations for social sustainability in construction also provided a foundation for subsequent project work by systematically presenting a set of best practices that should be included in solution development and implementation.
The instructor from Colorado State University found that when exposed to concept maps, the students generally reacted positively. Since many of the students may be resistant to writing, they appreciated the visual and geometric nature of concept maps as a communication tool. They liked their structure and functionality, referring to them as “road maps,” “visual aids,” “layout tools,” “maze of ideas,” and “organizing tool.” Students stressed that they liked the “non-linear” nature of the maps and how they allowed the user to connect interrelated or complex concepts to facilitate brainstorming. They also considered concept maps to be particularly useful in group settings since various members could simultaneously interact and communicate, allowing the group to “take ideas in different directions.”

The students at Colorado State University thought that concept maps were particularly well suited to describing sustainability. One student said, “[Concept maps] allow you to put all of your ideas down first and then choose and connect the interrelated ones. This method works well with this class because there are so many different ways and paths that lead to sustainability,” or another, “sustainability can be an extremely complicated topic and the most important part can be understanding relationships and how different aspects of sustainability affect each other.”

However, with limited practice and exposure some students struggled to create the concept maps. Practice is essential. A few students did mention that if the concept maps become overly complex, they can be confusing and, in fact, detract from communication by becoming something of a distraction. Interestingly, at Colorado State University, the interior design students were the most critical of concepts maps. They frequently compared them to the “space diagram” with which they are more familiar and seemed to have difficulty getting away from thinking of concept maps in a similar fashion.

CONCLUSIONS

The implementation of the social sustainability teaching module has provided another perspective and enhanced the content of Sustainable Construction and Infrastructure courses. The three courses benefited by covering a topic that was not previous taught because of the lack of a framework as well as by incorporating instructional approaches such as mini-lectures and in-class discussions that engaged the students with the subject matter. In addition, the use of concept maps helped students conceptualize their ideas and the implications of technical decisions during the design and management of construction projects. Although the assessment of the final concept maps is not provided in this paper, the preliminary results from this study suggest the teaching module helps students to learn about social sustainability in the delivery of construction projects. While they may not always remember the details and connections within social sustainability, students will carry with them the big picture, that sustainability is not just about green buildings or recycling. Future designers and contractors must be able to design and manage sustainable solutions that not only satisfy technical, economic, and environmental requirements but also consider the social pillar of sustainability.

From the facilitator’s perspective, one of the most fulfilling aspects of this module was the opportunity to teach the social sustainability framework to a range of students from various backgrounds as well as to collaborate with peers at other
institutions. Implementing this module made collaborating part of his regular job responsibilities and served as an incentive for him to provide references to the instructors of records that they might not have time to include in their class. In general, the inclusion of the module in each course did not disrupt the already full schedule of the syllabus, but it provided a platform for the students to integrate knowledge from different perspectives and approaches. Furthermore, the implementation of this module can be applied to other programs and institutions, collecting data to compare results that could be generalized. The authors welcome other faculty members to be part of the implementation of this module. All of these efforts will serve the main goal of preparing AEC professionals for learning about the concept of social sustainability in the classroom.

Finally, future studies could focus on the best way to integrate a construct like social sustainability into existing courses in addition to those in sustainable construction and infrastructure. The first step involves identifying the ways social sustainability concepts have already been integrated in various curriculums, such as service learning projects, community services, and the development of new courses.

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REFERENCES


