Impact of Educational Context on Teaching Sustainable Design and Construction

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Abstract

Teaching sustainability is critical to the education of Construction Management (CM) students and industry professionals. The magnitude and global nature of the environmental impact of the building industry prompts a variety of contexts for teaching sustainable principles and practices. In this research the authors develop a framework to assess differences in effectiveness of educational materials and methods across a variety of educational contexts. We create a three-by-three matrix and analyze educational settings across conditions. The educational settings we examine are based on the authors’ personal participation and teaching experiences, and include traditional graduate and undergraduate courses in the United States, an international 10 day travel course in Costa Rica, as well as on-going curriculum development in partnership with Egyptian Universities. The teaching contexts examined include culture and personal mission and beliefs, the role of climate in determining appropriate sustainable design strategies, and the selection of teaching styles with a focus on problem-based service learning. The research suggests modifications to teaching materials and methods within this matrix are necessary and advised. It encourages domestic and international educational partnerships and directs future development efforts of sustainable construction coursework to vary across a range of educational contexts to maximize educational value for both teachers and students involved in sustainable education.

Introduction

Many academic institutions acknowledge the importance of integrating sustainability and sustainable principles into core curriculum across disciplines. However, little research exists about the role of “educational context” in the development of the curricula. This study explores the importance of understanding “educational context” when teaching sustainable design and construction in the United States and abroad. The study is based on a review of the literature on
best teaching practices and the authors’ personal experience from teaching and participating in sustainable design and construction classes located around the world.

For the purpose of this study, educational context is defined as the conditions, circumstances, and facts that are relevant to teaching a class on sustainable design and construction. Sustainability is understood as a process that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). More specifically, sustainable design is defined as a collaborative process that involves thinking ecologically – studying systems, relationships, and interactions to design in ways that decrease stress from systems (AIA COTE, 2007).

Also relevant to this study, culture is understood as the customary beliefs, social norms, and material traits of a racial, religious, or social group and climate as the average condition of the weather at a place over a period of years as exhibited by temperature, wind velocity, and precipitation.

To illustrate how educational context impacts the delivery used in teaching sustainable design and construction, a comparative matrix developed by the authors is included (Figure 1). The matrix displays the contextual conditions of culture, climate and teaching style/delivery across three educational settings. For our purposes, examples of the collection and disposal of waste, climate responsive design, and problem-based service learning illustrate cultural differences across the curriculum in three different educational settings described below:

**Setting 1:** CSU semester long problem-based service-learning course taught in a classroom to Construction Management graduate students.

**Setting 2:** Costa Rican problem-based service-learning 10-day travel course taught both in a classroom setting and outdoors. The course is led by the Department of Construction at CSU and the University of Costa Rica (UCR) School of Architecture. It serves a mix of CSU students from a variety of disciplines and Costa Rica School of Architecture students.

**Setting 3:** Egyptian University and CSU developing problem-based service-learning course. The course will be delivered in a classroom setting and is intended to serve Egyptian students.

Following is a more in-depth description of each of the contextual conditions as experienced by the authors.
Figure 1. Context and Teaching Topic Matrix for 3 Educational Settings

<table>
<thead>
<tr>
<th>Context</th>
<th>Settings</th>
<th>United States</th>
<th>Costa Rica</th>
<th>Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Example</td>
<td>Established infrastructure that supports collection, processing and disposal in most areas of the U.S.</td>
<td>Minimal infrastructure leaving waste management to the discretion of the local government</td>
<td>Culturally established infrastructure in selected areas of the country and a new movement to use foreign waste management services</td>
</tr>
<tr>
<td>Culture</td>
<td>Waste Management – collection and disposal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate</td>
<td>Climate Responsive Design</td>
<td>Various options depending on latitude and longitude</td>
<td>Various options appropriate for Hot, Humid Climates</td>
<td>Various options appropriate for Hot, Arid Climates</td>
</tr>
<tr>
<td>Teaching Style/Delivery</td>
<td>Problem-Based Service-Learning</td>
<td>English Pre requisites and prior knowledge restrictions</td>
<td>Spanish/English Pre requisites and prior knowledge</td>
<td>Egyptian Arabic and English Level of prior knowledge Cultural</td>
</tr>
<tr>
<td></td>
<td>Language</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Prior Knowledge</td>
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<tr>
<td></td>
<td>Cultural Attitude</td>
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<td></td>
<td>Student Engagement</td>
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</tbody>
</table>

**Culture**

Culture has a range of impacts on the effectiveness of educational materials and methods depending on the subject matter being taught. The authors observed that culture plays a significant role in teaching several important principles in sustainable design and construction. For example, the focus and objectives to be taught with regard to construction waste management may change significantly depending on the predominant culture of the students. The following is a brief overview of historical and cultural context with regard to waste collection and disposal according to our three cultural settings: the United States, Costa Rica and Egypt.

In the United States waste collection and disposal began as an unregulated process of product disposal. It evolved over time in response to the desire to protect public health, followed much later by the desire to protect the environment (Hickman, 2007). Initially, the government played a minimal role in the development of sanitary systems and during much of the 1700s, and American cities remained relatively unsanitary (Melosi, 2000). In fact, garbage was burned or simply dumped into the streets, alleys, and waterways, and swine freely roamed the streets (Melosi, 2000). However, over the past forty years, efforts to educate the citizens of the United States about environmental issues associated with inappropriate waste management have seen
positive results as our nations’ highways and landscapes have become less littered and our rivers, streams and lakes less polluted. Specifically, from 1990 to 2005, the amount of municipal sanitation waste going to U.S. landfills has decreased by 9 million tons and continues to decrease each year (EPA, 2005). In such a culture, it is possible to set ambitious goals for further reductions when teaching about construction waste management.

In Costa Rica the collection and disposal of municipal waste has not been a national priority until recently. In the past, waste disposal was left to the local municipalities to decide how to deal with it. Thus, in some areas little or no infrastructure is available due to costs, priority, and attitudes. Natalia Vega Araya (2008) discusses the lack of waste management plans in areas of Costa Rica that “promotes the reduction and recycling of waste” and the difficulties with waste collection that involve “administrative and communication problems among the different sectors in the community” (p. 191). Accordingly, community members have been left to dispose of waste by dumping it in vacant lots, swamps, or in the rivers. In areas that do have waste collection, the majority of the waste is hauled to a landfill and left uncovered. People, some whom live in the landfill, scavenge through the trash to find anything of value for resale. This practice has been going on for many years and has become part of the waste management culture. In an effort to improve the waste management and recycling processes, the Costa Rican government has passed a recent law (2010) that establishes a national recycling program under the supervision of the Health Ministry. The ministry will be in charge of assuring that municipalities begin to “guarantee selective waste collection services” and that the townships keep public spaces and waterways trash free (McDonald, 2010). Efforts to combat previous individual practices of waste disposal may take some time and require much education on the part of local communities. It follows that teaching about construction waste management may first need to address the culturally acceptable practice of throwing garage into the streets and waiting for monsoon rains to take it elsewhere. Part of the new regulations requires local municipalities to promote training and sensitization of the citizenship (Salazar, 2010).

In Egypt waste collection and disposal has been in place ever since nomadic people settled in Cairo and began a garbage collection business approximately 100 years ago. During the years between 1930 and 1940, another group of nomadic people, the Zabaleen, began a cooperative venture to process the waste for their pigs and as a recycling business. The waste collection and disposal has been a critical part of the Zabaleen culture and involves most every member of the growing community (Fahmi and Sutton, 2006). More recently, efforts by the Egyptian government to privatize solid-waste management in Cairo have drawn attention to the impact and adverse effect this would have on the associated recycling economy and urban settlement system of the garbage collectors communities (Zabaleen). This community is located within the Muqattam mountain area, adjacent to Cairo’s old historical quarters (Fahmi and Sutton, 2006). Within such a cultural context, lessons about construction waste management in Egypt may not be initially embraced because students may think the result will continue or increase direct negative social impacts.
Climate

The predominant climate also influences the teaching methods and delivery. Most specifically, climate produces certain easily observed effects on architectural form. Some examples identified by Hassan Fathy (1986) for areas of intense sun near the equator include the proportion of window area to wall area, projecting balconies, and overhangs. Additionally, the pitch of the roof can vary depending on the amount of precipitation and snow. To illustrate these points, we briefly review predominant climates relevant to our three educational settings when teaching about climate responsive design. Climate responsive design is design that maximizes building performance by applying climate appropriate strategies.

The United States has a diversity of climates and weather conditions due to its geographical location and size, greater deviations in elevation, and proximity to large bodies of water. Areas of the country that are near the water masses are susceptible to higher levels of precipitation and humidity while they tend to be more temperate. In these regions, building designs may include numerous windows and openings to maximize ventilation and access to light. In contrast, northern areas of the country tend to have colder and snowier conditions during the winter months. This region benefit from designs that include steep pitched roofs, strategically placed windows with southern exposure, and added insulation. In the hot and dry southwest region, roofs tend to be flatter, and windows smaller. Here, the use of high thermal mass is an effective response to deal with hot days and cool nights.

In Costa Rica, the climate and weather conditions can vary significantly depending on the region of the country and the time of the season. Coastal weather conditions differ from those at higher elevations or those in the interior regions of the country. Costa Rica is also world renowned for its extreme range of bio-diversity. In all regions, building materials are primarily dictated by cost and availability. The primary construction type is concrete block. Windows tend to be small and roofs tend to have large overhangs to shade from the strong sun, and protect from the heavy rainfalls that occur during monsoon season. At higher elevations near the cloud forest, conditions tend to be more overcast, wet and cool. Here, larger windows are preferred.

Egypt is primarily hot and arid, with large urban populations living on the banks of the Nile. Building orientation is important to allow openings to take advantage of available winds to assist with cooling and natural ventilation. Temperature extremes during the day may reach 40 degrees Celsius, or above 100 degrees Fahrenheit. In these regions, thermal mass is critical along with deep loggias, protecting balconies, and overhangs to shade the thick building walls. In addition, large openings are frequently filled with wooden or marble lattices to reduce the glare while providing openings for ventilation. Much like the southwestern region of the United States, window size and placement along with building mass can help regulate the dramatic temperature swings from hot during the day to cool nights.
In conclusion, basic principles of climate responsive design may significantly and directly vary according to dominant climate characteristics. Therefore, course content regarding climate appropriate design strategies should be customized to the location where the students will be applying, or professional practicing, sustainable design and construction techniques.

**Teaching Style/ Delivery**

In his book, *Teaching with Style*, Grasha (2002) asserts that, “teaching style is more than a set of interesting personal qualities. Rather, such qualities are related to our preferences for particular instructional processes” (p. iii). These preferences cover a range of styles from “expert lecturer to participatory facilitator to delegator (Grasha, 2002). Consequently, there are various factors that can influence the selection of teaching style. These frequently center on a personal belief about what constitutes good teaching and are driven by personal preferences, abilities, personal values and philosophy (Crow, 1980 and Moore, 2001). Here the authors use personal observation to assess the range of effective and various teaching styles applicable across settings.

In the United States, many university students have a high level of basic knowledge regarding sustainability with eagerness to share this knowledge. Furthermore, a growing body of research exists that suggests students’ benefit greatly from participatory learning. Several faculty members, including one of the authors, are currently working to develop a problem-based service-learning course for construction management students at CSU. This experimental course, Applied Sustainable Project Delivery, is being developed in collaboration with graduate students and industry professionals. In the course, students will learn and apply basic principles of sustainable project delivery and have the opportunity to disseminate and apply these principles by completing a community service project. The core activity of the course will be CSU students teaching, supervising and managing local high school students to complete the building project. Motivation for this course seeks to satisfy student interest in teaching the principles of sustainable design and construction to others. Additional motivation builds upon the premise that it is imperative to provide to their students various models of active learning by which the benefits of the classroom experience includes critical thinking skills, deep learning, collaboration and team work (Scheyvens et.al, 2008).

Motivation to develop the travel course in Costa Rica came from a different source. This course implements slightly more traditional experiential teaching strategies including group exercises and participatory charrettes. Originally taught on-site in another remote location, a professor from the University of Costa Rica attended a 10 day intensive course on sustainable design and construction taught by Brian Dunbar, the originating CSU faculty member, and told him that he should bring such course content to Costa Rica. As a result, a collaborative travel course was born where the two primary student groups consistent of construction management students from CSU and architecture students from the University of Costa Rica. In addition to focusing on
personal mission and responsibility in regard to the surrounding environment, the course relies on participatory design charrettes where students learn about integrated design principles first hand, by performing such a process themselves. Such teaching methods prove effective based on course make-up, a diverse cross-cultural, cross-disciplinary group of students, eager to share ideas and collaboratively expand the knowledge base.

Finally, the Department of Construction Management at CSU is championing on-going intra-university initiatives with several Universities in Egypt. Due to the hierarchical educational system present in Egypt, as well as the self-reported lower level of basic knowledge with regard to sustainable building practice, CSU is taking the approach of transferring core curricula directly from US faculty to Egyptian faculty while taking care to observe proper hierarchical relationships within the University. Educational practice in Egyptian Universities traditionally tends to follow the expert lecturer paradigm. In addition, certain amount of academic distrust or skepticism has been observed to exist around teaching core principles of sustainability. Finally, the University systems appear extremely slow to change. For these reasons, the teaching methods that seem most effective to best promote the dissemination of sustainable design and construction knowledge has followed a top-down approach requiring significant administrative and faculty buy-in and support from the foreign partner.

Conclusion

Our study suggests that the contextual conditions of culture, climate and teaching delivery method are factors that influence the effectiveness of sustainable design and construction classes across educational settings. Construction waste management and climate responsive design were examples of two instances where course material should be customized to best suit the different educational settings. Based on personal experiences, different teaching styles were also found to be more or less effective in different settings. The summary matrix of these findings can serve as a framework for further assessing the role context plays in sustainable education. As more universities move to include sustainable practices in their curricula, either as a standalone class or within existing classes, teachers will be asked to develop various approaches to deliver the information to their students. Understanding how the contextual conditions of culture, climate and teaching delivery, impacts curricula across a variety of settings, may ease this process.
References


