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Interdisciplinary Environmental Education: Communicating and Applying Energy Efficiency for Sustainability

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Interdisciplinary Environmental Education: Communicating and Applying Energy Efficiency for Sustainability

This paper demonstrates that interdisciplinary alliances on environmental education projects can effectively address the gap between complex environmental problems in the real world and disciplinary curricula in a university. We describe an alliance between an advanced communication course and a general science course wherein we addressed interconnections of energy efficiency, economics, and global climate change with respect to their impact on individuals, local businesses, and society. This project established that an interdisciplinary environmental project focused on local solutions to global problems is both a valuable learning tool for students and an effective method of accelerating the application of appropriate technologies.

Keywords: environmental communication, environmental education, interdisciplinary, sustainability

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One of the more unfortunate tendencies of disciplinary specialization in higher education is its propensity to divorce knowledge from its context in society. As a result, students are well-trained to perform specific tasks in their major but often fail to graduate with the skills necessary to solve the complex discipline-spanning problems facing contemporary society (Boyer Commission, 1998). If higher education is to address such problems, we require an interdisciplinary approach that cuts across narrow subject specializations, especially when tackling environmental issues (Probert, 2002).

In this paper, we report on an interdisciplinary alliance between communications and science at a large land grant university that effectively communicated the link between energy efficiency, economics, and global climate change to the local business community. This program resulted in the acceptance by local businesses of student recommended actions for mitigating environmental degradation on a local scale. In reviewing the literature, one finds a plethora of educational projects addressing environmental issues and sustainability such as: recycling (Gerth and Wilson, 1994); logging, tree planting, and "litterless lunches" (Fallis, 1991); land use and lake restoration (Gannon and Fairchild, 1983); greening university buildings (Pearce and Russill, 2003); and water safety (Ostroff, 1996). Our project builds on the findings of this literature, yet focuses on developing environmental education's potential in terms of its less emphasized and less studied aspects: the integration of the project into different disciplinary curricula, the tangible benefits to community partners, and the relationship between university and community partners within surrounding community and societal concerns more generally.

This is perhaps no more complex real-world environmental problem than global climate change. Although people consistently list climate change as a significant concern, the public has been slow to accept the link between global climate destabilization and the increase in carbon dioxide (CO₂) concentration caused by human activities, primarily the burning of fossil fuels for energy (Kempton, Boster, and Hartley, 1995). In 1995, the Intergovernmental Panel on Climate Change (IPCC) concluded that global mean surface temperatures have increased 0.6-1.2°F since the late 19th century while the atmospheric CO₂ concentration has increased by more than 30% to the highest level in 160,000 years (IPCC, 1995). It is now quite clear that greenhouse gases, such as CO₂, play a crucial role in determining the earth's climate. The IPCC projects that globally average surface air temperatures will warm by 1.4 to 5.8°C relative to 1990 by 2100 (IPCC, 2001). The results of this warming range from tolerable to globally catastrophic. Unfortunately, energy industry sponsored analysis on the economic impact of burning less fossil fuel has resulted in the public, and the American public in particular, being slow to make concrete actions to reduce CO₂ emissions (Wood, 2001). We believe that developing local aspects to the global problem of climate change holds a great deal of potential for addressing this issue while demonstrating the importance of interdisciplinary environmental projects.

The Environmental Projects

The project described here addressed the breakdown in communication between scientists, industry and the public on the link between energy efficiency, economics, and the global climate. One method of reducing CO₂ emissions to help mitigate global climate change is the use of more energy efficient devices, such as the compact fluorescent light (CFL) bulb. CFL bulbs use one quarter the energy to produce the same amount of light as a standard incandescent light bulb, fit in the average light socket, last longer, and cost less over their lifecycle than incandescent bulbs. It is therefore possible to be fiscally responsible while reducing greenhouse gas emissions. However, despite widespread availability and ease of implementation, they are seldom used (EIA, 1996).

Our project was designed to address the issue of global climate destabilization by encouraging the use of CFL bulbs among local businesses in order to: i) make the concepts of communication theory and energy efficiency concrete for students in the respective classes, ii) improve the diffusion of more efficient and environmentally superior technologies for the common good, iii) to help the community by lowering the operating costs of local businesses and decreasing the environmental externalities of energy use, and iv) to see if interdisciplinary expertise could address a pressing contemporary problem and encourage understanding of the connections between students, local businesses, community needs and complex societal problems.

Theory : The Communications Course

The objective of the first part of the project is to enable specialized communication students to apply discipline based communication theory to practical problems in the diffusion of energy efficient light bulbs. The students were presented with a seminar on climate destabilization, the environmental/economic benefits to adopting

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CFL technology, and provided a set of frequently asked questions (FAQ) about CFLs, energy efficiency and climate change to serve as an information base from which they could build a campaign tailored for the community. They were then asked to develop a public communication campaign to be run by general science education students.

The class was divided into two groups of 4-5 students. Each group put together a campaign proposal consisting of: i) a theoretical model for guiding all outreach activities; ii) key concepts for focusing and refining selected communicative aspects; iii), sample primary documents for developing the campaign; and iv) actual arguments and rhetorical approaches that might be useful in the interpersonal context. Each group then gave a 50 minute presentation on their proposal to the general science instructor. Throughout the presentation the communication instructor and science instructor asked for points of clarification or elaboration as needed. The student groups also provided the science instructor with their presentation materials to utilize in forming the campaign. Although the communications instructor insisted that all proposed activities have a plausible theoretical warrant, the final decision on the campaign lay with the science instructor. In actuality, each group's proposal was similar in basic design and conceptual development although the primary documents and suggested rhetorical strategies differed greatly. Therefore, the final campaign combined the basic elements of each proposal.

The basic models were drawn from Protection Motivation Theory (PMT), an experimentally tested health communication model (Rogers & Dunn, 1997). PMT advocates attention to four key variables in message construction:

- the importance of the problem
- the impact of the problem on individuals addressed by message
- the efficacy of proposed solutions in addressing the problem
- self-efficacy or the ability of individuals to take up proposed solutions

It was suggested that primary materials and outreach activities should be designed toward the end of increasing problem salience (importance and impact) and coping strategies (efficacy and self-efficacy of proposed solutions). PMT research suggests the messages scoring higher on these aspects receive higher reports of intent to adopt recommended actions than messages scoring lower (Rogers & Dunn, 1997).

Students proposed bundling the problems of economic competition and environmental degradation into the construction of messages geared to conveying problem importance. They also strongly supported the tailoring of economic analysis to individual businesses in terms of individual dollars saved and environmental externalities avoided. Specifically, the communication students suggested that economic arguments be made with data from the particular business and that business owners/managers be given a graph illustrating the life cycle costs and payback periods for the CFL bulbs. Finally, they suggested each business contact receive a copy of the FAQ sheet. In this way, the impact of a relatively non-intrusive problem could be made tangible in terms of consequences for their everyday operations. This is important for as Trumbo and Shanahan (2000) note, the consequences of climate change rarely intrude on daily experience in the pressing way other problems do. Moreover, the proposal to retrofit light bulbs, while relatively simple to undertake, is not a trivial response to issues of energy efficiency and environmental degradation. For example, the Energy Information Administration (1996) estimated that the total U.S. household energy that would be saved by replacing all incandescent bulbs used four or more hours a day would be 31.7 billion kW-hrs. Even if business owners cared little for the environmental aspect of problems, it was hypothesized that they would appreciate publicity on their contributions toward resolving a recognized social problem.

Other important variables for accelerating the use of an appropriate technology identified by the students included demonstration effect, source credibility, repeated interpersonal interaction and increased self-efficacy:

(1) Demonstration effect

The university and increasing numbers of corporately owned hotels serve as visible and effective demonstrations of the technology already in use. In pointing to examples of early adoption, and on-going success of the campaign itself, students felt this would serve as an invaluable second exposure or confirmation of the direct outreach effort. Students also suggested supplementing this with an endorsement of the campaign by credible organizations in the business community, even gaining the endorsement of the Mayor.

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(2) Source credibility

Students strongly recommended that the university name be identified as the source of the outreach project. Expert sources often have a great deal of credibility in their areas of specialization, which can facilitate the internalization of the proposed recommendation. However, they stressed that this should not be perceived simply as a class assignment or homework project. Business owners/managers would associate more with the campaign if the community-university partnership were emphasized instead. It was also important that those involved in the campaign did not have any direct economic interest in whether or not the business adopted the proposed light bulbs.

(3) Interpersonal interaction

There is a long history of communication theory that stresses the central importance of interpersonal interaction and dialogue in the community context (Carey 1989, Dewey 1927, Lazarsfeld & Merton 1948). Adoption recommendations that are made within already familiar interpersonal relationships have much greater potential for success than 'cold-calling'. It is also important that students running the campaign demonstrate an appreciation and understanding of the specific characteristics of the business to which they recommend adoption. It was suggested that several contacts with business owners/managers take place to establish a relationship over time.

(4) Self-efficacy

Self-efficacy was increased greatly by providing a completed worksheet, a detailed explanation, an expert contact number for confirmation of information or questions, and a list of the types and availability of CFL bulbs at local retailers throughout the community and on-line. This was viewed as the most crucial aspect of the campaign. Simple transmission of facts, data or scientific knowledge is rarely sufficient to motivate action. It was recommended that communication instead focus on: i) the consequences of the information offered; ii) the everyday actions/decisions that brought about these consequences; iii) different actions/decisions that would bring about other more desirable consequences; and iv) the ease of taking up the recommended actions. Students also hypothesized a 'guilt' or 'shame' effect in which the gap between the extensive work of students in creating the context for a good decision on the businesses' part, and the ease of implementing the recommended action by the owner/manager, might play a positive role.

Action : The General Science Course

Students enrolled in a general education science course focusing on energy and materials carried out the information campaign developed by the communication students. The class was made up of students from all academic years, both sexes and non-technical majors. The course integrates the scientific and technological aspects of energy and materials with societal concerns and problems. The first part of the course provided an overview of the major unintended environmental consequences of society's resource (energy and material) extraction, consumption, and disposal. Particular attention was focused on the "sustainability crisis" : global climate destabilization as the result of anthropogenic CO₂ emissions enhancing the greenhouse effect and forcing us to the "limits of the natural system" (Orr, 1992). This evolving global disaster and its ramifications (species extinction, severe-weather economic devastation, premature human deaths and health problems) were intimately tied to our inefficient use of energy in antiquated devices and inappropriate technologies. The second part of the course attempts to provide some technical and behavioral solutions to global environmental problems.

Specifically an entire class was dedicated to lighting, which traced the science behind the evolution of our society's choice of lighting and some of the social and environmental consequences of those choices. The example for modern lighting included a comparison of incandescent and CFL bulb technologies. This lecture provided an overview of the FAQ about the newer CFL technology and provided a full economic lifecycle analysis (LCA) of the two technologies. After the instructor finished an LCA worksheet for his apartment, copies of the worksheet were distributed and the students were asked to analyze their homes to prepare them for the assignment. Finally, they were asked to do a life-cycle energy and economic cost-benefit analysis for their favorite local business by comparing incandescent and CFL bulbs and to present their findings to the business using the methods detailed by the communications students.

To address student concerns leading into the project and ensure they were comfortable to approach business owners and managers, role-playing was used with volunteer students in front of the class. The role-playing furnished an entertaining and informative method to prepare students for the worst (and the best) responses they could expect

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from the community. The science students were then asked to choose any local business currently using incandescent light bulbs and to complete an economic LCA for the CFL retrofit by: i) determining the cost of labor needed to maintain light fixtures by interviewing employees; ii) surveying the candidate light fixtures; and iii) determining the electrical power usage of the current bulbs. The students turned in their calculations in order for the instructor to check the accuracy of the calculations and give feedback for the students during the project. Students who had picked the same businesses were given the option to team up or choose another business. This represented roughly one-third of the class that decided to work in groups. Although assigning businesses would have resulted in a more comprehensive coverage of the community, the element of self-direction would have been removed. This element of self-direction is of key importance for ensuring enthusiastic student support, because college students, as young adults, prefer to be self-directed learners (Cranton, 1994; Pearce, 2001). The instructor must be cautious, however, that the attempt to develop self-direction through coercion does not become self-contradictory and thus ineffective (Torbert, 1978). This assignment, although coercive, maintained an extremely important "face-saving" aspect - students could choose their favorite business (e.g. a bar, the apartment complex where they live, the pizza shop their best friend manages). This was enough to maintain student enthusiasm despite the unconventional activeness of the assignment. In addition, by having the students choose businesses with which they were personally familiar with, they were better able to tailor the message to the receiver.

Next, the students returned to the businesses with the corrected worksheets and carefully explained them to their adopted community members. After answering all the business owner/manager's questions to the best of their ability, the students asked them to fill out a short form to quantify their behavioral intentions. Finally, upon completion of the assignment students were asked to write short reflection papers describing their experiences and the knowledge they garnered from them.

Outcomes

Students chose a total of 105 businesses to audit and identified over \$235,000 of potential savings from retrofitting incandescent bulbs with CFL bulbs. After the students talked to the managers and business owners, the majority of them (73 or 69.5%) agreed to make some retrofits. From these businesses, a third made written commitment to change all of their fixtures and 36% agreed to change some of their fixtures to see how the new lighting would work at their establishment. Thus, the overall success rate as measured by behavioral intention was ~67.7% with an economic savings of roughly \$120,000 for the community over the life of the first round of CFLs. It is interesting to note that where students had a personal relationship with the business the success rate was 100%.

The full economic savings will be realized in approximately 3 years and the 8,000 hour CFL bulbs would pay for themselves in 5.4 months assuming that the lights were used for 8 hours a day. The economic savings are impressive but the environmental savings are even more remarkable. Following the assumption made by the Union of Concerned Scientists (UCS) for the fraction of pollutants offset from a 500 megawatt coal plant producing 3.5 billion kilowatt-hours per year (2000), this project prevented the use of 1.3 million gallons of water and the emission of 2,197 tons of CO₂! In addition, the emission of over 600 pounds each of sulfur dioxide and nitrogen oxides, and over 594 pounds of particulates have been avoided. Given a conversion factor from energy to land area is 11,241 kW-hr/ acre, the ecological footprint or virtual land area conserved was 185 acres following the calculations from Wackernagel and Rees (1996). By any metric, the accomplishment of the students' project was a success.

A similar campaign to encourage the purchase of CFLs was conducted in 1990-1991 in the state of Schleswig-Holstein in Germany (Prose & Wortmann, 1991). The campaign, which concentrated on households, was run through mass mailed leaflets, newspaper articles, and a balloon release, resulted in an estimated 20,000 CFLs being purchased. During the campaign 8.7% of Kiel households installed CFLs for the first time and an additional 6.8% of households which already had CFLs purchased more. Thus, a total of 15.5% of a possible 48.7% that were cognizant of exposure to the campaign for a total success rate of 31.8%. This figure can be regarded as a lower estimate because the effects of the campaign were run over a specific time period in which the long-term effects of the campaign were not quantified. The education method outlined in this paper was more effective because i) the motives for adoption could be tailored for the individual owner/manager, ii) economic results were personalized for specific business, and iii) interpersonal contact helped to more fully explain the concept. It can also be assumed that business owners and managers were more open to economic arguments that would directly impact on their bottom line.

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Areas for Improvement and Duplication

In order to make the project even more effective and run smoother several additions could be made to the design we implemented. First, several of the students analyzed businesses that were using incandescent light bulbs with power draws other than 60 and 100 Watts. Those students were offered additional points to make new tables relevant to the alternate Wattage bulbs. The project would have been smoother if worksheets were prepared beforehand with all possible powers of bulbs and the first part of the assignment was broken in half. First, the students would determine the cost of labor, number of bulbs, and Wattages and second they would fill in the appropriate worksheets. In order to prevent printing many wasted worksheets for the entire class, the worksheets could be provided on-line for students to download and print as needed. To prepare to enact a similar project, the instructor should carefully research the rate structure for local businesses along with current prices of both incandescent and CFL bulbs to ensure accuracy in the economic LCA. It may be helpful to include a cost comparison of local stores carrying CFLs or internet sites in the FAQ. We avoided this in order to ensure that the students were in no way construed as "selling something," but in retrospect it would have made adoption of CFL technology more convenient. In addition, it is imperative to have answers to all reasonable questions in the FAQ. For an electronic copy of the FAQ and the worksheets to implement this project please contact the authors. Finally, the overall project could have been enhanced by facilitating more direct interaction between the two classes. The communication students could have given their presentations directly to the science students and in return the science students could have prepared a final presentation to report back to the communication students.

Conclusions

The passiveness garnered by traditional college classroom instruction fosters the student habit of avoiding the application of classroom knowledge in the real world. Many students were reluctant or self-conscious to approach business owners or managers because they "have never done anything like this before." This actually turned out to be an advantage. Students made sure they understood the behavioral decision and its ramifications (e.g. environmental, economic, and technical) because they did not want to appear ignorant when approaching their respective businessmen/women.

Interdisciplinary alliances on environmental education projects can effectively overcome the barriers obscuring connections between complex real-world problems and disciplinary curricula in the university setting. This study of such an alliance between a class of communications and a general science class effectively communicated the link between energy efficiency, economics, and global climate change for the local business community. Once again, correct knowledge of causes of climate change remains a strong indicator of positive behavioral intentions to take actions to ameliorate the situation (Bord, O'Conner & Fisher, 2000). The program enhanced the learning of students in both disciplines while addressing the global problem of climate change at the local community level. We demonstrated that an interdisciplinary environmental project focused on local solutions to global problems is not only a great learning experience for students but that the approach is an effective method of accelerating socially-responsible technologies. We assume that our campaign could be a useful method for actions to be targeted at the improvement of the use of appropriate technologies for a transition to sustainability in any school community. If the results of this approach are extrapolated to other schools on both identical CFL projects and other sustainable projects for their local communities, the improvements to our global environment could be formidable.

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