The Great Problems Seminars: Connecting Students with External Stakeholders in Project-Based Approaches to Sustainable Development Education in the First Year

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Abstract

The Great Problems Seminars program at Worcester Polytechnic Institute is a first year, project-based seminar series that aims to get first year STEM students to tackle real world, open-ended, and complex problems. We do this through an interdisciplinary team teaching approach that often includes local and international stakeholders. Each seminar focuses on one 'great problem' such as food, water, or energy. These courses culminate in student driven, team-based projects aimed at identifying and addressing some important aspect of the 'great problem'. In this process students work with external organizations (sustainable development NGOs, community organizations, businesses, etc.) to gain a real world context along with interaction with people affected by or engaged in solving these critical problems. Sustainable development education is a core part of the curriculum to prepare students to engage with external stakeholders. We have found that students really come to understand, and take ownership of many of the problems that they identify. In this chapter we will highlight ethical, pedagogical and practical challenges of this type of course, present successes, and describe our strategies for cultivating the evolving long-term partnerships with external organizations as they relate to ESD capacity building writ large.

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1 Introduction

As is well known, sustainable development is, in its most general definition development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland 1987, p. 8). More specifically, sustainable development attempts to take account of the spheres of the ecological, social, and the economic in ways that do not privilege one at the expense of the others, or as Dale and Newman (2005) have nicely put it:

> Sustainable development is the process of reconciliation of three imperatives, These are the ecological imperative to live within the global biophysical carrying capacity and maintain biodiversity, the social imperative to ensure the development of democratic systems of governance that can effectively propagate and sustain the values that people wish to live by, and the economic imperative to ensure that basic needs are met worldwide (352)

Sustainable development education then, attempts to teach principles and methods that lead to the further understanding of, research about, and practices around sustainable development.

As has been argued by many (Dale and Newman 2005; Jucker 2002; Steinemann 2003) teaching sustainable development is not the same as teaching a traditional, singular focused set of disciplinary competencies. This is because coming to understand what sustainable development is, applying its methods to specific problems and in specific contexts requires not only disciplinary knowledge from multiple areas, but also a set of transdisciplinary skills. Not only do students of sustainable development need to learn about and be able to apply concepts and epistemologies appropriate to ecological, social and economic study in the broadest sense, they also need to become good at targeting and finding the information they need in coming to understand a complex global/local problem from the perspective of sustainable development. This requires more than simple memorization of disciplinary facts. It requires that the student become able to integrate information from a variety of sources and a variety of contexts, forming it into new knowledge that can be applied in new and different contexts and in different ways. In short, sustainable development education is as much about helping the learner become a better researcher and critical thinker as it is about teaching the principles of sustainable development themselves. Thus, as Dale and Newman (2005) argue, teaching and learning about sustainable development is "process-based as well as fact-based; these tools must be flexible enough to generate appropriate responses specific to each individual situation and applied enough to allow engagement with global problems at the local level" (351).

For this reason, sustainable development education is best done through experiential, problem or project-based learning in which students face real-world problems, work to understand them, and offer solutions that conform to the principles of sustainable development. Participation and awareness are important aspects of sustainability education at institutes of higher learning (Drewel 2012) that can be increased through project-based courses. In such experiential learning, as Steinemann (2003) shows us, "students are given real world problems similar to those that would face as professionals. They take ownership of the problem, and the problem solving process. Instructors, in turn, take the role of cognitive coach" (218). This is because students are much more engaged when problems and challenges are viewed as authentic and not contrived to teach predetermined lessons. Through the process of the project, they must build the skills discussed above. Instructors, acting as 'cognitive coaches' work to help guide the student in the project process rather than simply give the student answers.

Such experiential learning is, in our view, best undertaken in teams or groups where students work together rather than individually on the project. This type of team-based, or cooperative learning also further enhances the skill-set or tools that are required for a good education in sustainable development. A ten year study in which researchers compared team-based cooperative learning with other forms of learning (individual and competitive) found that among other things, cooperative learning led to higher student achievement and more development of critical thinking skills than other forms (Johnson and Johnson 1984). Additionally we have found, that engaging other stakeholders in the project experience further enhances student learning and connects students even more to the process in ways that deepens their ability to understand and apply sustainability based concepts and solutions to the problems that the students face. We will discuss this more fully below, but we have worked with community partners across multiple iterations of our Great Problems Seminars courses (NGOs, schools, businesses, and other community members) and have found that doing this enhances the student connection to the projects and deepens their connection with and understanding of sustainability. Here is what one group of students, who worked on a project related to sustainable watershed management at a local pond, wrote in their learning statement at the end of one of our courses:

> When we decided on our project … we simply viewed this as a project that we had to complete. However, while conducting our interview [with a stakeholder]… we canoed along the pond and were able to experience the pond first hand. This changed our entire mindset about our project. Being that we were able to experience the pond itself, and the people who are so passionate about it, we felt much more compelled to do whatever we can to help. After this day that we were able to observe the pond, project work felt a lot less difficult. It was something that we wanted to do, not just meaningless tasks that we had to do. We now understand that the only way to truly help solve a problem is to experience the problem and those who care most about it.

Other students have expressed similar experiences and sentiments throughout our Great Problems courses as a result of both the format of the courses and opportunities to engage with stakeholders throughout the project process.

2 The Great Problems Seminars

WPI's Great Problems Seminars (GPS) are project-based courses that engage first-year students in real world learning, current events, societal problems, and human needs. Each seminar starts with an important global problem and helps students develop a project that addresses one small piece of a broader global problem. These courses were first developed to increase student retention in the first year but also serve as an introduction to WPI's project centered curriculum. In this way GPS courses fill the need that Brundiers et al. (2010) identify:

> Because incoming students are usually unfamiliar with the concepts and practices of real-world learning, they need to be introduced to those models, methods, and tools. This could be done through integrating an introduction to real-world learning paradigms into a regular course, such as an undergraduate methods course or the general introductory course for freshmen.

Each GPS course carries the credits equivalent to two courses and extends over two 7-week terms. The students spend the first term exploring the nature and extent of a particular great problem and searching for a piece of that problem they can address. During the second half of the course they work as a team to develop a solution to a smaller problem that the student team has identified that exists within the context of the larger great problem. This type of student driven project selection is not something most incoming first-year students have experience doing. As we will discuss more below, because of this lack of experience on the student's part, we design our courses to incrementally move students from short prescriptive assignments to one big open-ended project that engages stakeholders.

Every GPS course is co-taught by instructors from disparate disciplines generally one from engineering or the sciences, and the other from the social sciences or humanities. All of the GPS courses address sustainability issues and engage stakeholders to some extent. The three courses that we personally (collectively) teach are Power the World, the World's Water, and Biosphere, Atmosphere, and Human Fears, all of these courses have sustainability as a key component of the class. Due to the multiple pairings and expertise of instructors, however, each course and iteration of it varies to some extent but the GPS program has developed and shares a set of 7 common learning outcomes (Table 1) and each of the courses culminates in a set of team based final projects that are presented at a public poster session.

As Table 1 above displays, our learning outcomes are: cultural awareness, values, approach to problems, research, teamwork, writing, and presenting. These outcomes may look somewhat different than those for traditional classes. Competencies are favored over disciplinary specific content and objectives. As previously stated, sustainable development education teaches a diverse set of skills and the ability to generate new knowledge out of good research and critical thinking capacities alongside the concepts required for sustainable development work rather than simply absorbing a particular set of facts. Instead students must discern, evaluate, integrate, and apply the important facts that exist across multiple

Table 1 Learning outcomes for the great problems seminars

Cultural awareness	Articulate the differences in experiences of the "great problem" for stakeholders essential to development and acceptance of a proposed solution
Values	Describe your values and those of others as they relate to addressing the great problem
Research	Find varied, credible sources, assess their claims and relevance, and use them appropriately
Approach to Problems	When confronted with complex, open-ended problems, be able to identify answerable questions, and select and evaluate suitable solutions through the application of multiple perspectives and disciplines
Team Work	Collaborate effectively on a team
Presenting	Prepare and confidently deliver engaging and effective presentations
Writing	Produce clear, effective, evidence-based writing

disciplinary environments based on their relevance to the specific problem, place, and people they are working with. In order to reach these learning outcomes, as briefly noted above, we use a progressive approach where assignments and activities begin to introduce students to low-stakes but increasingly less structured learning opportunities in order to work up to completely open-ended, complex, and messy real-world problems that require sustainable solutions. Through each stage they gain more confidence and skill through practice and feedback.

An example of a first, low stakes assignment we use in our Power the World course is as follows: Students begin by exploring the various types of fuel used for energy production. They are prompted to answer questions about the origins and uses of particular renewable and nonrenewable energy sources, such as solar or oil, in relation to the social, economic, and environmental impacts of these types of energy production. Then they must do some team-based academic research on these sources, give a short presentation to the wider class about what they learned and also write a research essay. Additional assignments include a personal energy use log and reflection, a research notebook, a research workshop with our research librarian (whom students work closely with for the duration of the class), diversity training with the director of our office of multicultural affairs, and a larger, more open ended team-based global energy issues assignment. In aggregate, these experiences are designed to incrementally progress from basic to more advanced learning opportunities that prepare students for the development of their own project that engages stakeholders.

Students begin their major GPS projects by forming teams and choosing topics. Some choose based on common interest while others prioritize people. Next, each team identifies a particular issue they plan to address, like indoor air pollution or energy poverty, and a place where it is prevalent. There are a few GPS courses that skip this step and have predetermined projects that the students can choose from. The advantage with this method is that students can spend more time working on the problem and less time figuring out exactly what the problem is. The

disadvantage is that students do not have to do the work of identifying a problem, who it impacts, and at what scale it should be addressed. Further, a project that requires students to communicate with stakeholders in order to understand their needs has its own educational value. Often stakeholders do not agree and students are confronted with the complexities of trying to balance competing interests that confound real-world sustainability challenges. Past projects in our GPS courses cover a wide variety of topics such as, finding a sustainable solution to lack of lighting issues as a result of energy poverty in a small community in Sierra Leone, promoting sustainable water resources and STEM education at a local elementary school in Worcester Massachusetts, assessing the feasibility of LEED certification for WPI's aging Library, reducing cholera in Haiti through low cost biosand water filters, and sustainable cookstove designs to reduce indoor air pollution in Paraguay.

Once students have chosen a topic and done some initial investigation, they identify possible solutions that could address the problem. This is a variable and messy process that most students get frustrated with as they struggle through. Again, as noted above, something most, if any, of them have ever been asked to do. We do our best to prepare, guide, and support them through this phase. This is also when contact with stakeholders becomes crucial as it helps the students come to understand the varying viewpoints and experiences of those who are directly impacted by the problem.

Not all GPS courses have students engage directly with stakeholders and those that do fall on a continuum, as briefly noted above, from low to extensive contact. In our Power the World course we have found that having an organization, typically an NGO, mediate direct contact between stakeholders and students to be very effective. Especially necessary for students who want to work with communities in distant places like Africa and South America, these collaborations also help instill cultural awareness and prepare students for later experiences at our global project centers or careers where students are fully immersed in diverse cultures. In this way, students can be exposed to other cultures with less risk to themselves or stakeholders. This process is, however, not only effective for those student teams who want to work on issues in a global context, but for all teams regardless of where their project/problem is located.

After students have identified a problem and done some research, we ask each team to identify a set of stakeholders who are impacted in various ways by the problem the team is working on and contact them to gather more information. These impacts can range from direct–those who, for instance, directly experience the impacts of indoor air pollution from cookstoves, or who would benefit from LEED certification–to indirect, those who, for instance work for NGOs who work on issues surrounding energy poverty in Sub-Saharan Africa or who study sustainable watershed protection technologies. It is this type of stakeholder engagement that often pushes the student teams past the difficulties that they experience at the solution-identification stage of the project process. This is because actually talking to these stakeholders bridges the gap between the academic and intellectual understanding of the problem and the practical realities that it creates. All students are required to contact stakeholders associated with the problem they are addressing

but only a handful participate in what we consider sponsored projects. Each time the course is taught a few representatives of NGOs, companies, and local government agencies are invited to the class to solicit student involvement in potential projects. In many cases, those stakeholders that become partners and/or project sponsors for the remainder of the project process also become our partners in subsequent iterations of the courses, offering to sponsor student projects and/or helping convey their experience with the issues to new teams of students.

3 Project Partners

Partner organizations have the capacity to connect our students with communities all over the world and those nearby. Through this kind of relationship, students get to hear first hand from real people about the way they live and the challenges they face (Millican and Bourner 2011). Engagement with stakeholders would be difficult without the assistance of partner organizations like the Seven Hills Global Outreach, Fundación Paraguaya and the Coes Zone Task Force who have all been instrumental in shepherding GPS student projects (and/or connecting students with stakeholders).

Seven Hills Global Outreach (SHGO) is an Affiliate of Seven Hills Foundation that partners with health, education, and human services organizations in developing nations to "advance indigenous means to resolve global social challenges". SHGO has established long term partnerships in Ghana, Sierra Leone, Brazil, Guatemala, Haiti, Jamaica, and Bangladesh and are very adept at communicating the needs of their community partners to our students and helping the students recognize the importance of understanding community needs and capacities.

Fundación Paraguaya is an NGO aimed at eliminating poverty through practical, innovative, and sustainable solutions as well as a unique self-sufficient agricultural school for the rural poor. Through work with our students, Martin Burt, the founder and executive director of Fundación Paraguaya, has established a long-term relationship WPI including advising numerous GPS projects focused on food and energy sustainability in Paraguay that have even evolved into a permanent WPI Global Project Center.

The Coes Zone Task Force is a local collaborative effort to restore an urban pond and the broader Blackstone River watershed in Worcester Massachusetts. It consists of a diverse set of stakeholders including local landowners, city and state government representatives, NGOs, and academic partners. One group of GPS students worked with the Task Force to develop an outreach campaign to increase public awareness and engagement in restoration efforts.

During the project selection phase of a number of GPS courses, partners are invited into the classroom to introduce their organization and the challenges that the communities they work with face. This is when students get excited about working with stakeholders on an authentic problem rather than what the students described above as "meaningless tasks that we had to do". It also provides the opportunity for

students and partners to develop projects based on student interests and stakeholder needs. Students are more likely to take ownership and stakeholders are more likely to get useful and sustainable solutions.

Course assessments across GPS courses include end of course surveys with learning outcome specific questions, public project poster presentation events, program wide course project report evaluations, and reflective learning statements from students. Through these assessments we have found that project based courses in the first year that focus on sustainability enhance global awareness, values, the valuing of various perspectives, and problem solving. They also benefit from stakeholder engagement. One group of ambitions freshman even applied for and received a $4000 grant from a local non-profit to build a rainwater harvesting system at a local elementary school. Another team started a nonprofit to raise money to build new wells to access clean water in Africa.

Overall, students who engage with stakeholders have a positive experience. But we have found that some partnerships or methods of engagement are more successful than others. Teams that engage with only one or two stakeholders sometimes develop a myopic view of the problem/solution. Problems can also arise when student teams only contact academic stakeholders- as those types of experts can have the unintended effect of narrowing the student's view of the project and the solution. In light of this, we tend to prefer that teams contact a variety of stakeholders in order to avoid these kinds of issues. Given that our students in these courses are first-year students and for most of them, this is the first time they have ever undertaken this kind of work, we are understanding when these types of issues arise (and tend to think that, on balance, even those teams that end up in these types of situations, benefit more from them than they would without these types of interactions with stakeholders).

4 Conclusion

Project based learning can be an effective means to facilitate student engagement with stakeholders in sustainability education. WPI's Great Problems Seminars provide first-year students the opportunity to both broaden their understanding of sustainable development and also develop the skills necessary to work on problems and issues related to sustainability in a variety of contexts. These seminars also build foundations for later project-based experiences and work in students' professions. Instructors of GPS courses have increasingly moved away from traditional lecture formats and embraced the role of academic coach and structuring course assignments and course meetings to actively engage students in building skills through practice and feedback. Engaging stakeholders in this process has been a critically important component of the educative process in these courses.

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