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Riding the Slinky:

Science and Service Learning

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I am a plant ecologist. I passionately love plants. I hug trees, I am worried about the sustainability of our society and the massive ecological degradation and environmental changes that we are casually imposing, and I find teaching to be deeply satisfying. Therefore, I expected that teaching Ecology would be a wonderful experience. However, after I taught Ecology at the University of Evansville once, I was determined to change the course substantially. I was bored, the students were bored, and the ratings of my teaching by the students were horrible. I had designed the course in the traditional lecture/canned lab format, assuming that most students wanted to become ecologists. However, my students were mostly junior and senior pre-medicine or science education majors with a superficial interest in ecology but with no plans to pursue a career in ecological science. The clash between my expectations and their abilities and interests was considerable.

When I began the Indiana Campus Compact application process I was looking for more information about service learning, some money to support my course restructuring, and an external validation of the pedagogical changes I wanted to make. However, the implications of teaching with service learning as a pedagogical tool have been substantially broader. In this document I describe several of these implications, using the Slinky toy as a metaphor for the process of doing science.

Learning Science By Doing Science

Ecology is a deceptive field, because most people have been exposed to its basic principles, often with a heavy dose of prescriptive environmentalism, yet have never encountered any of the quantitative theories or methods that enable ecological scientists to analyze complex systems. Thus, students taking Ecology typically expect to hear a set of natural history stories, some tree-hugging theology with some bashing of western civilization, and hope that maybe they will get to pet fawns or swim with dolphins. They simultaneously think that they already understand ecological theory and are resistant to a more rigorous analysis of the theory, especially any use of mathematical equations or complex statistical analyses of collected data.

Therefore, I decided to radically restructure my ecology course. I wanted to expose my students to the process of doing science, get them outside into an ecosystem on a regular basis, and force them to see that it is possible to make a difference with your actions. After several discussions with Dr. Nancy Leonard (a former Indiana Campus Compact Faculty Fellow at the University of Evansville), I decided to center the course around the theme of a service-learning investigation of the ecology of Wesselman Woods Nature Preserve, a 220-acre oldgrowth bottomland deciduous forest located only five minutes from the university and completely surrounded by urban land uses. Conversations with the Wesselman Woods Nature Preserve staff clearly demonstrated that while they were excellent environmental educators they knew little about the forest's plant ecology, particularly in terms of quantitative ecological information, and that they would be very interested in collaborating in a service-learning project. It is around this theme of investigating the ecology of Wesselman Woods Nature Preserve that I framed my ICC application and redesigned my Ecology course.

I successfully taught ecology in the fall of 1998 as an experiential learning course. We produced

a wide range of analyses of the ecology of Wesselman Woods Nature Preserve, including an analysis of gap dynamics, woodland insect diversity, pond water chemistry, soil lead contamination, pond insect diversity, pawpaw demography, pawpaw distribution in response to light gradients, and tree community composition. My teaching ratings increased substantially, and I enjoyed the course teaching experience immensely.

Using a post-course questionnaire, I determined that while my students were generally enthusiastic about the course, there were some significant problems. First, they did not like being given the option of deciding as a group what our class-oriented projects were. Second, they had difficulty managing the process of performing a group project, so that several groups failed to perform their analyses at the level of sophistication I expected. Third, they found the actual process of doing science to be less glamorous than anticipated, and were occasionally upset by spider webs, poison ivy rashes, and working in cold wet conditions. Finally, they expressed frustration with the fact that I did not know what the answer to our investigations was "supposed" to be, and that in several investigations we ended up concluding that we needed more data assessing the influence of more variables before we adequately understood an ecological interaction.

However, my students responded very favorably to restructuring the class around the theme of experiential investigation. While they felt that the course was a lot of work, they enjoyed the hands-on work and the feeling that their actions were making a difference to the nature preserve by generating useful information. By the end of the course they realized that they had made significant strides in mastering the skills of designing, implementing, analyzing, and writing a research project.

Riding The Slinky

Science is an accumulative discipline, and typically we science professors are so concerned about the massive amounts of information that has accumulated and the need for our students to comprehend this information that we neglect to teach them how science is actually conducted. Instead, due to the need to move on to the next subject, we create a series of carefully designed laboratory experiences, each of which culminates within two or three hours in a set of results that concisely illuminate the topic of the day. While these planned laboratories are essential teaching tools, they inadvertently teach our students a set of false ideas about how science actually happens. College science students typically believe that a scientist has an idea, designs an experiment to test it, performs the experiment, collects the results, quickly analyzes them, always finds that they support his ideas, and still has time to go home by 4pm to watch Oprah!

I gradually realized that many of the issues my students expressed reflected their ideas about doing science, not just learning about ecology. Thus, when my students expressed frustration with the fact that I did not know what the answer to our investigations was "supposed" to be, felt that the course was a lot of work, and that in several investigations we ended up concluding that we needed more data assessing the influence of more variables before we adequately understood an ecological interaction, they were expressing their belief that science should be done in three-hour pieces and that any confusion at the end of the lab meant that someone had done something "wrong".

I decided that my course needed more restructuring to incorporate a different metaphor for doing science. When we teach the scientific method, typically we teach it as a straight line: Idea to Hypothesis to Experimental Design to Data Analysis to Re-evaluate Idea. Good teachers then draw an arrow back to the idea stage. However, students don't comprehend that the arrow back to the idea stage is a critically important piece. I decided to use a Slinky toy as a metaphor for the scientific method: each spiral of the slinky is one iteration of idea generating and testing, but true science is moving through multiple spirals in the process of shaping ideas, reshaping them, and finding new ways to test and express our understanding of how the world works.

As a result, I restructured the course slightly. First, I rearranged the course schedule so that it was more evident to the students how my theory-oriented lectures related to our investigation we were currently performing. Second, I added a weekly hour of data analysis, in which we as a class statistically analyzed the data we collected the previous Wednesday. Third, after that hour of analysis we decided as a group what follow-up investigation we would perform the following Wednesday. Fourth, I created a much tighter time-line with more supervisory checks in the form of meetings with me and intermediate project deadlines, to minimize the last-minute crunch that unfortunately characterizes so much of academe. Fifth, I divided the class into smaller groups for their independent projects, because it became clear that three or more students were almost always incapable of finding a common time to meet and work on their project.

When I have taught this revised course, it worked very well. Interestingly, the students who took the revised course were much less upset with the amount of work and occasional drudgery involved in doing science. I believe this is due to the changes that I have made, and especially to my repeated use of the Slinky metaphor to describe the work we were doing. By collecting data, analyzing it, and then determining what needed to happen next the students saw that we were making multiple iterations along the science Slinky.

Changes to Wesselman Woods Nature Preserve

When I applied for the Indiana Campus Compact fellowship I did not expect the professional service component requirement, and I remember being somewhat annoyed that this additional requirement existed. I decided that that my professional service component would include a thorough examination of the information that was available about the ecology of Wesselman Woods Nature Preserve and that I would work with the preserve staff to promote a more holistic management of the preserve. In retrospect, I realize that this component was vitally important, by forcing me to engage myself more deeply into the matrix of teaching, service, and scholasticism.

Wesselman Woods Nature Preserve is a nonprofit organization funded in part by the City of Evansville to manage a 200+acre oldgrowth bottomland hardwood forest within the city of Evansville, and to teach a wide variety of audiences, especially K-12 students, about ecology and environmental awareness. Since 1973 the preserve has successfully achieved their teaching mission. However, they have never had the resources to carry out formal analyses of the ecological state of the forest, and their past management plan has been simply to preserve the community within the confines of the preserve in a "natural" state. This has created some significant management difficulties, including a deer overpopulation grazing problem and an inability to predict how changes to the forest might affect its future. I also decided to work with

the Wesselman Woods Nature Preserve staff to assist the supervisory board as it develops and implements a sustainable forest management strategy. One particular component that was badly needed is an understanding of the successional trajectory this forest is pursuing, which was vital to ensure that the forest was managed in ways that maximize its sustainability for the future.

I obtained from Alice James, the director of Wesselman Woods Nature Preserve, and other sources a fairly wide variety of previous publications or studies of Wesselman Woods Nature Preserve. I have organized them into an ecologically logical framework and digitized the entire collection. I then wrote an analysis of this material in which I assessed its strengths, weaknesses, and implications for Wesselman Woods Nature Preserve management. This document has been given to Wesselman Woods Nature Preserve, and is being used as a framework to guide future management and scientific research plans.

I joined, and subsequently chaired, the Wesselman Woods Nature Preserve Natural Resources Committee, which has the responsibility for scientific oversight of the natural areas of Wesselman Woods Nature Preserve. As a member of this committee, I was extensively involved in two different projects, both addressing significant ecological threats to the integrity of the preserve.

First, we advised the Wesselman Woods Nature Preserve staff about the necessity to control the deer population, which was extremely high. Then we worked with the staff as it planned and implemented its first-ever deer hunt to reduce the deer population. As a result, two successful deer herd reduction programs have been implemented, and have reduced the herd to less than 25% of its original estimated population size. I also wrote and published a case study examining public perceptions of deer overpopulation management (Ribbens 2001).

Second, we determined that several species of exotic plants, especially Japanese honeysuckle, were invading the preserve perimeter, had taken over about 25 acres of second-growth forest, and were a significant threat to the forest interior. We implemented one volunteer honeysuckle removal project, and I developed a webpage about honeysuckle and suggested treatment. I worked with Mr. Lee Patrick of Invasive Plant Control to design an exotic-plant removal program, and provided scientific testimony to the City of Evansville when Wesselman Woods Nature Preserve sought additional funding to finance the removal program.

Changes to My Philosophy of Teaching

After completing my service-learning courses, I rewrote my statement of teaching philosophy. While doing this I realized that the concept of service learning has deeply penetrated my philosophy of teaching. For example, in my teaching philosophy I state “it is vital that my students are challenged to think about science and its relevance to their lives, not just memorize information”. While this statement does not explicitly mention service learning, I find that service learning is perhaps the most effective tool I can use to accomplish this goal. Later, I state “I am a guide to help them move further down the path we jointly travel, not a gatekeeper who decides whether travelers may continue”. Again, I have found that quality service-learning requires this attitude on the part of the instructor; often the students identify areas they need to examine which I would not have considered, and sometimes their insights create serendipitous

results which I would not have predicted. I have also incorporated into my statement of teaching philosophy a brief description of the role that service-learning can play in my courses.

All of these revisions reflect a change that I have experienced. While I have always had a sense that science should be doing more than cramming students for MCAT tests, experiential service learning is the mechanism that I was seeking. I have enjoyed teaching my service-learning classes more than most of my other courses, I intend to incorporate service-learning again in the future, and I have advocated service-learning as a technique that my colleagues should consider. Service-learning lends itself well to more realistic scientific investigations, and empowers students because they realize the work they do is not just coursework, but will make a difference.

Service Learning in Science Courses

Why should science courses incorporate service-learning? First and foremost, science courses typically don't expect students to do real science! Service-learning can provide a structured framework for students to conduct original scientific research, analyze their research, write a summary report, and communicate their results with the client. It forces students to understand that real science does not occur in three-hour increments, that it can be messy and difficult, and that sometimes the answer you expect is not the answer you obtain. Second, there are important unanswered questions which can directly benefit other agencies. Many college students believe that it is impossible to make a difference in science without a Ph.D. and a large research laboratory; this is completely erroneous. Third, science is often inaccessible to the public. Service-learning provides an important opportunity for scientists to communicate with non-scientists, and a great training opportunity for our students to learn what conversations about science with non-scientists are like. Fourth, students appreciate the empowerment of knowing that the research they are conducting will be used by someone, and is not just a teaching exercise.

How big should the project be? A wide range of service learning projects can be used. For example, a one-week project to test water quality of the river flowing through campus can be a service project. On the other extreme, spending an entire semester working on one large question can also be a service project.

Here are a few ideas for incorporating service-learning in science courses. Ecology ties in excellently with managing natural areas, identifying important community characteristics, etc. An amazing number of natural area managers have very limited knowledge about the ecosystem that they are managing. Environmental Science classes can extend into service-learning by creating information for agencies to make environmentally friendly changes. For example, a campaign to promote recycling on campus is a natural environmental science service project. Human Health classes can offer massages, dietary analyses, exercise advice, etc.

Challenges to Successful Service Learning

There are some potential obstacles which should be considered before implementing service learning in a science course. Service learning courses often require more hours of effort. Students may feel frustrated when encountering the obstacles inherent in accomplishing tasks and meeting

goals. There is less time to lecture on theory, so students may learn a more narrow segment of the course topic than a conventional class might offer. It is often impossible to allocate work loads evenly, so some students may work more than others. The external agency will have to spend some time working with people at the beginning of the learning curve, and risk having a defective service given to them. Professors also experience some risks. Students may be frustrated with the difficulties of completing service experiences and express their frustration in reduced course ratings. Service learning will require more time and energy than simply dusting off old lecture notes before class. External agencies expect the professor to ensure that a successful product is produced. Finally, the lack of control associated with service learning may expose gaps in the professor's knowledge.

The professor needs to identify a willing agency, and work out plans for the service. The professor is risking her/his credibility by promising to deliver an acceptable product. Finally, the agency needs to understand that some cooperation and effort will be required of them.

Students need to be prepared to shoulder responsibility. The professor must create a sense of group identity to minimize interpersonal conflicts. Students get frustrated when things don't go smoothly, and have been conditioned to expect that scientists always get the right answer the first time they try. Students may not appreciate that the course is still a rigorous one, and be surprised when high expectations are maintained. The professor may not realize how much time it takes students to get up to speed on a project, and how much assistance and encouragement is required.

Students may not have a good work ethic, frustrating the agency. Agencies may not treat students seriously, and students may not treat the agency seriously. In particular, many agencies expect that they are a high priority, whereas if students do not understand the importance of their service learning project they may see it as a low priority item to be done whenever they feel like it.

Universities may challenge the validity of the learning experience. Science faculty in particular frequently have the bias that there is a large set of scientific information that must be taught before any real scientific investigations can be performed. Professors who teach courses for which your course is a prerequisite will worry that your students will not be well prepared for their course. My response is that students retain information more comprehensively, and are also learning how science is done because they are doing science.

Summary

Successful service learning is a triad between students, professor, and the agency being served. The university as a whole can also become involved, and this web of interactions can be tricky to manage. However, while there are potential problems with incorporating service learning into science courses, the benefits can be enormous. Students enjoy active learning, feel empowered by knowing that they are accomplishing something significant, and can more readily understand the connection between theory and example when they are experiencing the example. Furthermore, a service-learning project will enhance a post-college résumé and provide employer-desired experience. There are also significant benefits to the professor. Students generally enjoy the course more and thus are more likely to rate the class highly. Service-learning projects avoid lecture-related boredom and stagnation, force relevance, and refresh and update conceptual skills.

The external agency receives an act of direct benefit. Alice James, Director of Wesselman Woods, summed up many aspects of the service-learning interaction in an email to me, in which she stated " ... We are seeing a few flowers that we haven't seen in a while, in any number. Jack in the Pulpits everywhere. Even have some Sweet Cicely which the deer usually have decimated to nubbins. There are still way too many deer here but we put a dent in the herd. Invasive Plant Control is doing a great job with the honeysuckle already and they were only here a few days this winter. They are coming back tomorrow through Friday for the big kill. We sure do miss you Eric. That stuff you sent was awesome. I've read through most of it ..." My service-learning experience with Wesselman Woods involved managing the deer herd, reducing invasive plant species, and compiling and summarizing the student-gen erated data which is a major part of my analysis of Wesselman's ecology. Therefore, from the agency's viewpoint this was a successful project.

A student told me that one reason he was offered a job after graduation was that when he was asked in his job interview if he had ever managed a project he was able to describe how he coordinated efforts of students in one of our large class projects. However, perhaps the best reason for incorporating service-learning into Ecology courses is described by one student who took my revised Ecology course. She wrote "I worked harder in this course than I have in any other course, but I didn't really notice how much work it was because it was fun." From the student standpoint this experience provided effective job training and presented the conceptual information they needed to learn in Ecology within an enjoyable umbrella of service-learning activities.

While I greatly enjoyed the entire service-learning experience, and appreciated the increased scores on my student evaluations, for me the most important benefit of the service-learning component was the opportunities I had to make a difference, both for Wesselman Woods Nature Preserve and for my students. I contributed to Wesselman Woods by concisely summarizing all of the various pieces of information about its ecology and by advocating for deer herd and invasive plant reductions. But ultimately service learning should be about enhanced teaching. I have found that service-learning within a course shifts the professorial role from the "fount of information" lecture mode to a mentoring mode, as I shift from a gatekeeper to a facilitator. I had many interactions with my students in which we focused on figuring out how they could accomplish a task or reach a goal. This shift is both exciting and humbling, because the end product reflects the students' work more overtly and the professor's work more subtly.

References Cited

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