

# Applying Ecological Principles On the Job

## Engaging Students in Authentic Environmental Projects

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Students have traditionally been drawn to ecology programs because of their interest in natural history and their desire to make a positive contribution to ecological causes. However, the strong intrinsic motivation that attracts students to the study of ecology is frequently ignored in curriculum planning, which typically provides students with few opportunities to engage in authentic ecological projects.

We believe that this oversight is rooted in several reasons. First, ecology is a complex subject. A large number of courses from varied disciplines are required to fulfill even the minimum requirements for most undergraduate programs. Consequently, the perception is that there is little room left in the curriculum for practical work. When there is, it is often in the form of a self-directed honors thesis that emphasizes research abilities rather than the multifaceted problems associated with contemporary ecological issues.

Second, many instructors tend to “cover” the material presented in course textbooks. Although most ecology texts are well designed in that they provide examples to illustrate concepts, the examples used are not native to environments familiar to many students. The un-

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*The authors have developed a course that requires students to work in groups to address a local ecological problem of interest to a client external to the university. Students learn the skills needed to apply their knowledge and gain the satisfaction of assisting others. For educators, the ecological projects provide an important source of feedback to identify the strengths and weaknesses of the curriculum.*

fortunate outcome is that students learn ecological principles, but do not appreciate the full relevance and importance of their knowledge to the local environment.

Based on these observations, we developed a course designed to require students to use their ecological knowledge on a current, local ecological problem. The intent of this course was not to provide students with additional skills or knowledge about ecology, but rather to provide a capstone course that challenges students to apply what they have learned over the course of their entire program to address a problem (Atchison 1993).

In this article we describe the original plan for the course, some of the teaching and learning experiences in implementing that plan, and the modifications we have made based on these experiences.

### The Course

The course is a dual-track graduate/undergraduate course designed to provide students with the opportunity to work on a contemporary ecological problem of interest to a client external to the university. We believe our use of applied projects to be unique, however, since the students were not simply accountable to their instructors, but also to their peers and an agency external to the university.

In the first cycle of this course, the graduate and undergraduate tracks were distinguished by responsibilities to the project and by the degree of independence expected in carrying out these responsibilities. At the graduate level, each student was assigned to be the project leader for a different team of five undergraduate students. Project leaders were not required to do the work necessary to complete the project, but were required to manage the project by guiding their undergraduate team in developing a project management plan, identifying the tasks required, setting priorities, scheduling tasks, modifying the plan as needed, and meeting deadlines.

At the undergraduate level, students worked in teams of five to share the responsibility for completing the project as planned with their external client and the graduate student project leader. Teams were selected after we reviewed brief summaries of skills and expertise submitted by the undergraduate students.

We solicited and received two projects from agencies external to the

### ONLINE EXTENSION

To view the authors' original and revised outlines for the course described here, NSTA members can visit JCST's web site at [www.nsta.org/pubs/jcst](http://www.nsta.org/pubs/jcst).





*Students at the University of Manitoba address current ecological issues in their local environment, such as this riparian zone along an unlogged creek in central Manitoba, Canada.*

university. The first project required the group to review literature and make a recommendation on the establishment of buffer zones around riparian habitat. The second project required the development of an assessment plan for monitoring a tallgrass prairie reclamation program. Although the general parameters of the projects were established by the professors to ensure their suitability for the course, the specific contracts for the projects were negotiated between the clients and each project team.

In preparation for their project management responsibilities, the graduate students enrolled in the course participated in a workshop on project management led by one of the authors (KLT). This workshop, based on Randolph and Posner's (1992) guidelines for project management, was designed to introduce the graduate students to managing a group of people and the skills necessary to develop and implement a project management plan.

### Anticipated Challenges

Despite considerable planning, we anticipated two major challenges in implementing our plan. The first was time. From the outset, we knew students would be faced with a very tight schedule if they were to complete their project successfully within a 13-week term. Our approach to dealing with this problem was to have students work in teams of five individuals closely supervised by a graduate student. The course was structured so that the first five weeks were spent developing effective group processes and defining the individual projects. Then, under the direction of their graduate student leader, each team was to develop a project plan that would allow them to complete their work in the remaining eight weeks of the course.

In this eight-week period, the role of the graduate student was critical. It was the responsibility of the graduate students to meet at least once a week with their teams to review progress, consolidate ac-

cumulated work, make any modifications necessary to the project plan, and determine specific goals for the upcoming week. On a pragmatic level, the project team approach meant that the work could be shared in a time-efficient way. From a pedagogical perspective, working in teams would promote discussion of relevant knowledge and procedures, thereby facilitating the selection, synthesis, and evaluation of the students' collective knowledge (Smith and MacGregor 1992).

The second anticipated challenge was how students would be graded. Decisions about grading procedures were based on the course objectives. Since we emphasized producing a finished team project for a client, the grading scheme included an assessment of project quality by the professors and the clients and the contribution of each student to the team's effort as assessed by other students (Mathews 1994), the graduate student leaders, and the professors. The following grading schemes were used:



A wetland in Manitoba adjacent to a logged forest. As part of their studies, students make recommendations to improve such ecologically fragile areas.

#### Undergraduate:

- ♦ 40%: the professors' evaluation of the team project X the average peer evaluation, e.g., a team project grade of 34 X an average peer assessment of 93% of the normal work load = 32).
- ♦ 40%: each individual's contribution to the project based on weekly log sheets provided by students and structured activity reports submitted by the project leaders.
- ♦ 20%: awarded by the client who solicited the work based on how well he or she thought the students had met their contractual obligations.

#### Graduate:

- ♦ 100%: awarded by professors and client based upon student's ability to produce a final product (both oral and written) and its quality.

#### Student Perspective

In addition to data from weekly activity logs and three peer evaluations conducted in the course, students completed a course evaluation questionnaire, provided in table 1, at the end of the semester. In all the data sources, students expressed similar themes, which were: the learning value of the course and recommendations for changes to the course with respect to learning challenges experienced, professor-student interactions, and course structure.

#### Learning Value

In their open-ended comments, six students indicated that the course was a "valuable learning experience." In particular, five students reported that the course was a "finishing course to help better prepare us for the real world" by providing work experience in a professional setting and networking opportunities. They also felt that they learned from working as part of a team and from writing a professional-style report.

#### Learning Challenges

The learning value of the course did not always come easily. Across groups, seven

students were hampered by the few opportunities to receive feedback on their course grade and on how their projects were developing. Another widely reported impediment was the intense time crunch experienced at the end of the course. This difficulty is evidenced in the workload profile (table 1), in the hours logged on a weekly basis in the activity reports (fig. 1), and in comments such as "a massive rush at the end."

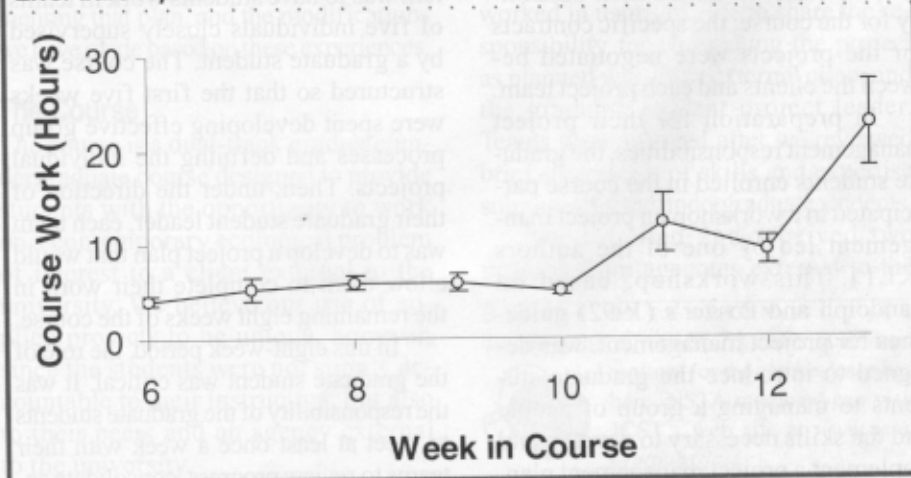
Two students identified their lack of experience with working in groups as a challenge. In one of the groups, the lack of clear objectives was a significant problem, as illustrated in the comments of one student: "I feel that we went in a thousand different directions looking up everything under the sun for about a month after we found out what project we were working on. This left us pressed for time by the time we got focused [on] where we were going with it."

These perceived challenges are reflected in the recommendations students made for modifying the course.

#### Professor-Student Interactions

Across groups, eight students expressed a strong need for more direct interactions with professors over the course of their projects. Their written comments were supported by their consistent requests for more input from faculty in determining the original direction of the projects (table 1). Students also reported that they experienced conflicting advice from the client, the graduate project leader, and

Figure 1. Person-hours spent on the projects based on student self-reports. Error bars represent one standard error.





the professors, and felt it was the professors' expectations that would have to be met in the end. Under these circumstances, they wished to consult with the professors directly.

### Course Structure

Students also made a number of suggestions for modifying the structure of the course that would address student concerns and optimize learning. In their open-ended comments, seven students recommended consolidating the first four weeks of the course to permit an earlier start on the project. This suggestion was also supported by their low rating for the usefulness of the early class sessions in preparing for the project (table 1). A second widely supported recommendation was for more specific feedback from professors during the term.

Six students expressed concerns similar to one who wrote: "The biggest concern I had about the course was that we thought things were going along fine, and then about nine days before our final presentation, [both professors indicated] we hadn't done what was expected of us throughout the course. More ongoing feedback in terms of marks is required so that students will know where they stand."

Because time was an issue throughout the course, students were asked for their views on reasonable time commitments to the course (table 1). Students suggested more than one meeting per week, especially in the second half of the term, for a total of three-and-a-half hours of meeting time per week. Their recommendations for time spent in addition to meetings was approximately seven-and-a-half hours per week. Unlike most other responses, which demonstrated little variation across students or groups, their suggestions for time spent outside of group meetings varied from two to 20 hours. This variation in expectations indicates an area that needs to be explicitly addressed in future cycles of the course. Less dominant themes in the students' recommendations included more frequent peer evaluation and more extensive use of library skills.

## The Professors' Perspective

### The Product

Student groups were required to prepare a written document for their client and to

make an oral presentation at the client's workplace. Consequently, the last three weeks of the course were devoted to preparing and revising written and oral presentations to the clients. This aspect of the course was very successful. Both clients were extremely pleased with the written documents and the oral presentations. In particular, they noted that these were the best student presentations they had seen, and they placed a high monetary value on the work provided by these groups. A number of students commented that the oral presentations were the highlight of their student careers, and that they appreciated the emphasis on "getting their work right."

group members reported receiving confused messages from clients, project leaders, and professors. Clients did not clearly describe the focus of their projects yet were agreeable to most suggestions provided by group members. These sometimes ad hoc conversations resulted in new agreements that contradicted what the group understood as its original focus.

In addition, the graduate students tended to lose their management focus and became overly involved in the day-to-day work of the projects. As a consequence, they sometimes lost sight of the group's plan for the project. The professors unintentionally compounded the

**Table 1. Mean Responses on the Students' Course Evaluation**

Evaluation Item	Group 1	Group 2	Combined
On a scale of 1-10, how well did your previous courses prepare you for the work performed?	5.2	5.1	5.2
On a scale of 1-10, how useful were the introductory lectures in preparing you for group work?	1.4	1.4	1.4
On a scale of 1-10, how much input should faculty members provide in the determining the original direction of the project?	7.2	7.6	7.4
On a scale of 1-10, how did the workload of this course compare to other courses during the first four weeks of the term?	2.0	2.8	2.4
On a scale of 1-10, how did the workload of this course compare to other courses during the last four weeks of the term?	10.0	9.4	9.7
On a scale of 1-10, how did the workload of this course compare to other over the whole term?	8.8	9.0	8.9
Ideally, how many times a week should a group meet?	1.7	1.8	1.8
How many hours per week should be spent in group meetings?	3.5	3.5	3.5
How many hours of work per week should be done outside the group meetings?	7.4	7.5	7.5

The quality of work produced is reflected in the clients' early use of the reports. One document has now been distributed as a reference source. The work of the other group was presented at a national conference to illustrate the value of collaborations with universities. From the product perspective, the course was a success.

### The Process

From a process perspective, there were challenges. During the post-course review,

confusion when they tried to assist the groups through their problems by making suggestions that were often not consistent with recent conversations between the client and group members.

Toward the end of the course it was clear that the plan to distribute the workload as evenly as possible throughout the term did not work (fig. 1). One group suffered serious computer problems, resulting in the loss of their document and several weeks of work. The second group had difficulty developing a



*Students also consider damage done to tallgrass prairie. This mock air disaster by the Canadian Air Force resulted in soil compaction from the presence of the heavy machinery and damage from the use of fire retardant chemicals in the exercise.*

focus for their project and experienced some internal group difficulties.

With respect to grading, student feedback and our own experience indicated several areas of concern. Our use of peer evaluations to modify the project mark for individual students meant that we did not assign students accurate grades during the term. This lack of feedback resulted in some surprises when students received their final grades. We were also dissatisfied with the fairness of some students' peer reviews. These concerns, together with feedback from the students, formed the basis for revisions to the course.

### **Modifications for Future Offerings**

Based on the teaching and learning experiences in the first cycle of the course, we propose to modify the ways project requirements are communicated, the structure of the early part of the course, the management framework provided

for graduate students during the course, and the evaluation procedures.

### **Defining the Projects**

A fundamental change to this course will be to make information about individual projects available to students earlier in the course. To do this, each graduate student team leader will meet with a client well in advance of the course start date. At these meetings, the graduate student will be responsible for negotiating a contract that clearly identifies the boundaries of the project.

The client will then be asked to sign off on this agreement so that each group will have a clear indication of the nature of their project from the first week of the course. Clear expectations will also reduce the frequency of communications with the client and will encourage both the students and the clients to conduct any communication within the

context of a clearly outlined project agreement. These modifications are intended to minimize multiple understandings and variations from the original project plan.

### **Course Timetable**

To simultaneously increase the time available to complete the project and ensure that students use the library effectively, the structure of the course will be modified to streamline the project start-up timetable. First, the client presentations will take place during the first class, based on the agreements reached with the graduate project leaders. In addition, we will require students to submit outlines of their expertise in advance, allowing groups to be formed during the first class.

The second class will involve working on a group library exercise relevant to their assigned projects. This will encourage effective use of the library, pro-



mote coordinated group activity, and provide an opportunity to give groups feedback on their performance earlier in the course.

In addition to addressing several concerns raised during the first cycle of the course, this modified schedule will reclaim three weeks within the course for work on the project. While we have eliminated the original group-building exercises, our students indicated that their groups worked best when they were engaged in their assigned projects and meeting real deadlines, and the revised schedule would provide this motivation at an earlier point in the course.

### Project Management

Effective project management by the graduate students is critical to making this course work smoothly. To assist the graduate students, we have scheduled more explicit benchmark points in the course schedule. To motivate their teams to meet benchmark deadlines, each graduate student will assign a portion of the process grade to the performance of each individual in the group. This additional evaluation feedback will allow students to have some leverage in their expectations that assigned tasks will be completed each week.

### Evaluation Procedures

Receiving feedback during the term was a major concern of students in the first cycle of the course. In future offerings, group members will receive grades associated with some of their ongoing activities, such as the library assignment or weekly activity reports. In addition, the project leaders and the professors will conduct a midcourse review worth 20 percent of the final grade. As with their final evaluations, the midterm evaluation will include a peer evaluation of each group member to determine an individual midterm grade for students. In this way, students will have a good idea of their performance levels and of whether their work meets the expectations of their peers.

It is also important that the distinct role of the graduate student as a project manager be clearly defined and formally recognized in the grading process. To do so, we plan to assign a formal grade to a detailed project management plan outlining specific goals and how the group is going to achieve these goals, and to the graduate

student's performance in implementing the plan. Furthermore, we will extend the peer evaluation concept by requesting that group members use a set of clearly stated criteria to evaluate the project management of their graduate student leader. Across all peer evaluation situations, students will be required to justify the grades they assign.

### Conclusion

While the first offering of this course presented some challenges, the teaching and learning experienced were worthwhile. Swinehart and Morse (1995) have noted that applied ecological problems are a valuable means of getting students to apply scientific principles. From a practical point of view, this course provided students with opportunities to apply their knowledge and skills outside the university in an environment similar to that in which they might ultimately work, and to make contacts that may prove important in establishing their careers.

From a teaching and learning perspective, the course demanded higher-level cognitive skills, including application, analysis, synthesis, and evaluation, in a collaborative and active-learning environment. This approach encouraged deep rather than superficial learning (Dunkhase Pennick 1991; Tribe 1994) on the part of both students and professors. It also exposed students to the use of science in dealing with real problems and some of the difficulties they can encounter (Fenton et al. 1996).

In addition to academic objectives, the course was designed to help students develop transferable skills, such as oral communication, teamwork, initiative, and professional report writing, that are highly valued by the employment community (McNally 1994; Yasso and Morgan 1991). This kind of learning experience exposes students to high expectations, using different learning styles and talents, synthesizing learning experiences, integrating education and experience, engaging in active learning, and collaborating with others (American Association for Higher Education 1996).

Apart from the benefits to the students, courses like this one also aid curriculum assessment by helping to determine whether students have developed the necessary knowledge and skills to meet

the demands faced by contemporary ecologists. From all of these perspectives, the first cycle of the course provided valuable learning and teaching experiences, and we look forward to implementing revisions to enhance learning in the future.

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