PROJECT REPORT

# Mud, Muck, and Service

## Action Research on Direct and Indirect Service Learning in Ecology

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## Introduction

As service learning (SL) becomes more prevalent in university courses, the relative proportion of courses in the scientific disciplines has not kept pace (Furco, 2001). In many cases, an understandable challenge is simultaneously introducing a thorough, often rigorous, canon of new material while working to provide opportunities for students to apply that material to issues in local communities (Sherman and MacDonald 2009). The premium placed on expertise in scientific endeavors, especially those that can address local issues with sufficient depth, tends to limit students' abilities to contribute through their academic knowledge until upper-level courses (Reardon, 1998). And, by that point in their academic careers, many science students are dedicated to preparation for professional or graduate schools that demand further material and time that dissuades instructors from embarking on the endeavor (deKoven and Trumbull 2002). This said, there have been numerous excellent examples of SL successfully applied across a wide variety of science and engineering programs (e.g., NSTA 2009; Draper 2004, Haines 2003). Thanks to these efforts, and honest recognition of the challenges, there is no reason why the sciences cannot increase the prevalence of these opportunities for students in the future (Deegan et al. 2009). Most important to the concept of SL, these opportunities represent not distractions from other requirements, but enhancements to existing curricula.

In this context, ecology and environmental sciences have traditionally offered the greatest opportunities for SL in the sciences (Leege and Cawthorn 2008). Due to the identifiable needs in local communities for work on multiple types of environmental issues, there is much support for collaboration from potential community partners (Brubaker and Ostroff 2000). There is often considerable enthusiasm from students in these courses who often arrive with volunteer experiences or dedication to environmental causes. In some cases, the challenge for ecology courses becomes identifying the most fruitful collaborations for SL that can be most effectively blended with the course material beyond caring for the environment in a general way. A true benefit of these collaborations is the establishment of long-term relationships that can lead to real progress addressing critical local environmental issues.

The focus of this action research was to test the viability and contributions, defined broadly, of two types of SL incorporated into the ecology course at Seattle University.

### *Project-based Service-learning Model in Ecology*

An effective SL approach for the ecology course is the project-based model because it enables students to provide community partners with useful data and research reports while retaining greater ability to provide advice to students on research methods. The project-based SL model involves students working together, often in teams, on a small set of activities with a small set of community partners. These projects sometimes have time constraints during the course to enable more than one project. The goals of these projects are often specifically defined through collaboration between the community partners and the class. In other courses, the placement-based approach is highly effective, where students can individually manage time and relationships with more community partners associated with a course. The technical requirements associated with learning ecological field and laboratory tools and techniques places a premium on insuring students receive sufficient advising. These technical requirements are also important because the projects' goals are defined through identifying potential overlaps between community partners' research needs and student research capabilities. In addition, by focusing the students on two research sites, students have the opportunity to conduct research that is comparable amongst other class members.

Two approaches to service learning in ecology were compared through courses that employed indirect or direct models (Coomey and Wilcenski 2005; Kaye 2004). Indirect SL in the sciences frequently involves data collection by students to be shared with a community partner, with the data often being useful but not essential to the partner, given the students' level of research experience. Direct SL in the sciences can involve students working hand-in-hand with members of the community to expand the data collection experience into opportunities to interact and learn more immediately the purpose of their work (e.g., CSU 2010; OSU 2010).

### *Indirect Service Learning in Ecology*

The indirect model of SL in this course involved students providing data and research reports to the community partners, but interactions with the partners was limited to initial site visits. The primary research sites for the course are Seward Park and the Duwamish River, and community partners have been willing to collaborate on finding appropriate projects for ecology students. The indirect model was utilized in fall and spring quarters.

Seward Park is a remnant Pacific Northwest old-growth forest in southeast Seattle. Our community partners are: Seattle City Parks and Recreation (Urban Forestry), Washington Audubon (Environmental Learning Center), and Friends of Seward Park (a neighborhood group). All three partners have significant interests in forest restoration, and collaborate with one another on projects throughout the park. Through conversations with these partners, they identified the valuable products from ecology student research to be increased understanding of the forest dynamics and baseline assessments of sites prior to restoration projects. Hence, students were encouraged to explore widely in their ecological hypotheses. Completed research reports and data were delivered to the partners.

The Duwamish River is a significantly altered waterway encompassing the Port of Seattle and an EPA Superfund site in south Seattle. Our primary community partner is People for Puget Sound (PFPS), who manage several marsh restoration sites along the lower river. Similar to Seward Park, conversations with PFPS identified valuable student research on increased understanding of river dynamics. Of particular importance for student projects were quantifying pollution levels across habitats and organisms and assessing the success of the restoration efforts in the marshes. Students were again encouraged to explore widely, and many of the marshes had nearby restored and unrestored areas ideally suited for ecological comparisons. Completed research reports and data were delivered to the partners.

To expedite sharing student reports and data, the ecology course has a public website with links to the community partners: Seattle University Creative Collaboration on Terrestrial and Aquatic Scientific Hypotheses (SUCCOTASH) . The site allows students to share their work with the partners and the general public. All the reports are organized by quarter with downloadable pdfs.

### *Direct Service Learning in Ecology*

The direct model of SL in this course involved partnering with Summit High School, an alternative K-12 school in the Seattle School District, to guide high school students in participating in research projects designed by the ecology students. The direct model was utilized only in spring quarter.

Through collaboration with the science teacher at Summit, we generated a plan for having our students work together. After the ecology students initially visited the Duwamish River sites conducting class research projects, they proposed individual research projects as in fall quarter. In this case, their proposals were organized to form five teams made up of students with similar research projects. Then, the initial visit to Summit High by the ecology students involved introducing the high school students to the Duwamish, and describing the five research teams they could work with. By the second visit, the high school students had selected their preferred research teams, so the college students introduced their new colleagues to the research tools and methods they would be using in the field. The third week of the collaboration was an all day field research session at one of the marsh sites, where the teams worked on their projects, collecting and analyzing multiple samples. Afterwards, our partner from People for Puget Sound guided an additional invasive plant removal and shore clean up activity. For the final visit to Summit, the ecology students brought laptops with the team data, and each team worked together to give presentations on their results.

## Methods

To evaluate the contributions of service learning in an ecology course, the course was compared between two quarters: (1) Fall quarter 2007 when the SL component was solely the indirect model, and (2) Spring quarter 2008 when the SL component included both indirect and direct models. Responses to a pre- and post-course survey, grades, and written feedback were used to compare these courses.

### *Ecology Course Overview*

Ecology is offered in the Biology Department and is a requirement of all biology majors. It also meets a course requirement within the environmental studies major. Hence, all of the students are from these two majors, and most of them are seniors. The class size is kept small because of equipment availability, access to sites, and intensity of research and advising. Due to this, the course is offered every fall and spring.

While the syllabus is modified for improvement routinely, the course follows a similar structure every quarter. During the three one-hour lectures each week, major concepts in ecology are covered. The concepts were the same for the quarters compared. During the four-hour laboratory every week, students have the opportunity to learn ecological field techniques, and then apply those techniques with concepts from lecture to generate hypotheses to test through individual research projects. The first lab of the quarter is often introductory, with research on campus and an opportunity to learn appropriate data analysis procedures. Generally, three weeks are spent at each field site, with the first week dedicated to introducing methods and tools through a class research project, and the second and third weeks for individual projects. The last lab of the quarter is the symposium where students present talks in the form of scientific conferences on one of their individual research projects. If there are remaining weeks in the quarter, those labs are dedicated for analysis of collected samples or data.

There are four major assignments in the course. The students submit research proposals for each independent project that must include a specific hypothesis, methods, and relevant background. After each project, students submit research reports in the form of manuscripts for major ecological journals. Students select one of their projects to present at the symposium, and submit their presentation in electronic form. Students complete a natural history project describing ecological information on ten species at a local site. In addition, there is a midterm and final exam.

### *Differences between Quarters*

During the fall quarter (n = 15), the indirect SL model was utilized. During the spring quarter (n = 17), both the indirect and direct SL models were utilized. In addition, there were other aspects of the fall course that differed from the spring. Every Friday lecture session was dedicated to discussing relevant ecological papers, and teams of students rotated through responsibility for guiding discussion. After the first research paper on Seward Park forest ecology was submitted, students participated in a thorough peer review process where each student anonymously reviewed two papers, and those reviews were graded. In spring quarter, paper discussions were superseded by visits to Summit High, and insufficient time was available for peer reviewing.

### *Pre-course Survey*

On the first class day for both courses, students responded to a set of questions designed to determine their prior knowledge and interests in a set of topics related to course material and upcoming work (see Appendix). The initial questions identified the student's major, year in school, and reason for taking the course. The remaining questions asked students to evaluate themselves on a scale from strong (5) to weak (1) on their backgrounds, understanding, and interests. The first set of questions focused on ecology and biology, in general. This set was intended to determine the class' incoming knowledge. The second set focused on research, field research, and independent research. This set was intended to determine the class' incoming perspectives on research. The third set focused on service, natural history, writing, and communication. This set was intended to determine the class' broad prior experiences. Mean values for each question were calculated per class.

### *Post-course Survey*

On the last day of class for both courses, students responded to the same set of questions as the pre-course survey. The questions on ecology and biology background were removed since the goal was no longer to establish prior perceptions but any changes in understanding or interests. Mean values were again calculated for each question per class. Also, mean differences in values from pre- to post-course surveys were calculated to determine whether understanding or interest in the array of topics and concepts had increased or decreased. By comparing the changes in mean values of understanding and interest between fall and spring quarters, this approach enabled a measure of the contribution of direct SL to the course.

### Grades

Final grades from fall and spring quarters were compared by examining differences in the grade distributions across all students in the classes. While direct SL may not be focused specifically on improving grades, ultimately they are the measure by which students are formally evaluated. Hence, this comparison could enable another measure of the contributions of direct SL. Also, mean numeric grades on specific assignments were compared between quarters. These assignments were selected based on the differences in field research experiences due to involvement of the Summit High class and the time dedicated to that activity versus alternative writing exercises.

### Feedback

While the survey form requested additional feedback comments, a more successful approach for generating feedback on the Summit High direct SL activity was provided by their teacher. Her survey asked the SU students to rate the project from excellent (5) to poor (1) across an array of components: enjoyment of overall project content, clear project guidelines, interaction with Summit students, field trip, educational experience, organization, and preparedness. The results from this survey enabled assessment of spring quarter students' opinions on the direct SL project. Also, the survey asked for three highlights or suggestions from the students, and these were interpreted. In addition, a separate survey asked four questions of the Summit students: (1) describe why you selected this SL experience; (2) describe the activities that you participated in during this SL experience; (3) what did you learn from the SL experience? (4) describe how you made a difference in the lives of other people. Through this survey, the value of the SL project for the Summit students could be interpreted.

### Statistics

Survey results and grades were compared between the fall and winter quarters to examine differences in student perceptions and performance associated with experiences in indirect and direct service learning. To analyze perception differences, mean responses on the survey scale (1–5) were compared for each question between quarters using Analysis of Variance (ANOVA) with academic term and question as fixed factors to enable comparisons both across terms and among questions. Tukey post-hoc comparisons were made where appropriate. To analyze performance differences, mean grades on five assignments were also compared between quarters using ANOVA. Frequency distributions of final grades between quarters were compared using chi-square analysis.

## Results and Discussion

### Pre-course Survey

Results from the pre-course surveys show similar backgrounds, understanding, and interests among the students in fall and spring quarters (Figure 1). Students indicated they had relatively little background and understanding of ecology, but higher interest. In a similar vein, they had less background

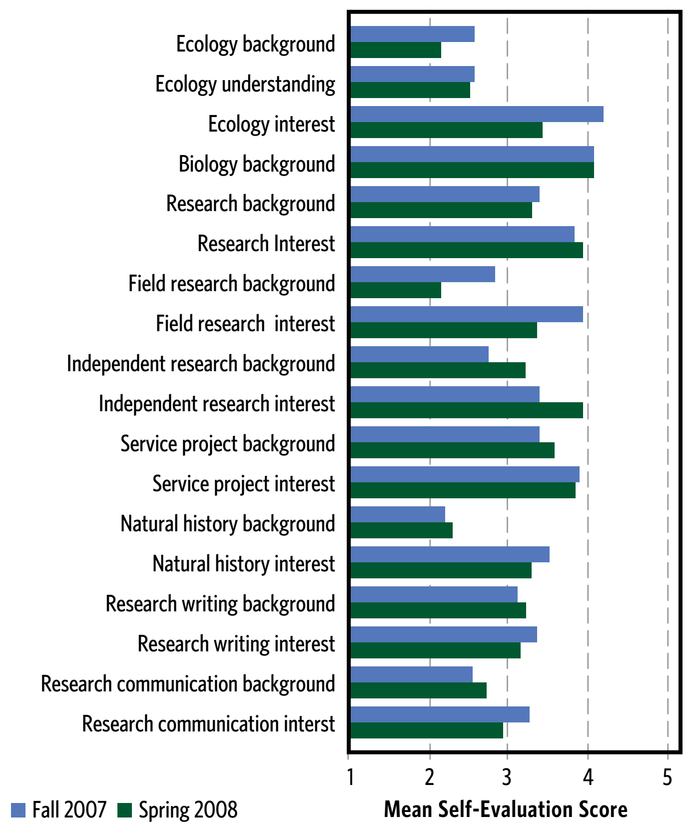


**FIGURE 1. Similar results in pre-course surveys of backgrounds, understanding, and interests between fall and spring quarters. (5 = strong, 1 = weak; Fall n = 16, Spring n = 17)**

in field research and natural history than other elements, yet they had high interests. Taken together, the positive is the students' enthusiasm for the course, despite being required, and the reality is they lack ecology concepts and skills coming in. This lack of background material reflects a challenge faced when utilizing SL in science courses. The only statistically significant differences between terms in the pre-course survey were in ecology interest (ANOVA, $p < 0.05$) and field research background ($p < 0.05$), with both higher in fall term. Overall, the pre-course survey suggests the two quarters began with similar student characteristics, enabling differences in post-course surveys to be based on course content potentially more than student tendencies.

### *Post-course Survey*

Results from post-course surveys show differences in understanding and interests among the students in fall and spring quarters (Figure 2). In the majority of categories, spring quarter students indicated greater understanding and interest than fall quarter students. Students who experienced direct service learning by working with high school students on research projects had greater ecology understanding (ANOVA, $p = 0.059$), research interest ($p < 0.05$), field research understanding ($p = 0.054$), service project understanding ($p = 0.052$), service project interest ($p = 0.055$), and natural history understanding ($p < 0.05$). While by no means conclusive, this suggests that participation in direct SL may have enhanced the course experience for the spring students. To examine more closely changes in student perceptions, the difference between pre- and post-course values were calculated.

Results showing changes from pre- to post-course reinforce spring quarter students indicating higher understanding and interest, and illustrate categories where the change was greatest (Figure 3). Overall, the majority of categories demonstrate increases in understanding and interest, hopefully reflecting that the course helped the students learn and increase their enthusiasm for ecology.

Student responses suggest interest in ecology increased slightly, but understanding increased greatly both quarters,

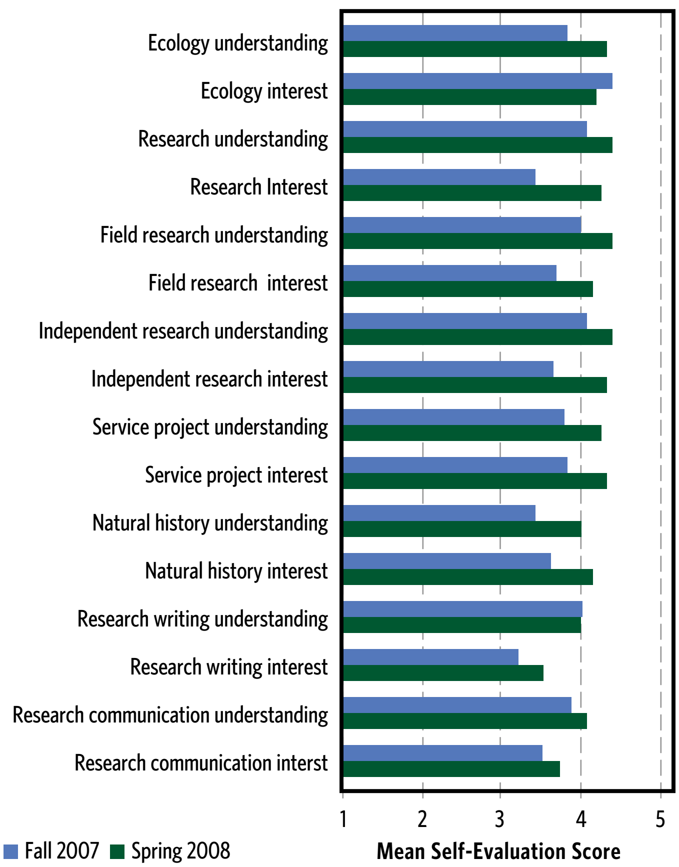


**FIGURE 2. Differences emerge in post-course surveys of understanding and interests between fall and spring quarters. (5 = strong, 1 = weak; Fall n = 16, Spring n = 17)**

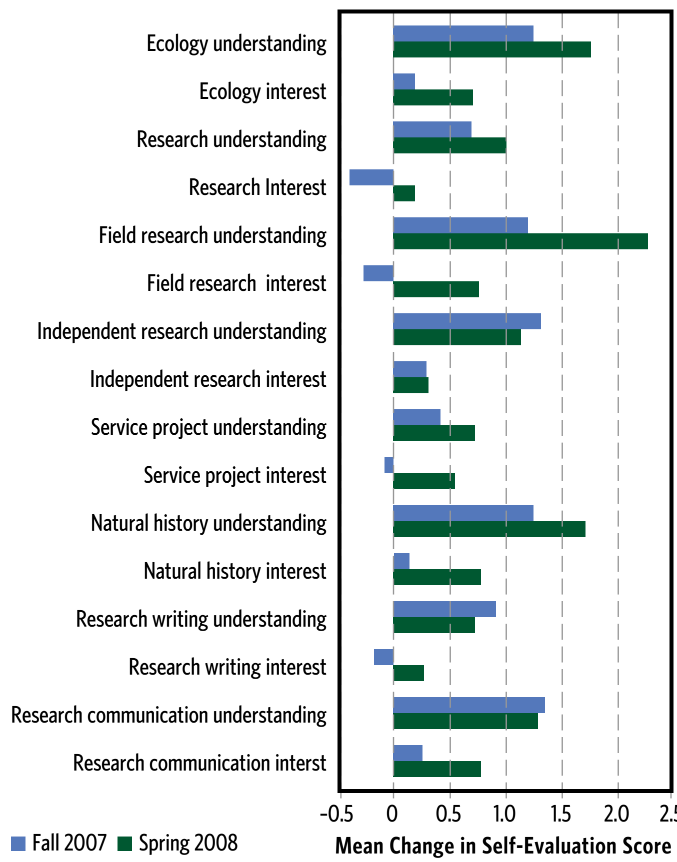


**FIGURE 3. Differences in understanding and interest between pre- and post-course surveys. Overall, both courses increased understanding and interests. There are some differences in the magnitude of increases between Fall and Spring quarters. (Fall n = 16, Spring n = 17)**

with an even greater increase in the spring (ANOVA, $p = 0.166$). While sparking interest is a goal of the course, generating greater understanding is more so, and the potential for direct SL to further increase that understanding is exciting.

Regarding research, understanding again increased more than interest in both quarters, but change in research interest was higher in spring ($p < 0.05$) potentially due to lower values in the pre-survey. The most substantial differences between quarters were in field research understanding ($p < 0.005$) and interest ($p < 0.05$), and there exists the possibility that the direct SL where the students had to guide the high school students through all the aspects of ecological methods may have strengthened that understanding.

Not surprisingly, service project understanding and interest had greater increases where students participated in direct compared to indirect SL (understanding: $p = 0.252$, interest: $p < 0.05$). The indirect model is certainly valuable, and in some ways logistically easier, but the direct model required greater investment by the students. That said, there were a number of occasions over the course of spring quarter where the students seemed to lack real investment in the high school activity. Due to the timing of the visits to Summit, there were a number of students who could not or did not make the effort to join us. While there was always a representative from each team, there was a distinct lack of continuity, and this was noted by the high school students and affected team dynamics. All ecology students did prioritize the all day field event, which was by far the most important element of the SL project, but future courses must identify ways to increase student investment and identify appropriate incentives or requirements.

The two categories where changes in understanding did not differ between quarters were research writing and communication. In fact, writing understanding increased more in the fall, and this may very well be due to the peer review process used in fall but not in spring. In official university evaluations, multiple students commented on the usefulness of the peer reviewing in the fall, as well. Peer reviewing was sacrificed during planning for spring due to lack of sufficient time for reviewing given other commitments to the Summit High project. This reflects the challenge of courses having zero-sum syllabi. Despite the laudable goals of both peer reviewing and SL, it is a challenge to fit both, and if the structure were altered something else would have to give. The lack of differences in communication may be related to writing, since fall students incorporated peer suggestions not just into their reports, but also their presentations. Though, the greater increase in communication interest by spring students may reflect their experiences having to communicate concepts guiding the high school students. By garnering feedback from the students and their achievements, the decisions on syllabi can be made more systematically.

### *Grades*

Final grade distributions among students in fall and spring quarters were similar (Figure 4; Chi-square $p = 0.497$). The experience with direct SL and the absence of other elements did not appear to dramatically affect final course grades.

Mean assignment grades did appear to differ somewhat between fall and spring quarters (Figure 5; ANOVA $p < 0.001$). Related to comments above on the peer review process in fall quarter, the slightly higher grades on the peer-reviewed paper (Seward) should not be surprising. Higher grades on the Duwamish paper may be attributable to increased writing acumen due to the overall peer review process improving the second paper as well. The higher grades on the final in spring compared to fall are surprising ($p < 0.001$), but it is difficult to attribute the direct SL experience compared to other factors as a primary cause for better exam grades.

### *Feedback*

The spring ecology students indicated they found the direct SL experience with the Summit High students to be overwhelmingly positive (Figure 6). From the feedback survey, students seemed to find the project enjoyable, well planned,

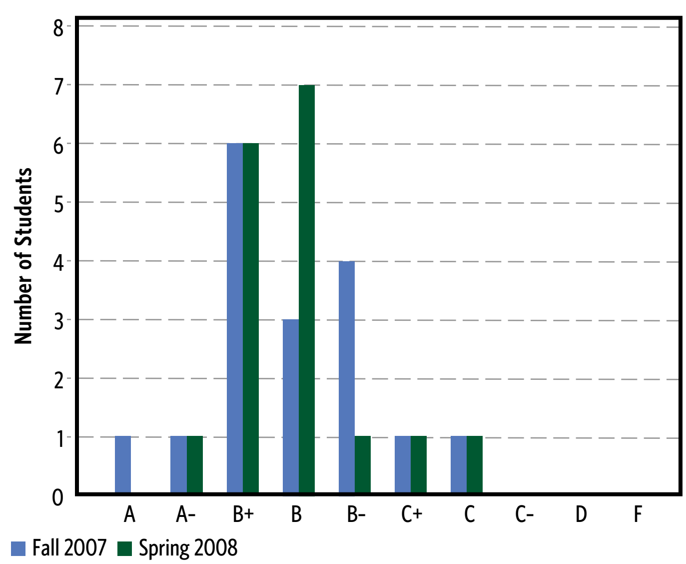


**FIGURE 4. Similar grade distributions between fall and spring quarters (Chi-square p = 0.497; fall n = 16, spring n = 17).**

educational, and rewarding to interact with the high school students.

Additional comments from ecology students focused on: the Summit students' enthusiasm, the worth of sharing and presenting the final data analysis, and gaining an appreciation for teaching. Suggestions for next time include: more variety in projects, adding laboratory work, increasing time for interactions among the students, and giving more suggestions for how to continue helping out in the community.

The feedback from the Summit students provided an opportunity to assess what they learned from the ecology students and the whole experience. The Summit students enjoyed having the opportunity to interact with college students, since these students at an alternative high school do not normally get to do so. Summit students mentioned the techniques and tools they learned to use, and a greater awareness of the condition of the river with implications for public health. Impressively, some Summit students' comments indicate their understanding of the connections among organisms and habitats, and the value of restoration efforts.

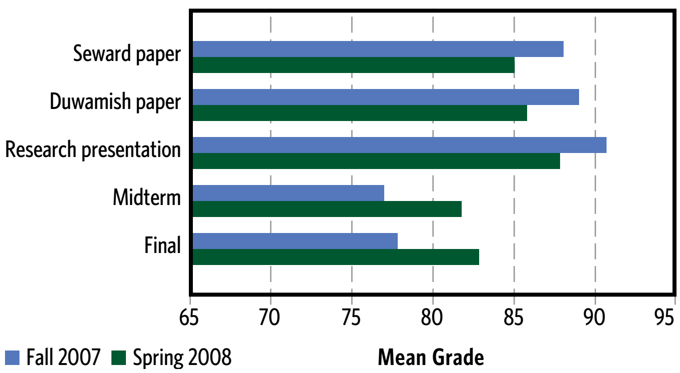


**FIGURE 5. Grade differences between quarters on research papers, presentations, and exams (2-way ANOVA Course x Assignment $p < 0.001$; Fall $n = 16$, Spring $n = 17$)**

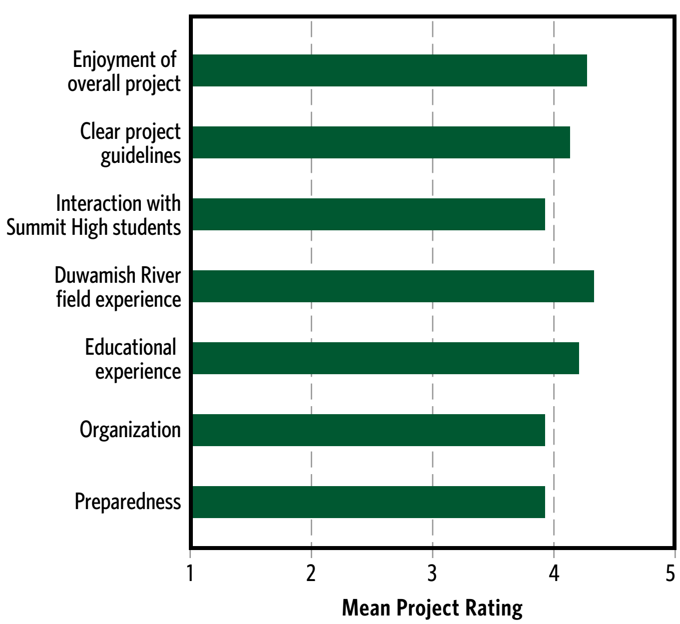


**FIGURE 6. Feedback from students on direct SL component working with high school students. (5 = excellent, 1 = poor; n=14)**

These comments were shared with the ecology students at the end of the course, and were an excellent reminder of the value of their efforts beyond learning the ecology for their grade. The feedback from the Summit students accentuated the positive experience from the SL project and provides the impetus to continually improve how the course incorporates SL. Specific insightful comments from the high school students include:

- "[O]pportunity to work with real college students on site, which is pretty rare."
- "I learned how to test for phosphorus, nitrate, turbidity, and plankton in the water. I also learned some new types and uses for plants."
- "That [the work] isn't that bad and it was fun and constructive. Also, that plankton can make a big difference in the life of fish."
- "Cleaning is good, and we need to be more careful [about] what we put in our rivers."
- "I don't really feel that I helped people so much as plants and animals. I suppose through data collecting we were helping both. People, to better help them understand what's going on at the site, which may help the environment."

## Conclusions

Prior to initiating this action research project, the challenges to incorporating SL into courses were clear, but the experience highlighted a few. The zero-sum aspect of courses was illustrated through the survey results and grades, and future iterations of the ecology course will strive to integrate peer reviewing along with direct SL effectively. The lack of student expertise was somewhat assuaged during conversations with community partners, as they emphasized the value of any data. Particularly memorable was the comment from Eliza Ghitis of People for Puget Sound. She pointed out that—instead of one partially trained volunteer walking the marsh twice a year—they would have about thirty students that they knew had taken ecology dedicating even more time, which was well worth the partnership. Student commitment is always a challenge with so many other items on their plates, but feedback from the Summit students heightened the need to adjust the SL design to enable greater continuity. The website and peer-reviewing will continue to be improved to increase the quality of reports and data, as well.

The rewards of SL are achieved through indirect involvement with community partners, but multiple aspects of this action research project indicate that direct experience enhanced those rewards all the more. From a course material perspective, the ecology students had to work to increase their understanding of concepts and techniques to be able to guide the Summit students and answer their plethora of questions. Explaining their research projects to high school students in terms they could comprehend also emphasized the value of generating information for an audience beyond the college classroom. By incorporating SL, both courses recognized greater relevance of the ecological concepts to the local community, but perhaps in the spring ecology students felt they had even more opportunity to interact with community members .

Overall, this action research project demonstrates not only that SL can be effectively incorporated into an ecology course, but also that the challenges of direct SL can generate rewards in increased student understanding, interests, and becoming effective educators themselves.

## About the Authors

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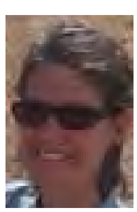

*Sara Hoofnagle* is currently a science teacher at Eckstein Middle School in Seattle, WA. She earned her undergraduate degree in natural resources at Cornell University in 1995. She went on to earn her masters in education at the University of Colorado, Denver in 2003. Her professional interests include finding novel methods for bringing outdoor education into her classroom and connecting students with different careers in science.

## Appendix: Pre-Course Survey

Student Number: ______________________________

Major: ______________________________

Year in School: ❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ Other

This course fulfills: ❑ requirement for major
❑ requirement for minor
❑ elective general education requirement
❑ personal interest

❑ Strong (5) ❑ Moderate (3) ❑ Weak (1)

| | | | | | |
|---|---|---|---|---|---|
| My background in ecology: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My understanding of ecology: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in ecology: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in biology: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in field research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in field research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in independent research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in independent research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in service projects: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in service projects: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in natural history: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in natural history: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in scientific writing: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in scientific writing: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My background in communicating research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |
| My interest in communicating research: | ❑ 5 | ❑ 4 | ❑ 3 | ❑ 2 | ❑ 1 |

In the space on the back, please provide any additional information you'd like to share about your interests, understanding or background relevant to this course.

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