COMBINING ON- AND OFF-CAMPUS SERVICE-LEARNING IN A STATISTICS METHODS COURSE

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Many models for implementing service-learning are possible, but the issue of meeting the needs of a community service organization within an academic time frame must be considered regardless of which model is chosen. Organizational deadlines that occur too early or too late in a course can minimize the contribution of the service project to students' learning. Expanding the definition of 'community' to include the academic community allows the possibility of working with student, faculty and administrative 'clients' across campus whose data analysis needs may agree better with the time frame available during a single course. Service-learning in this expanded definition of community can meet the necessary criteria for academic service learning: relevant and meaningful service within the community, enhanced academic learning, and purposeful civic learning.

INTRODUCTION

Many authors have described the benefits of incorporating service-learning projects into their courses. Root, Thorme and Gray (2005) describe the impact of a writing component within a service-learning course on students' abilities to synthesize course material and correctly apply inferential methods. Nordmoe (2007) reports on the results of an end-of-course survey that indicate that students find service-learning projects to be more meaningful and engaging than other non-service assignments. And, a study conducted by Phelps and Dostilio (2008) suggests that service-learning contributes to an enhanced understanding of social responsibility and an increase in student empowerment. Despite these benefits, instructors who incorporate service-learning assignments into their courses can encounter a variety of problems that can interfere with or minimize the potential benefits. One problem is working with a community agency whose project timeline doesn't fit well within a semester or quarter system. This mismatch between student preparedness and the time line of the community partner can result in limited enhancement of academic learning and/or unmet community need. This and other project management issues have been addressed by several authors, for example, Hydorn (2005) and Massey (2005). Another problem for instructors is managing a large number of projects at the same time. Even with the aid of a campus service learning office working with many community service organizations at the same time can be difficult, especially for faculty who have a high teaching load or other time commitments. For example, Nordmoe (2007) describes difficulties encountered with overseeing projects for just six community agencies for a class of about 25 students. Another problem experienced by some faculty is the difficulty of making contacts with community service organizations to begin the process of developing service learning projects. A large number of e-mails, phone calls or other communications might result in very few projects suitable for a particular course. Webster and Vinsonhaler (2005) provide suggestions for focusing the search for community partners and for obtaining additional on-campus support for service-learning activities. Additional problems faculty might encounter concern ensuring student safety and the availability of resources needed to participate in off-campus service activities. Sending students to work at a local agency can put students at risk and, without a car or other means of transportation, some students might be unable to attend off-campus meetings or perform required service activities. Nordmoe (2007) comments on how student commitment to service-learning resulted in shared rides to service learning sites so that more students were able to participate in a service-learning project.

A possible solution to these problems associated with implementing service-learning is to expand the definition of 'community' to include the on-campus community. In this context service-learning could involve working with campus administrative offices, student organizations, faculty and students in other courses. Each of these possible collaborations can provide service opportunities that fit more easily within the academic calendar, especially the last option when the

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service-learning project involves providing statistical support to students in another course. Both the students who are providing the service and those who are being served must fit their course-related activities within the academic time frame. In addition, if students collaborate on projects that meet a requirement for both groups of students, it is possible that between-course collaboration will result in a more manageable number of service-oriented projects. For example, if teams of statistics students provide assistance to groups of students in another class the service-learning instructor may need to coordinate activities with only one other person, the instructor of the other course. On-campus service-learning also helps to solve the problem of making contacts and arranging for service projects because faculty are used to working with each other and with administrators in the academic setting. Many statistics faculty are called on to provide statistical support to faculty in other disciplines, thus providing a possible service-learning connection between disciplines. Finally, performing service-learning activities on campus means that all students have the opportunity to participate and that instructors won't have the added worry of ensuring student safety while participating in service-learning activities.

This article describes a service-learning collaboration between students in a statistics methods course and students in a human physiology course. The physiology students, many of whom have no previous statistics experience, must design and conduct an experiment for a course requirement. Working under the guidance of the statistics instructor, the statistics students can satisfy a course data analysis requirement by collaborating with the physiology students to help plan the experiment with a focus on what analyses are appropriate once the data has been collected. The statistics students who choose this option also help with carrying out the data analysis and with interpreting the results for the physiology students. Students who don't join a physiology consulting team can fulfill the same course requirement by participating in a traditional off-campus service-learning project or by designing and conducting their own data analysis project. In addition to describing how the statistics students are prepared to perform as consultants to the physiology students, how on-campus service-learning satisfies the criteria for academic service learning will be discussed and tips for working with student clients will be offered.

ON-CAMPUS CONSULTING PROJECTS

Statistics educators have explored many ways to enhance the quality of learning in their courses, including projects, use of real data, computer animations and consulting. While many graduate programs in statistics include consulting courses or centers where students can gain some data analysis experience, fewer consulting opportunities are available to students at the undergraduate level. Boomer, Rogness and Jersky (2007) describe undergraduate consulting courses at three different institutions that are intended for upper-level statistics majors, and provide insights into what contributes to a successful consulting experience and what problems instructors might encounter. Root, Thorme and Gray (2005) describe a service-learning project in an applied statistics course with four options, one of which can be satisfied through an on-campus consulting experience. These and other authors extol the benefits of consulting toward improving students' knowledge of statistics and skills for working with clients, particularly at the graduate level, and show how consulting and service-learning share similar objectives of merging project goals with course objectives. (See, e.g., Gunaratna, Johnson & Stevens, 2007; Jeske, Lesch & Deng, 2007).

The statistics method course discussed in this article is similar in content and structure to the second course in statistics discussed by Phelps and Dostilio (2008) for which students choose between a service learning project and a traditional final project. For the course being discussed here, the consulting project is one option that students can choose to meet an end-of-course data analysis project. Statistics students that choose the consulting option work with a partner to help design and analyze an experiment for students who are enrolled in a human physiology course. Consulting teams consist of two or three students. With larger groups there is not enough work for each team member to make a significant contribution to the project, which could lead to some students becoming disengaged with the project. Because most students won't have had any previous experience as a consultant they should have at least one partner to confer with on experimental design and data analysis issues.

Unlike the small size of the statistics consulting teams, the physiology students typically work in groups of four or five. Their need for help with designing an experimental and analyzing

data was discovered through conversations between mathematics and biology faculty concerning the mathematics and data analysis recommendations put forth in BIO2010 (2003). The biology major at the University of Mary Washington does not include mathematics course requirements and many biology majors don't take additional mathematics courses beyond those needed to meet a general education requirement. Consequently, a partnership was established to link students in the statistics methods and human physiology courses to enhance the learning experiences of both groups of students. The goals of this partnership are to provide an opportunity for the statistics students to apply newly learned statistics methods in a meaningful way and to prepare the physiology students for a statistically sound research experience. A typical offering of the statistics methods course begins with a review of statistical hypothesis testing, followed by analysis of variance, design of experiments and multiple regression analysis, and ends with non-parametric statistics and categorical data analysis. Experience with these methods is sufficient for preparing the statistics students to meet the needs of the physiology students in both experimental design and analysis methods. Physiology projects from previous semesters include determining the impact of different amounts of capsaicin on heart rate, the effectiveness of sports drinks in replacing electrolytes, and comparing the vital capacity of swimmers and non-swimmers.

To help prepare both groups of students for collaborating on the physiology experiment project the two classes meet together for two lectures, the first on design of experiments about midway through the course, and the second on methods of statistical inference a couple of weeks later. Because these topics are part of the content of the statistics methods course, all students in that course benefit from these lectures, not just those participating in the consulting projects. Outlines of the two lectures are given in Table 1 below. After the first lecture, the physiology students meet in their groups to decide on a research question and to determine a data collection protocol. The statistics students receive guidelines for consulting, including a series of questions to help them focus on the primary research question the physiology students wish to explore and how to identify the dependent and independent variables involved. Both groups of students are also given examples of possible study designs, such as one- or two-way ANOVA and repeated measures designs. The physiology students are encouraged to focus on a small number of possible independent variables, to limit the complexity of possible experimental designs. After the second lecture the statistics consultants meet with the physiology groups to help identify the appropriate study design to address the physiology students' research question and to provide assistance on randomization and control issues. They give an informal presentation of their recommendations in class, giving the non-consulting students an opportunity to ask questions and provide advice. The statistics and physiology instructors confirm the recommendations made by the statistics students before the physiology students proceed with their experiment. Because the statistics course is more content oriented than the courses described by Boomer et al (2007), the students are expected to be less autonomous as consultants than students with more statistics experience.

Table 1. Outline of combined class lectures

Lecture 1 Topics	Lecture 2 Topics
Goals	The research process
Principles of good design	Hypothesis testing
Types of variables	Determining the right test
Basic study designs	Examples
Planning your study	

As part of the data analysis project all students give an in-class presentation about their project and the results. The students that participated in a consulting project also report on their consulting experiences. They describe how they arrived at an appropriate experimental design, the data collection protocol used by the physiology students and how any randomization was achieved. They also give a summary of the consulting process, describing any group meetings and what they learned by serving as a statistical consultant. Boomer et al. (2007) describe a similar consulting report where students are asked to write a paper describing their consulting experiences and making recommendations for success as consultants. These types of assignments serve the purpose

of providing an opportunity for critical reflection, an important factor for successful service-learning. (See, e.g., Heffernan, 2001; Howard, 2001. In addition, Webster and Vinsonhaler, 2005, provide an extensive list of possible reflection activities.)

THE CAMPUS COMMUNITY AS A SERVICE-LEARNING COMMUNITY

Practitioners of service-learning have put forth a variety of definitions or characteristics of successful service-learning courses. Hadlock (2005) offers a simple definition for service-learning: a collection of activities that enhance the impact of curricular material, and provide civic engagement or social contribution. Howard (2001) provides a set of criteria for academic service learning, (1) relevant and meaningful service with the community, (2) enhanced academic learning, and (3) purposeful civic learning, and offers both a strict interpretation of civic learning and a robust interpretation of civic participation. Some factors suggested by other authors include the importance of reflection for improving understanding and appreciation of course content and including activities that offer reciprocity where both the students and community benefit for the service activities. (See, e.g., Heffernan, 2001; Eyler & Giles, 1999.) As implemented through the collaborations between statistics and physiology students, on-campus consulting meets all of these criteria. Not only is the academic learning of the statistics students enhanced, but the end result for the physiology students is a more meaningful application of relevant course content. By contributing to the learning of their physiology partners, the statistics students are engaged in their academic community, and while not a requirement, many of the physiology projects involve or are related to important health and medical issues with implications far beyond the academic setting. Both groups of students benefit from developing improved interdisciplinary communication skills, which can prepare them for the increasingly interdisciplinary nature of scientific investigations. In addition, by providing advice on designing and analyzing experimental data, the statistics students are contributing to an improved academic experience for the physiology students, many of who will conduct research as graduate students or laboratory assistants. By participating in the physiology research project, the statistics students also gain insight into the larger arena of scientific research and its impacts. Armed with a better understanding of scientific methods these students are better prepared to make informed decisions, for example, about community policies - including expenditures on health and medical research and science education.

Heffernan (2001) has identified six models for service-learning course design, for which Hydorn (2007) discussed possibilities for implementation in a statistics course setting. These models are listed in Table 2 below. On-campus consulting fits most readily in the category of problem-based service learning, which is characterized by a ‘consultant’ and ‘client’ relationship. Service-learning through on-campus consulting could also be implemented as a capstone course, such as the consulting courses described by Boomer et al (2007), which is intended for majors and is typically offered to students in their final year of undergraduate study. It could also be implemented as community-based action research, which requires students to learn research methodology while performing service as an advocate to the community. One such example is the multidisciplinary Lake Winnecock project at Unity College, described by Heffernan (2001). A consortium of 17 service-learning courses, including a second course in statistics, serves the Lake Winnecock community by monitoring water quality and conducting a natural resource inventory of the lake.

Table 2. Models for incorporating service-learning

Pure service-learning	Capstone courses
Discipline-based service-learning	Service internships
Problem-based service learning	Community-based action research

TIPS FOR WORKING WITH STUDENT CLIENTS

Webster and Vinsonhaler (2005) provide a set of tips for working with community partners, such as making sure they are aware of the academic calendar, setting up a service contract that lists expectations for the students and the community partner, and creating opportunities for face-to-face interactions between the students and the community partner. Following are some

additional tips that may be useful when the clients involved are also students. If possible the statistics class and the partner (client) course should be scheduled at the same time, allowing for the possibility of joint class meetings. While some consulting activities can be conducted through e-mail, for example, having the opportunity for face-to-face communication during regular class meeting times can make for easier project management. With the additional time commitments many students have, such as jobs or sports activities, finding time when all members of a consulting team can meet with all or most of the members of a client team can be difficult, and offering the courses at the same time provides a convenient time when all students involved are available. Because students can be notorious for last-minute completion of assignments, it is important that both groups of students understand how timely completion of project activities can affect the ability of the partner group of students to complete their course assignment. Deadlines need to be set up and the issue of respect needs to be addressed so that neither group of students is placed in the situation where they cannot complete project activities on time. It is possible that some students in the client course may not feel they need the expertise of the consulting students. This has happened on several occasions between the statistics and physiology students when, for example, some of the physiology students have taken experimental design and statistics methods courses offered by the psychology department. In cases such as these the physiology students should be reminded that, by acting as a client for a team of statistics students, they are also providing a service to the statistics students by offering them an enhanced learning experience. Frequent reminders by both instructors of how the pairing of statistics and physiology students benefits both groups of students has helped to minimize resistance to being helped on the part of some physiology students. It can also be helpful to establish the qualifications of the statistics students as legitimate consultants by describing the statistics course to the client students, including the fact that it may be an elective chosen by these students because they enjoy statistics and because they possess skills that are needed for successful data analysis collaborations. Finally, both groups of students can benefit from an emphasis on the importance of designing an experiment with a particular inference method in mind, to avoid the problem of not being able to answer a research question because of an inappropriate experimental design.

CONCLUSION

In defining successful service learning experiences in the mathematical sciences Hadlock (2005) suggests that the value of the service project needs to be real and it needs to be embraced by participating students. Both of these qualities are met by on-campus consulting. Similar to reasons stated by Nordmoe (2007), service-learning through consulting projects was implemented in the statistics methods course to provide a greater impact on student learning than is possible with some student-generated projects. By linking students in a statistics course with students in a data-based research course, statistics students are provided with a richer learning experience, one that supports course content and connects them to the larger campus community.

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