

Service Learning Experiences in University Science Degree Courses

Ann Sherman · Leo MacDonald

Published online: 14 April 2009
© Springer Science + Business Media, LLC 2009

Abstract This article describes a study about a service learning project at a small undergraduate university. We examined how professors and students became involved in service learning through course work and related activities. This study sought to find out why participation in service learning is low in post-secondary education science and mathematics courses. Participants described challenges to participation as well as benefits which, if emphasized, may allow for some growth in participation by science degree students.

Key words service learning · science degree · university

Introduction

This article describes a study of a service learning program at St. Francis Xavier University, a small undergraduate institution. We examined how professors and students became involved in service learning through science and mathematics course work and related activities. All of the students participating were enrolled in a Bachelor of Science degree program and were taking either a science course (biology) or a mathematics course, which were the two courses we studied. They are all considered "science students" at this university and will be so termed throughout this article.

Ann Sherman is the Vice Dean in the Faculty of Education at the University of Calgary. She received her Ph.D. from the University of Nottingham.

Leo MacDonald is the Chair of the Teacher Education Program at St. Francis Xavier University. He completed his Ph.D. at the University of Alberta. The researchers have a special interest in teaching and assessment strategies in science education.

A. Sherman (✉)
Faculty of Education, University of Calgary, Calgary, AB, Canada
e-mail: lasherma@ucalgary.ca

L. MacDonald
Teacher Education Department, St. Francis Xavier University, Antigonish, NS, Canada
e-mail: lxmacdon@stfx.ca

This study was conducted as part of a large Centre for Research in Youth Science Teaching And Learning (CRYSTAL) grant focused on science and mathematics education and was sponsored by a large Canadian federal granting agency. The grant allowed the investigators to examine perspectives about the learning of science and mathematics through university projects that support school science and mathematics K-12 curricula. The service-learning program at this university includes projects that incorporate university curricula and involvement within the local community. However, few science and mathematics professors and students tend to participate, as indicated in the program's annual reviews (STFX Service Learning Annual Program Report. 2006, 2007). The goal of our study was to find out why participation in service learning remains low in these courses.

Service Learning in the University Context

Service Learning is an innovative way to integrate experiential learning, academic study, and community service. It builds upon a tradition in education of social responsibility and brings a philosophy of outreach to the undergraduate academic experience. A growing body of research shows that well designed service learning experiences are beneficial to students, the institutions, and community members (e.g. Eyler et al. 1996; Criz and Giles 2000; Furco 2001; Harkavy 2004). The literature reveals general agreement among participants and community members that well designed service learning is worthwhile, useful, and enjoyable and that it is a powerful learning experience for those involved (Conrad and Heldin 1991). Most colleges and universities are interested in developing a sense of civic responsibility and engagement in their students, and they form creative partnerships between the institution and the community and commit funding to do so. Service learning is one way of enhancing civic responsibility (Bringle and Hatcher 1996).

At St. Francis Xavier University, the service learning program coordinates the University's involvement in the community while promoting student learning. The predominant type of service learning opportunity offered to students is course-based. Professors offering course-based service learning design rigorous assignments that seek to link the experiences of students to specific course outcomes (Hartley, personal communication, Nov. 24, 2006). For example, activities that are of direct service to the public such as providing administrative support, doing consulting projects, assisting with resource production, and completing community-based research on behalf of an organization are well suited to course-based service learning. Students complete individual or small-group service placements in the local community as part of their academic course work. They relate course concepts to community issues in settings such as seniors' homes, schools, day care and women's centers, and non-profit organizations.

Central to service learning is the notion of reciprocal impact; that is, beneficial outcomes for the students are also beneficial to the community partner (Jacoby and Associates 2003). Well structured service learning programs work to the benefit of all involved. In addition, it is important to ensure that the experiences for the students are meaningful and of consequence if the service learning is to be effective (Harkavy 2004).

A major component of course-based service learning is reflection. Student experiences in the partner community differ greatly from their experiences in the classroom. While relevant connections may not be obvious at first, careful reflection will help students make those connections. Students need to think beyond the specific tasks they are performing and use the ideas examined in class to understand their service experiences. The professors

assign specific readings and encourage students to ask questions such as the following so as to guide the learning experience.

- How does the service activity relate to my classroom learning?
- Are there particular concepts, theories, or skills from my course that relate to this “real world” situation?
- Why is the service provided by my community partner necessary?
- Who benefits from this service?
- What are the underlying issues that need to be addressed?
- How does my service make a difference and to whom?
- What am I learning about course content, about myself, and about the community?

These questions help students think about the ways to connect the service learning activities with their course and its learning goals.

If we are to begin to meet the challenge set out by Boyer (1994), who suggested that higher education institutions need to reconsider their mission to be that of educating students for a life as responsible citizens rather than educating students solely for a career, then we need to address the way our course content and pedagogical strategies help students think about their own relationship with the community after graduation. Service learning provides one way to address Boyer’s challenge.

The Study

Service learning is well established at our university, and it has become a central pedagogy over the last ten years. As part of the Centre for Research in Youth Science Teaching And Learning (CRYSTAL) initiative, a service learning component has been created specifically for encouraging the involvement of science and mathematics students. A student coordinator was hired, prior to the start of this study, to coordinate the activities through which students in a science degree program and their professors are provided opportunities to work with local school children and local organic farmers. The purpose of this study was to examine the opinions and experiences of both the professors and students in an attempt to understand better the reasons why participation in science and mathematics related service learning opportunities is low. We elicited descriptions of barriers and benefits of the experience to identify reasons why they choose to participate or not to do so in the service learning activities. This study was conducted after receiving ethics approval through the University’s ethics review process.

The service learning coordinator developed the placement of the students in community programs in schools and on local farms. A principle of service learning is to try to have service learning activities initiated by the community; and so, while we made offers of suggested activities, no service learning partnership was formed without the community initiating the activity. Other community-based projects exist that relate to science or mathematics, but for the purpose of this study we limited our investigation to the two projects in the school and at the farms.

Once partnerships were formed between students and the community-based groups, we invited participants to be a part of this study. The service learning activity was in no way dependant on their agreeing to be part of the research; however, we had sought and received ethics approval with the expectation that the opportunity to interview or survey participants would arise.

We used data gathered from two professors, one teaching biology and the other mathematics, and their students in two courses. In the case of the mathematics course, the service learning assignment was optional and involved students working individually to design mathematics lessons for children related to conceptual ideas within their university course. Students were partnered with teachers from local elementary schools and participated in mathematics lessons with the children and teachers outside of their university class hours. As part of this assignment, the students developed and practiced learning activities and then, in consultation with their partner school teacher, carried them out in the classrooms at the elementary school. The students essentially team-taught mathematics topics with the elementary teachers. Each week the students worked alongside the teacher during mathematics classes, teaching small groups or individual children who needed more specific attention, using the activities developed by the university students. None of these students were in education courses, and for many this was a new experience for them. They learned to explain the mathematics at a level appropriate for the children. They also learned to engage the young children, drawing on both their own enthusiasm for the subject matter and the children's eagerness. This project occurred within the period of one term of sixteen weeks.

In the case of the biology course, the service learning activity was a required assignment, and the students worked in small cooperative groups to gather and analyze data collected on-site at local organic farms as part of a conservation project. The partner group was a community-formed action group working to promote awareness about organic farming in the community. The students visited five farms, meeting with and interviewing farm owners and action-group members. They collected scientific information about organic farming; and, by adding information they had researched at the university about the benefits of organic food production, they created information pamphlets for the promotion of organic farming. They learned about production differences between organic settings and regular farms, and they investigated the effects of chemical fertilizers on plant growth and learned about the alternatives used on the organic farms. Not only was their biology knowledge used, but their communications skills were utilized as well in the production of the pamphlets. The service learning assignment culminated with a public information session open to the community in which students reported on the results of the work they had carried out at the farms.

The two professors were interviewed before the service learning projects began and then again at the end of the project. We surveyed all students at the end of the term and interviewed volunteers individually. A total of 148 students participated in these two courses. All 148 students completed the short survey, which included general, open-ended questions about service learning and other questions specific to their project. We asked them to describe the benefits and challenges of participating in service learning and to describe ways in which the service learning activity had affected how they learned. The survey asked if students would recommend service learning activities to other students and what changes they would like to see in the way these opportunities were included in their courses. A total of 20 students volunteered to be interviewed individually after the end of term, and we used interview questions similar to those used in the survey. During the interviews, participants were encouraged to expand on their survey answers and to address more detailed follow-up questions. The interview questions focused on ideas of service and learning as related to science and mathematics experiences and drew out descriptions of their personal experiences and learning growth throughout the project. We asked both the students and the professors to speak directly about why students completing Bachelor of Science degrees in a science content area or in mathematics might not feel able or willing to

participate in service learning. We also asked them to make specific connections between the service learning project and the learning of science and math. Because the interviews were informally conversational, the questions asked each time varied somewhat but had the same intent and flowed from how each participant had answered their previous question (Marshall and Rossman 1999).

After the data from the surveys and interviews were transcribed, we identified emerging themes and categorized individual responses within those themes. During the analysis, we looked for negative examples that conflicted with our goal of identifying a stable set of themes that were consistent across the entire data set. The responses provided across the students' data were fairly consistent, and we believed that a stable set of emergent themes had been reached after interviewing twenty students. Although this number is not high, the questions we were asking, while open ended, were quite specific about why participation in service learning is low in higher education science and mathematics courses; and the student responses reflected a focus on these questions. The interview data also closely reflected the responses which the entire group of 148 participants had provided on the surveys. Thus, we had consistency in the data (Bogdan and Biklen, 1998). We now present selected comments from the interviews and surveys in order to highlight participant thinking within the emergent themes.

Findings and Discussion

We divide our findings and discussion into two sections. The first section examines the challenges of and barriers to participating in service learning. The second section addresses the benefits of the service learning experiences as identified by students and professors. We include comments from the interviews and written surveys to illustrate the participant opinions.

Challenges and Barriers

As we identified challenges and barriers to participating in service learning activities, four thematic categories emerged. They were (a) the time commitment required, (b) the nature of the immersion of students in the community context, (c) the perception of scientific rigor, and (d) the potential impact on career opportunities.

Time is precious for all of us; and several students said that, while they enjoyed the service learning experience, they found they were stretched for time. One student's comment highlights this perspective: "I really enjoyed the fieldwork, but with my lab schedule I couldn't give it the kind of time I felt I should. I hardly had time to get my other course work done" (student survey). This statement supports the findings of deKoven and Trumbull (2002), who identified the time required for service learning experiences as a potential barrier. Science students engage in extensive laboratory work, and they often have up to twenty hours of scheduled laboratory time each week.

The professors involved in this study had anticipated that students might consider the potential additional time required in course-based service learning to be a problem. The biology professor did not increase the assignments expected of students, so service learning was an integrated part of the biology course expectations. Despite these accommodations, over half the students interviewed still considered the time involved to be a barrier to becoming fully involved. It is clear that student interest in participating in service learning projects, specifically in science and mathematics courses, is impacted by uncertainty regarding the time required to complete an assignment.

The nature of the immersion of the students in the community context is a second factor that can impact on students' participation. While this issue was not a concern for the students from the biology class, it was a significant factor for the students from the mathematics class. Four of the eight students interviewed from the mathematics course identified difficulties they had experienced in working with young children. While the number of students who mentioned this problem was rather small, we considered this finding to be a barrier because the professor considered it an issue; and it serves to highlight a broader set of issues related to course-based service learning. He explained as follows.

Only a small number of students chose the service learning assignment. Students really seemed reluctant to immerse themselves in the activities of the elementary classrooms. If a student was interested in a teaching career, they participated. Otherwise they did not. (interview comment)

As noted earlier, the service learning component of the mathematics course was optional. More than 50% of the students chose not to participate in this component, which required them to become involved in teaching a mathematics lesson in an elementary school. Students who had not made this choice identified issues that were barriers for them. Some considered this assignment to involve a high degree of uncertainty and risk in the sense that they were not confident that they could have a positive impact on the mathematics understanding of the children they would be teaching. The professor said many students were worried that the quality of their teaching might not be considered good enough by the elementary classroom teacher. She said that virtually all of the students could see the potential rewards or value of this kind of assignment, but they weighed these rewards against the potential risks. Despite the efforts of the professor to assure hesitant students that they would receive significant support in designing and carrying out a lesson for the children, the students were not convinced. The result was that less than half of the mathematics students participated in the service learning project.

This finding suggests it might be useful to offer students alternative ways to complete this kind of assignment and that categorizing the service learning assignment according to the level of uncertainty and risk involved may help to increase the number of students who choose to participate. For instance, the mathematic service learning assignment might be adjusted so that it could be completed by a pair of students, or some students may prefer to observe the regular teacher carry out the lessons the students had designed rather than become directly involved in teaching. Students could still design the lessons but choose whether to teach them or not. Much of the service in this opportunity was, and could remain, the creation of the lessons.

This issue also arose in the comments of the professor, who recognized that students may feel the most valuable learning occurs in the context of university-based classes and laboratories. For instance, one of the professors commented, "I haven't found a way to make it as rigorous as I would like to make it, but I still see the benefits in it." Based on such comments, perhaps educators who are knowledgeable about service learning approaches can work to convince both students and professors of the rigor that can be found in well designed service learning experiences. Our conversations with other science professors, who were not included in this study but who were considering incorporating a service learning component, revealed that science professors often do not consider reflective writing about experience to be a valuable learning activity. Typically, these professors understand that this is a key dimension of service learning, but they are hesitant to consider it when they are designing an evaluation strategy for a service learning assignment. This suggests that working with science professors

to help them understand how students' reflective writing can be included in their overall approach to assessment might help them to view service learning more favorably.

The connection between involvement in a service learning project and personal career objectives is another issue that 25% of the students identified as a challenge and potential barrier. One student commented as follows: "I didn't mind doing the work, and I did learn something about farms; but I'm not sure that anyone will consider it in the future when I apply for a job." (student interview)

It is possible that these students, who are heavily involved in traditional laboratory research, may not see the value of field-based research and that the students in the mathematics course may not consider working with young children incapable of understanding complex mathematical work to be of career benefit to them. Although proponents (deKoven, A. and Trumbull, 2002) of service learning are convinced that sufficient scientific rigor can be demonstrated in these kinds of activities, some students and professors remain unconvinced of the scientific rigor while still acknowledging that service learning does have benefits. One student's comments highlight this issue.

I think that most people consider service learning to be a fluffy extra in a science course. If I were applying to another program like medicine or dentistry, I would expect that my marks in lab based courses would come first. Also, I think that anyone who was thinking of hiring me would want to know that I did well in my other science courses that are more rigorous than a service learning course. Despite this, I learned a great deal through this activity and value it for what it was...a great experience. (student interview)

Benefits

From the interview and survey data we identified two thematic categories related to benefits and encouragement to participation in the service learning projects. These themes are (a) the quality of learning and (b) the recognition of reciprocal impact that emerges from course-based service learning. Overall, students and professors described service learning as a positive experience. All but one student said they would participate in service learning again. It was perceived as promoting tangible connections between classroom learning and the "real world" science and mathematics involved in the projects. The professors saw the projects as a way of promoting student engagement in the outcomes for their courses. If students are challenged to use their service learning experiences to understand concepts better, then they can begin to understand the causes of the problems their service addresses. The students developed rudimentary understanding about the importance or relationships between community issues and research. They also began to recognize the challenges faced by teachers, families, students, and their communities, depending on the project in which they were involved.

It should be noted that service learning is a promoted form of pedagogy on this campus and professors are urged to consider using service learning by personnel in the service learning office. Involvement with service learning is considered positively when professors apply for tenure or promotion.

Those students who helped tutor elementary students in mathematics increased their understanding of what it means to be a teacher, and some of them were considering teaching as a possible career. They also increased their understanding of the mathematics content through teaching it to younger children. This student interview comment highlights this benefit: "The

service learning experience provided a connection between the text and reality in a way I couldn't see before. It linked theory and practice in a way that is now much clearer than before.”

All the students who worked with farmers also felt their experience had a positive impact on the quality of their learning in their biology course. The following comments reflect this perception.

The combination of classroom-work and service-work has helped me to think about preconceptions and assumptions I held about the farm where we were working. I was forced to re-evaluate the way I look at certain contexts. (student survey)

I really enjoyed the service learning work we did this term. I think service learning is a great idea, and more people should do it. It provides valuable experience that goes beyond the classroom. What you take from the experience will stay with you for life. I enjoyed this course more than most because of it. (student interview)

By being able to apply theory to an actual setting, I feel that my understanding of theory is improved in ways that I couldn't imagine before I did the service. This experience helped me to apply my academic learning to real situations in a more natural setting than the lab. (student survey)

Students believed they had been able to apply their science and mathematics learning in a way that they could not do in the classroom, or even in the laboratory; and they indicated they would recommend these experiences to others in science and math courses. Students urged their professors to look for ways to incorporate service learning in science courses in either mandatory or optional assignments. They suggested that they had found ways to explain science to others outside the institution and recognized the importance of making science accessible to others.

Seven interviewed students discovered that reciprocal impact is an important quality in service learning experiences and reported this as a significant aspect of what they learned from the overall experience. This is reflected in the following comment from a student interview.

I like having service learning in my science course. I really enjoyed seeing how science is directly applied in the farms we all visited. I was surprised to see how much the farmers really felt that we contributed something important to their work. I think that the farmers learned how they can more effectively communicate with the wider community and other organizations about how their farms work effectively as an integrated system. I learned a lot too. Farms, especially dairy farms, are full of science and require many decisions to be made that are informed by science. The service learning dimension of our course really helped me better understand that. (student interview)

For the professors, developing a course with a service learning component meant giving up some control and autonomy in order to allow students to be more responsible for their own learning. In the end, the professors said they ended up creating a more student-centered course. They also found that they needed to use different types of assignments in course-based service learning situations so as to tap the full learning potential of service learning placements, and they recognized the positive impact the service learning experiences had on the quality of their students' learning. The professors commented as follows:

The service learning program has proven to be a valuable addition to the classroom education, in addition to providing students with direct service experience which can benefit them in the future. Some saw connections that

couldn't have been made simply by talking about it. The hands-on connection, the actual work on the farm, applying what they learned in class, made it "real" for them. (professor interview)

Having [university] students describe their experiences for classmates really pushes everyone's learning. The students develop tremendous communication skills in addition to their science skills. The explaining of the science pushed their levels of thinking in new ways that I haven't seen in my classes before. (professor interview)

Both professors were pleased with the opportunities the service learning projects provided for their students. They felt the students were able to demonstrate a deeper understanding for the subject areas than in earlier versions of these courses.

Tompkins (1996) has urged us to tie course content to the world outside because she believes doing so helps to create a real-world site for asking theoretical questions; it answers students' need to feel that their education is good for something other than a grade point average. She suggested that it also begins to address the problem of the student who has no conception of what is possible after graduation. By helping students make connections between course work and future careers, we enable them to see, more fully, the purpose of their course work.

Projects promoting the immediate application of course content to real situations and real world problem solving should be encouraged. This work fosters the interest of these students pursuing a science degree (in either a science content area or in mathematics) and allows them to integrate their university-gained knowledge with everyday situations. The findings of our study suggest that this kind of connection is motivational and argues for the value of the experiences.

Conclusion

In the two courses examined in this study, the professors wanted to encourage a high level of participation in the service learning projects and sought to integrate the assignments into the normal course activities as much as possible. They were openly supportive of service learning but recognized that their science students had many pressures that might keep them from being able to commit, as readily as others, to service learning work within a course. We encourage faculty members considering incorporating a service learning component to think about ways, while planning the course, to head off possible negative reactions that can accompany this change from what students think of as "normal" university and college teaching.

While the students and professors we surveyed and interviewed enjoyed their opportunities to explore science and mathematics, they identified challenges to participation. The amount of lab work expected of science and mathematics degree students and the amount of time that lab work takes remains a large barrier for students and reduces the number of students who will seek to participate in service learning. Students express an interest in service learning activities but simply cannot find the time given their course workload.

The two professors participating in this study are moving in directions that may alleviate this by trying to help students see ways to manage the amount of time involved by, for example, structuring service trips during class time and tightly connecting the course work to the fieldwork. While acknowledging the service learning to be of value, both students

and professors recognize the commitment it will take to ensure greater participation from university science students.

This study of participation in the service learning assignments in the context of the biology and the mathematics classes highlights the fact that there can be significant differences in terms of the level of immersion that may be required by students within the community context. The mathematics students were immersed more deeply with their community context than were the biology students in the sense that, while the biology students were simply observing and gathering data within their community context, the mathematics students joined the community, albeit for brief periods of time. Alternatively, it may be useful to consider categorizing service learning experiences into different levels based on the nature of the involvement with the community partner and to distinguish between these kinds of experiences on students' transcripts.

More work needs to be done in relation to how students perceive the value of course-based service learning, both in terms of the scientific rigor included in these kinds of courses and in terms of how these courses are valued as career builders. Perhaps students will see service learning courses as positive experiences that lead to career choices if there is a greater explicit recognition of their value by the university. This explicit recognition might come from incorporating a service learning dimension on university transcripts and/or presenting graduation awards connected to exemplary participation in service learning within science and mathematics. Additional work in recognizing the value of service learning may help to increase the level of participation of science students in this important area.

References

- Bogdan, R. C., & Biklen, S. K. (1998). *Qualitative research for education: An introduction to theory and methods*. Boston, MA: Allyn and Bacon.
- Boyer, E. (1994, March 9). Creating the new American college, *Chronicle of Higher Education*, p. A48.
- Bringle, R. G., & Hatcher, J. A. (1996). Implementing service learning in higher education. *Journal of Higher Education*, 67(2), 221–238.
- Conrad, D., & Heldin, D. (1991). School based community service: What we know from research and theory. *Phi Delta Kappan*, 72(3), 754–757.
- Criz, N. L., & Giles, D. E., Jr. (2000). Where's the community in service-learning research? *Michigan Journal of Community Service Learning*, Special Issue Fall, 28-34.
- deKoven, A., & Trumbull, D. (2002). Science graduates doing science outreach: Participation effects and perceived barriers to participation. *Electronic Journal of Science Education*, 7 (1). Retrieved October 12, 2008, from http://ejse.southwestern.edu/original%20site/manuscripts/v7n1/articles/art05_dekoven/dekoven.PDF
- Eyler, J., Giles, D. E., Jr., & Schmiede, A. (1996). *A practitioner's guide to reflection in service learning: Student voices and reflections*. Nashville, TN: Vanderbilt University.
- Furco, A. (2001). Advancing service learning at research universities, *New Directions for Higher Education*. Summer, 2001(114), 67–78.
- Harkavy, I. (2004). Service-learning and the development of democratic universities, democratic schools, and democratic good societies in the 21st Century. In M. Welch & S. H. Billig (Eds.), *New perspectives in service-learning: Research to advance the field*, pp. 3–22. Greenwich, CT: Information Age.
- Jacoby, B., & Associates. (2003). *Building partnerships for service learning*. San Francisco, CA: Jossey-Bass.
- Marshall, C., & Rossman, G. B. (1999). *Designing qualitative research* (3rd ed.). Thousand Oaks, CA: Sage Publications.
- STFX Service Learning Annual Program Report. (2006). Retrieved February 12, 2009, from <http://www.stfx.ca/academic/servicelearning>
- STFX Service Learning Annual Program Report. (2007). Retrieved February 12, 2009 from <http://www.stfx.ca/academic/servicelearning/>
- Tompkins, J. (1996). *A life in school—What the teacher learned*. Jackson, TN: Perseus Books.