Students as Mentors: A SoTL project in Cell Biology

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Abstract:

This project is part of a larger effort within the SoTL community to try and better understand the effects of service projects on student learning. Service learning is an integral part of the culture at Rockhurst University, but there remain questions about its effectiveness in improving learning. In this project, my students work in groups of three to mentor a single student (in 6-10th grade) from an inner city charter school. My research question is, "What do biology students learn from serving as mentors for science fair projects?" Surveys, exam questions, and reflection papers have been gathered as evidence. Collectively, the different forms of evidence allowed me to look at the student understanding of scientific process and the impact of mentoring on their learning. Feedback from this conference will be used to revise or refine both my central question and the design of the project..

Key Words:

Scholarship of Teaching and Learning, Service Learning, Biology, Student Mentors.

Introduction

This paper is my attempt to reflect upon the ways I've learned to engage students in Biology classes that both addressed content material in biology as well as speak to the values and mission of the institution where I work.

When I entered into a tenure track position at Rockhurst University, my teaching experience was minimal. I had been trained as a molecular geneticist for the previous nine years, working almost exclusively in the laboratory as a graduate student and post-doctoral fellow. Because of my experience as a student from a small college (I am a Rockhurst alumnus), I valued the personal attention and supportive environment found in teaching-centered institutions. As a new faculty member, the challenge for me

involved using course design to effectively evaluate student learning. At the larger institutions I came from, professors stood in front of large groups of students, read from slides, and gave multiple choice exams to look at knowledge and comprehension of the material presented. I knew that this strict lecture format was not conducive to developing scientific reasoning skills, so my methodology at Rockhurst (like many of my Biology colleagues) evolved to include a more active learning environment (Knight and Wood, 2005).

Rockhurst as an institution has resources in place to help faculty develop Scholarship of Teaching and Learning (SOTL) questions in their classrooms. Faculty frequently meet over the course of a semester, share ideas and approaches in the classroom, and attempt to move their SOTL projects into more formal publications or presentations. Rockhurst was a member of a group of regional institutions associated with CASTL, a program to develop projects in the scholarship of teaching and learning at the Carnegie Foundation for the Advancement of Teaching, and our faculty members frequently attend regional and national SOTL meetings. Over the course of five years, I have attended workshops, work groups, and meetings focused on student learning in the classroom. With the support of the faculty mentoring program and the Center for Excellence in Teaching and Learning, I was able to work on developing pedagogies that fit the particular goals and objectives of individual courses. I tried various techniques and assignments in my first several years including group work, case studies, clickers in the larger lecture courses, worksheets, and oral presentations.

In the past, my classrooms were active, but the assignments and methodologies employed didn't always align well with my course goals and objectives. In general, I tended to try a technique or assignment without specifically designing a question about how that assignment would affect student learning. With help from faculty mentors at Rockhurst, I began to look more carefully at the impact of individual assignments via course embedded assessment. By tweaking and refining individual assignments over time, I was able to ask more clear and concrete questions about student learning in my classroom.

In addition to exposing my own students to the scientific process in the classroom, I wanted to use service learning to incorporate community outreach into my courses. Rockhurst emphasizes learning, leadership, and service as part of our student experience. By using service-learning in courses, students are able to meet a community need while engaging in scientific investigation. There are several schools in the immediate vicinity of our campus that are in need of resources and mentorship in the sciences. Over the course of five years, I have worked with three different schools as community partners in several different courses. Students in my courses have served as mentors, tutors, and teachers in both elementary and high school classrooms. Over time, I have been able to identify the length and type of service learning experiences that I thought would work best for my students both logistically and as learning experiences. I decided that pairing with Brookside Frontier Math and Science School (BFMASS) would be an ideal match because of its close proximity to Rockhurst and the need for BFMASS student improvement on standardized science and math exams. BFMASS is charter school a three minute walk from the Rockhurst campus with an emphasis on science and mathematics.

Question in Classroom

When asked to teach an upper division Cell Biology course comprised of 48 juniors and seniors, I began to think about how to evaluate analytical and problem solving skills in our upper division students as they progressed through the Biology or Biochemistry curriculum. I noticed that students struggled on exam questions relating to data interpretation and analysis. I also found myself focused on emphasizing large amounts of content in the course. Because of these observations, one of the skills I wanted to examine more deeply in my classroom was experimental design and data interpretation (Fink, 2003).

When students enter Rockhurst as freshmen, they are all enrolled in a seminar course in the science division called "Freshmen in Science." This course was originally designed to help with retention in the sciences at Rockhurst (Salem, Dronberger, Kos and Wilson, 1997). Part of this course is dedicated to the understanding of Jesuit mission and values and how these relate to their experiences at Rockhurst. I wanted students to revisit these ideas by asking them to engage in a service learning experience in my Cell Biology course. My question was, "Will engaging in a service learning project help students better understand the mission of the University?"

I was fortunate to be accepted into the June 2009 CASTL institute held at Creighton University as a scholar. At this institute, I described a project that I was working on with my Cell Biology students in which students were serving as mentors for inner city high school science fair projects. I benefited from my interactions with and feedback from Alix Darden, a Carnegie scholar and biologist who reviewed my project design. Professor Darden is an SOTL leader, emphasizing the importance of undergraduate research experiences in her classroom (Darden, 2003). With her comments in mind, I wanted the focus of my classroom to include group work involving open ended scientific questions to have students engaged directly in the process of science (Elmendorf, 2006).

Project Design and Implementation

A key part of my project was the identification of a community partner. In the past, I have worked with other schools in the Kansas City public school system. Due to issues with transportation, fluctuation in teachers, and scheduling I was forced to do a large search for an effective community partner. I sent emails to twelve local schools and received an immediate response from BFMASS. I worked closely with the teachers in the fall semester and decided to sit in on the science classes to assess their student population, teaching methodologies, and their use of scientific method in the classroom.

After observation and consultation with teachers from BFMASS, I was able to conclude that their need of a community partner to improve their science education fit well with my need for engaging Rockhurst students in the scientific process. We were able to define a clear project with Rockhurst students working in groups to mentor BFMASS students over the course of a semester. My students worked in groups of three or four to mentor one student from BFMASS. The steps of the project are outlined in Figure 1.

Figure 1: Steps in Science Fair Service Learning Project

The project involves:

- Brainstorming for experimental ideas
- Filling out appropriate paper work for the science fair
- Writing and submitting a research plan for approval by science fair officials
- Making a supply list
- Conducting experiments
- Collecting and interpreting data
- Poster assembly
- Poster presentation at Greater Kansas City Science and Engineering Fair
- Periodic reflection pieces and final reflection paper (performed by Rockhurst mentors only)

Qualitative and quantitative methods of assessment were used throughout the course of the semester to look at the impact of service learning on 1) students understanding of scientific process and 2) students' understanding of the mission of the university. I chose to use the Views About Science Survey (VASS) as a quantitative assessment for Rockhurst student views about the process of science. "The Views About Science Survey (VASS) is designed to survey student views about knowing and learning science, and to assess the relation of these views to student understanding of science and course achievement (Grades 8-16). VASS probes student views in three scientific dimensions and three cognitive dimensions. Scientific dimensions pertain to the structure and validity of scientific knowledge, and to scientific methodology. Cognitive dimensions pertain to learnability of science, reflective thinking, and personal relevance of science" (Halloun & Hestenes, 1998, p. 562). A sample question from the VASS is shown in Figure 2.

Figure 2: Sample question from the Views About Science Survey (VASS)

Each question offers students two contrasting answers. On a scale of 1 – 8 the students are then asked to rate their view based on the following criteria:

1. Only a, never b
2. Mostly a, rarely b
3. More a than b
4. Equally a and b
5. More b than a
6. Mostly b, rarely a
7. Only b, never a
8. Neither a nor b

Example question:

How well I do on biology exams depends on how well I can:

a) Recall material in the way it was presented in class

b) Answer questions that are somewhat different from ones I have seen before

I administered the VASS on the first and last day of class to Rockhurst students in my Cell Biology course and compared responses to twenty questions. Two responses that stood out from the survey are shown in Figure 3.

Figure 3: Responses from VASS questions.

How well I do on biology exams depends on how well I can:

a) Recall material in the way it was presented in class

b) Answer questions that are somewhat different from ones I have seen before

Average score first day of class: 3.7

Average score last day of class: 5.6

In order to answer a biology question, I need to:

a) Have seen the answer to a similar question before

b) Know how to apply general reasoning skills

Average score first day of class: 4.2

Average score last day of class: 5.9

All data taken as an average from 48 responses on the first and last day of class.

The increase in the scores demonstrates that over the course of the semester, students favored option b over option a. In science, students frequently come into college thinking that memorization of terms and concepts is essential to success. By utilizing a hands-on service learning experience in cell biology, my intent was to have students engage in the scientific process. Although there are multiple factors both within and outside of this course contributing to the score differential in Figure 2, students leaned toward answers that had an emphasis on application cognitive level in Blooms taxonomy. For example, students felt more strongly about their ability to apply reasoning skills in order to answer biology exam questions. In the application cognitive level, students are able to use material they learned previously in a novel situation (Bloom, 1971).

For qualitative assessments, I administered periodic reflection pieces. Students were asked to reflect after each visit or interaction with their respective BFMASS student. I chose to do a series of short hand-written reflections in class taking about 5-10 minutes during five class periods. I returned their reflections with written comments to be used in their final reflections. A set of example quotes from students' final reflection papers is found in Figure 4.

Figure 4: Sample reflection responses from Cell Biology students.

Reflection question 1: What values, opinions, beliefs have changed about BFMASS students, the science fair, and/or public education?

Example from student paper:

"The kids that go to BFMASS and other urban public schools get a reputation that they are the type of kids that are going to grow up to cause nothing but problems. However, after spending time with them in the classroom and in the lab, it is clear that they are just kids, no different from the kids I went to school with. They looked up to us as role models, a part I was happy to play."

Reflection question 2: What impact did you have on the community?

Example:

"The success the students achieved in the science fair helped the community realize not only the great potential of their students, but also the intelligence and dedication of their students. I hope my work with Christina has helped raise community awareness for the significance of science in our lives and also the great abilities of youth to become leaders in science in the future."

Reflection question 3: Look back at your syllabus and read the course goals. Look at the Rockhurst website and read the mission of the University. After looking back at BOTH sources, please clearly articulate how your service learning experience in this course relates to the course goals and the university mission.

"One of the course goals was to actively engage BFMASS students in the scientific method. This goal was achieved by meeting with the students, planning the experiments, working through the project using scientific methodology, drawing conclusions from our data, and reporting our results in a display poster. By conferring our assistance to a neighborhood school, we were able to increase the academic growth and overall well-being of our local community."

Reflection question 4: Would you recommend that this project continue in the Cell Biology course at Rockhurst? Why or why not?

Example:

"I think that it is really important that this project continues in Cell Biology. Besides this class, I haven't really had the opportunity to make connections with my education and the community very often. Sure, I do volunteer hours, but all of that seems disconnected from my classes. When I leave Rockhurst and move on to the next chapter in my life, this class will make me more aware of the need to always make community work at the heart of everything I do."

48 out of 48 students (100%) recommended that this project continue in the following year.

The mission statement of Rockhurst University states, “Rockhurst University exists to transform lives by creating a learning community centered on excellence in undergraduate liberal education and graduate education. Rockhurst is Catholic and Jesuit, involved in the life and growth of the city and the region, and committed to the service of the contemporary world.” In reading my student reflections, it became apparent to me that the connections students made with the community were an important part of this project. Students frequently mentioned that doing service within a context of a course helped them to establish meaningful relationships with members of our local community. It also became clear to me that having students mentor a scientific investigation from the beginning (forming a question) to the end (data interpretation) helped my students transform from passive to active participants in their learning.

In three semesters of this project, Rockhurst students have served as mentors to over forty science fair projects at BFMASS. Several of these projects have been awarded cash prizes at the Greater Kansas City Science and Engineering Fair. Ongoing assessment of reflection papers, student attitude towards science, and science fair project design continues in this course each spring.

Future Directions

I found that students were able to use this work to connect to the Rockhurst mission. In their reflections, they were able to clearly articulate how their experiences as mentors are connected to mission of the university. In casual discussions with students upon completion of the course and after graduation, I repeatedly hear that this project helped connect service experiences to their coursework. As the project evolves, I plan to alter several components listed in Figure 5. The ideas for these changes have come from my experience at the CASTL summer institute, presentations at regional and national meetings, and review of the current literature in service learning (Kuh, 2008).

Figure 5: Future directions for Mentoring Project.

1. Clarify a process to evaluate the posters presented at science fair.
2. Think more carefully about how to measure the impact of the project on BFMASS students.
3. Include documentation student-mentor interactions via taping of sessions.
4. Track the long term impact of the project on student understanding of the Rockhurst university mission after graduation.

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