

# Development and Assessment of Service Learning Projects in General Biology

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**Abstract** Service learning involves providing service to the community while requiring students to meet learning goals in a specific course. A service learning project was implemented in a general biology course at Rockhurst University to involve students in promoting scientific education in conjunction with community partner educators. Students were required to develop learning objectives, design and complete a community service exercise, and write reflection papers to assess the quality of their learning experience. Rockhurst students worked with high school or grade school students in the local community, providing learning experiences relating to course topics. Information gathered through reflection papers showed high student achievement and satisfaction in the following areas: 1) contributing to the learning of others, 2) contributing to their own learning, and 3) supporting the mission of the university.

**Keywords:** service learning, general biology, community education

## Introduction

Service-learning components in courses allow students to build their knowledge using experiential learning with a community partner. Connecting service to an academic field of study contributes to cognitive development and learning in the affective domain (Batchelder and Root, 1994, Giles and Eyler, 1994, Kezar and Rhoads 2001). Examples of outcomes in the affective domain include social responsibility, civic-mindedness, acceptance of cultural differences, and self-confidence. Thus, while making an impact in the community, students develop new knowledge and attitudes. Students also gain communication and teamwork skills that are necessary for post-graduate education and careers in science.

The three major components of effective service learning experiences are developing clear learning objectives, working on a project in cooperation with a community partner, and reflecting on the learning experience (Gelman *et. al.* 2001). We partnered with University Academy, a K-12 college preparatory charter school located within a mile of the Rockhurst University campus. Service learning requires that students are meeting a community need and integrating the experience into the academic goals of a particular course. The reflection component is structured and encourages students to address their interactions with peers, community partners, and course material (Daudelin, 1996). In

order for reflection to be effective, faculty members must consider the goals of the project, design a series of appropriate questions, and develop a structured reflection activity to that is appropriate for assessment of the service learning experience (Hatcher and Bringle, 1999). Questions for our project addressed group dynamics, interactions with students, and relation of the project to course goals.

In our project, the major components of service learning were achieved by requiring our undergraduate students to teach younger students in the local community about a variety of topics taken from their general biology course. Students were required to develop learning objectives, develop and deliver a learning activity, and complete a reflection paper on the project. We chose the teaching experience, as it provided an excellent opportunity for our students to gain competence in their subject matter. In addition, the experience provided an opportunity for Rockhurst students to make their course content relevant for a younger audience. Finding relevance is essential for encouraging students to learn more in the sciences (National Research Council, 1996). The students in the community were also exposed to unique and relevant approaches to learning science such as creative games, skits, and epidemic simulations. Student to student contact is an important element for promoting interest in further scientific educational opportunities, an achievement that is essential for the future of science education.

In addition to the benefits for Rockhurst students, service learning is also congruent with the mission and values of many colleges and universities. The mission of Rockhurst University involves an emphasis on inquiry and service. As expressed in our mission statement, Rockhurst is "...involved in the life and growth of the city and the region, and committed to the service of the contemporary world." Thus, service learning projects not only provide unique learning experiences for students but also support the goals of the university as a whole.

## Article II. Overview of Project

We selected two separate courses for implementation of a service learning experience. Courses in which a service learning project was undertaken and documented included three semesters of General Biology I and one semester of an Honors section of General Biology I. Each course is populated heavily by freshmen with varying levels of high school biology experience. Some students lack experience in applying scientific practice and using scientific language. The course is designed for science majors, but approximately 25% of the students in the course are not science majors. Students in the Honors section of the course enter Rockhurst with an ACT at or above 28, and a high school GPA of 3.5 or better on a 4.0 scale. Because Honors bring a special set of gifts and talents to the classroom, we thought it would be interesting to compare their performance with those in the General Biology sections.

Undergraduate students from General Biology I worked with two different groups from the community. The first group consisted of local grade school aged children who were involved in a community garden project. The second group consisted of high school students attending the University Academy, a Kansas City charter school for potential first generation college students located close to the Rockhurst University campus. Rockhurst University is located in an urban setting as is common for many Jesuit institutions. Our urban location provides significant opportunities for community outreach to individuals underrepresented in science.

Students in their first college biology course often struggle with gaining a clear conceptual understanding of many course topics. This student population is the one that lends itself to the type of meaningful active engagement provided by a service learning experience. The service learning project consists of four major phases: 1) Topic selection, 2) Development of learning objectives, 3) Completing the project and 4) Reflection. Each of the phases is described in detail in the subsequent sections. Table

1 displays the allotted classroom time for each phase of the project and student expectations outside of the classroom.

TABLE 1: Overview of project.

Phase of Project	Class or Lab Time Allotted	Expectations Outside of Class	Points Allotted
Topic Selection	20 minutes for students to consider course objectives and complete a survey to choose topics.	none	0
Development of Learning Objectives	1.5 hours for a project overview discussion and instructor feedback and guidance on developing age appropriate objectives.	Students met in groups to revise objectives.	0
Developing appropriate activities	1 hour for discussion and sharing of proposed activities.	Students generated demonstration materials, photocopied handouts, developed powerpoint presentations.	5 pts through peer review
Completing the Project	3 hours (1 lab period) for rehearsal and delivery of learning objectives. This portion was completed at either Rockhurst University or University Academy.	Students made final preparations for demonstrations/ activities prior to the start of class.	5 pts through peer review
Reflection	45 minutes to review the requirements for the reflection paper and discuss project outcomes.	Students wrote a 3 page reflection on their experience.	30 pts through instructor review

### Topic Selection

Typically, a portion of one lab period was allotted to introduce the service learning project, the expectations for students outside of the classroom, and the time line for project completion. For the first two classes undertaking the project, the topic of photosynthesis was selected by the instructor. This approach was chosen due to the observation that photosynthesis has traditionally been perceived as one of the most difficult course topics for students. In the last two courses in which the project was

completed, students were allowed to select their own project topic from a list of topics covered in the course (biological molecules, cell structure and function, photosynthesis, cellular respiration, molecular genetics, genetic inheritance, and virus structure and function). Table 2 summarizes the topic selection portion of the project.

TABLE 2: Topic Selection

Course	Undergraduate students	Projects	Community group
General Biology I, spring 2003	24	Photosynthesis	Community garden
General Biology I, spring 2004	24	Photosynthesis	University Academy
General Biology I, fall 2004	2 sections of 24	Course concepts, selected by students	University Academy
Honors General Biology I, fall 2005	18	Course concepts, selected by students	University Academy

### Developing learning objectives

The goals for the service-learning project were that students would: 1) collaborate to develop a meaningful service project that is relevant to a course objective; 2) design teaching approaches related to the chosen topic; 3) teach others about this concept; and 4) reflect on the effectiveness of the project for their learning and for the impact on the community. With this general framework, students were guided to develop their own specific learning objectives for their project at University Academy along with objectives they wanted to achieve with their student audience. Table 3 shows the questions formulated to help students to develop specific objectives and a plan for achieving them. Students were encouraged to use hands on activities or experiments to emphasize content for their specific topics. Most student objectives were centered on learning more about their chosen subject. For example, many student groups choosing genetics as their topic developed learning objectives relating to increasing their ability to solve genetics problems. Similar objectives were listed for their student audience. Some Rockhurst groups also generated objectives relating to learning how to work better with those in our local community. Students had about one-half of a three hour lab period to develop learning objectives, discuss them with the instructor, and modify them as needed.

TABLE 3: Generation of student objectives and plans

1.	List three learning objectives that you would like to achieve to help you with the material in this class (think mostly about what you need to know for the comprehensive final exam). This should explain what you would like to learn.
2.	List three learning objectives that you would like to achieve with the community group. Keep in mind that the goal of the project is to get these students excited about these areas of science by doing hands-on activities. In addition, these students already have some knowledge in these areas, so we want to try to show them additional information that they might not get exposed to in a high school biology class (i.e. we don't want our presentations to be too elementary). This should explain what you would like your audience to learn.
3.	Describe how you will accomplish your objectives above in the following ways. <ol style="list-style-type: none"> <li>Outline the concepts that you will present. Include information from your lecture notes, from your textbook, and from laboratory activities. Work as a group to make sure that this information is accurate and detailed.</li> <li>Outline the activities that you will develop for the students to allow them to learn the concepts.</li> <li>List the materials needed to accomplish your project.</li> </ol>

### Completing the project

Rockhurst students were guided to develop beneficial learning activities, including explanations and diagrams, demonstrations of experimentation, games, and other tasks promoting active learning. The learning activities were mostly developed by student groups meeting outside of class. However, the week before activities were presented, groups shared their plans with the rest of the class. The class then had the opportunity to make suggested changes to each group before final preparations were completed. Depending on the circumstances for each semester, community students either attended part of a Rockhurst laboratory period or Rockhurst students presented in the University Academy science laboratory room or at the community garden. Rockhurst students worked in groups of three or four, creating stations that community groups rotated through. Involvement of the student audience included answering questions, solving problems, completing experimentation, building biological structures, drawing diagrams, completing worksheets, and moving game pieces. Some examples of student projects include: 1) an overview of the steps of photosynthesis, including explanations and visual aids; 2) demonstrations of experiments such as observing oxygen production from plants with

different pigments and measuring carbon dioxide consumption by plants grown in the presence or absence of fertilizers; 3) observations of osmosis in plant cells; 4) games where students formulated genetic predictions; and 5) skits with students dressed as organelles. To work toward equal participation within the groups, students were required to evaluate the quantity and quality of participation by their peers, assigning 25 percent of the grade for the project.

### Reflecting on the project

An essential component of a service learning experience is structured reflection. Reflection is essential both for student learning and for faculty assessment of the project. Students were required to write about three major aspects of their project. The most current requirements for the reflection pieces

are shown in Table 4. The first section of the reflection paper focused on students documenting and critiquing their learning about their course topic for their project. The second section required students to assess their individual contributions, the ability of their group to work together, and possible future modifications of the project. The last section required students to reflect on how the project impacted them personally. This section included reflection on what they personally gained from working with the community group and any attitude changes that may have occurred about the subject of biology based on their experience. Students were encouraged to supply both positive and negative feedback. Table 5 provides samples of student comments from reflection papers showing discussion of learning from the project or personal development (see Discussion section for additional information).

TABLE 4: Requirements for the reflection paper

Paper section	Requirements for full credit
Critique of learning	<ul style="list-style-type: none"> <li>The learning objectives for the group and for the community students are clearly stated.</li> <li>A description of the biological process presented is detailed and thorough (at least ½ page).</li> <li>A description of whether learning goals were met is thorough, including the reasons for either meeting or not meeting the objectives (at least ½ page).</li> </ul>
Project logistics	<ul style="list-style-type: none"> <li>The ability of your group to work together to accomplish the objectives is evaluated.</li> <li>Your specific role in the project is identified.</li> <li>Ideas for things that you would do differently if you undertook the project again are included.</li> </ul>
Personal aspects	<ul style="list-style-type: none"> <li>An evaluation of whether the experience was worthwhile from a community service perspective is included.</li> <li>An explanation of what you learned from your student audience is included.</li> <li>An explanation of how the experience impacted your feelings about our student audience or social issues is included.</li> <li>An explanation of how this experience influenced your attitude about biology is included.</li> <li>Evidence that the student has put significant effort into thinking about the 4 areas above is apparent (at least 2/3 page).</li> </ul>

TABLE 5: Student reflection paper comments

Comments about conceptual understanding	Comments about personal development
It is easy to memorize facts then regurgitate them on a test or quiz. However, it is more of a challenge to find an application of the material or understand the material well enough to explain it to someone else and be able to answer questions concerning the topic.	Being a product of this city's urban public school system, we were not exposed to an opportunity such as this.... I know that so much of life's education is built on the foundation of having exposure and experiences. That is what separates so many people. On average, no one or groups of people are any smarter, it is the various experiences we have that will separate our learning.
Right before we were to teach the tri-hybrid cross, none of us could remember how to do one. We had to ask for help and look it up before we could even do it ourselves. After working one out with the students, I couldn't forget how they work. I remembered it right away on the exam.	The way the students responded made me feel like we really taught them something that they too valued as worthwhile. It made me feel good about myself and about what Rockhurst does and stands for.
I learned that I have a good biological background that allows me to communicate topics in a way that can help others learn. There were no questions that the students asked that we could not answer, and their questions helped me learn about the subject.	The service lab really helped me to see that it is important to spread the topics of biology. Biology is not for everyone, but if it is never presented or elaborated on, a student that has potential to be a biology whiz may never have the opportunity to meet that built in potential. Biology is also one area that the way it is presented is key to fully understanding its concepts.
This made me try to understand biology in a different way. I look at the complex things and try to break them down into something that I fully understand and use everyday. I also have tried to get a better attitude towards the things that I'm studying in biology and look at it in a different way.	This experience made me realize the importance of interaction between diverse groups of students. Often, we end up spending most of our time with people who are more similar to ourselves. I feel the whole society needs to promote activities and opportunities to interact with people from different neighborhoods, different school districts, and different.

**Reflection paper analysis**

To begin to assess the impact of the project on students, we analyzed reflection papers from three sections of General Biology I (groups 1-3) and one section of Honors General Biology I (group 4). We determined the percentages of students reporting positive, negative, or no responses in the categories of conceptual learning, group interactions, satisfaction with the results, and learning about community service. For the first two groups of students, these categories were the major required categories for the reflection paper. During the initial analysis, we noted that students sometimes volunteered additional information not required in the assignment. One major area of reflection not included in the original assignment was a section on personal development. Thus, personal development was documented for the first two groups but was not required in the reflection paper information until the third and fourth groups completed their projects.

discuss personal development in the reflection paper, while groups two and three completed projects on self-selected course topics and were required to discuss personal development in the reflection paper. Group four also differed in that it was an honors section of General Biology.

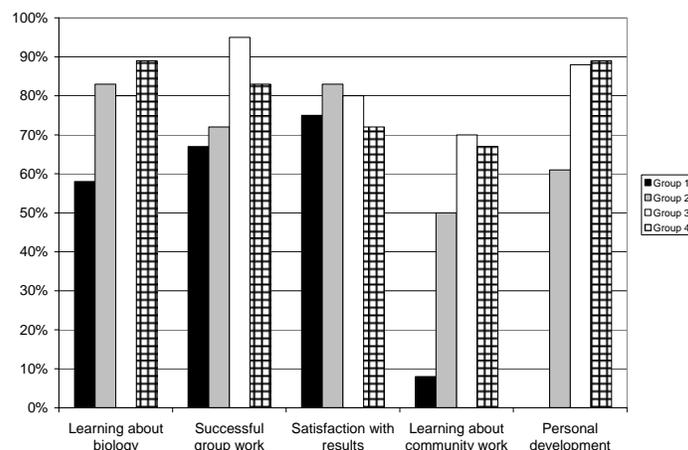


FIG. 1: Comparison of student responses in reflection papers: Percentages of students responding positively on items in the reflection paper (learning about biology, successful group work, satisfaction with results, learning about community work, and personal development) from all four groups are shown. Group one worked with grade-school aged children, and groups two through four worked with high school students. Groups one and two completed projects on photosynthesis and were not required to

Figure 1 summarizes a comparison of the percentages of positive results in each of the categories examined. The only difference in the projects from the first two classes was that the first class worked with grade school-aged students from the community garden and the second group worked with high school-aged students from the University Academy. Students perceived a greater level of learning about biology and community service when working with high school students (83% positive)

rather than elementary students (58% positive), leading us to continue the project at University Academy. We also wished to determine whether self-selection of projects (groups 3 and 4) influenced student reflections when compared to projects where photosynthesis was chosen for students (groups 1 and 2). The results for group 1 show that overall, the scores for this group in each category examined were the lowest. Group 2 had lower positive responses than groups 3 and 4 in the areas of successful group work, learning about community work, and personal development.

### Performance on Final Exams

All students took a common final exam in the lecture sections of the course. To evaluate student learning in relation to their service learning experiences, we looked at performance on the final

exam. Final exam scores for questions covering the four service learning topic areas were compared. Averages were taken for students who had completed service learning in a particular subject area versus students who did not complete service learning in that area. For example, the 11 students who completed service learning on the topic of cells were compared to all of the other students on questions about cell structure and function. Overall averages on the final exam for groups were also documented as a potential point of comparison. The areas of Cells, Genetics, and Viruses all show modest increases in exam performance when comparing service learning participants in that topic area with non-participants (Table 6). However, several changes to the project design need to be addressed before a more accurate picture of exam performance can be captured (see Discussion).

TABLE 6. Test score comparisons for one section of General Biology.

Student group	Cells		Genetics		Photosynthesis		Viruses	
	Service learning students (n=11)	Non-service learning students	Service learning students (n=32)	Non-service learning students	Service learning students (n=6)	Non-service learning students	Service learning students (n=6)	Non-service learning students
Service learning topic questions	89.5%	84.7%	91.7%	85.2%	69.4%	77.3%	89.8%	80.4%
Total Final exam percentage	77.5%	78.4%	79.3%	77.6%	78.7%	78.3%	88.6%	77.5%

### Discussion

We chose to implement a service learning project in the General Biology I course at Rockhurst University to promote a greater level of student understanding of course material. Our analysis of reflection papers showed that most students believe that they are gaining a better conceptual understanding for the material (58% for the first class, 83% for the second class, 80% for the third class, and 89% for the fourth class). While additional assessment methods are needed to further understand the impact on student understanding, we feel that student reflection about their own learning is an important first step in building confidence and helping with mastering difficult concepts. In addition, several students commented on how their project helped them succeed on exams in the course, suggesting that the service learning experience led to a better retention of course concepts for some students. Interestingly, students who worked with the

high school community group reported a higher level of increased knowledge, suggesting that the more complex projects undertaken with older students may better enhance learning. The community partner was the only factor examined that markedly affected student perceptions of learning, as only small differences were observed when comparing groups where the community partner was the same but self-selection of topics or level of student preparation were different (groups two through four).

Another anticipated outcome for the service learning project was some level of increased personal development. This expectation was due to research suggesting that service learning enhances acceptance of diverse groups and social responsibility. Even when we did not require students to document their level of personal development, up to 61% of students volunteered information about increased personal development. When we required students to discuss their personal development (groups three and four), 8-89% of students documented an increase in this area. Student comments documented in Table 5 add

additional support that students are developing greater self-confidence regarding their learning and greater respect for their minority student audience.

In addition to enhanced perceptions of learning and personal development, we found students to be highly satisfied with the project as a whole (72% or greater in all groups) and with the ability of their group members to work together (67% or greater in all groups). These findings are important, because of the inherent challenges of group work and the difficulties encountered when trying to engage a diverse student population in a survey level course. Students seemed particularly pleased with their group work in projects where topics were self-selected versus those in which the photosynthesis topic was assigned.

In the area of learning about community service, students initially reported lower levels of positive responses. This may be due to the fact that our time with the community groups is limited to 2-3 hours and that many of the students who come to Rockhurst have extensive service experience prior to their entry into college. Due to the commitment of Rockhurst to service, many students who are heavily involved in service are attracted to Rockhurst. When students were asked more specifically to address their learning about community service in the context of personal development, positive responses increased from a high of 50% to a high of 70%.

When our students were asked to discuss what they would do differently, a common theme was to have more time with the community groups. Some students also commented that they would get better at their presentation if given additional opportunities to practice and present their activity. Finally, specific changes in experimentation, preparation, level, detail, and assessment of learning in their audience were also recommended. These suggestions have helped us to improve the projects documented here as well as those planned for the future.

Future directions for this project will include more frequent visits with students at University Academy to encourage a longer collaboration with our community partner. In the Fall of 2007, students in the Honors course will visit University Academy 3 times during the semester to carry out their service projects and to reinforce relationships. Another area of assessment of this project will come from evaluating the experiences of students at University Academy. Students at University Academy will be asked to reflect on their experiences as learners. In addition to increasing our interaction and assessment of University Academy students, better tools for more accurate assessment of Rockhurst student

learning in relation to their service experience need to be developed.

Our general perceptions about the project have been extremely positive. We find that our students are enthusiastic about making contributions to providing a fun and engaging learning environment a younger audience (see comments in Table 5). We have observed students who have had difficulties with course material or who have been passive participants in the course make dramatic adjustments through service learning projects. Quiet students express their excitement and ideas about the projects, and struggling students frequently comment that service learning helped them understand the concept addressed in the project.

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