

Teaching Methods

Meeting Learning Objectives through Service-Learning: A Pomology Case Study

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SUMMARY. Undergraduate students enrolled in the introductory pomology course at California Polytechnic State University, San Luis Obispo, CA, from 2007 to 2010, participated in a service-learning project. Students helped the community organization, the California Rare Fruit Growers (CRFG), teach grafting skills to San Luis Obispo County high school students and community members. At the end of each quarter, pomology students completed evaluations of their experience. Results of these evaluations were used to improve teaching methodology and the experience in which the students participated. Self-reported and instructor evaluations of the service-learning project demonstrated that students increased their grafting knowledge and skills, their confidence in learning new skills, and their interest in fruit science and community involvement. The service-learning project enabled students to meet course learning objectives of understanding and becoming experienced in horticultural techniques, such as grafting, and to meet university learning objectives of developing critical thinking and communication skills and increasing community involvement.

There is a growing emphasis on service-learning in higher education. Students in all disciplines are learning not only in the classroom but also in the community. Historically, there have been numerous approaches to teaching university students how to apply knowledge in the “real” world, including internships, externships, practicums, cooperative education, and student teaching. While some of these pedagogies help meet the needs of businesses, government agencies, and schools, service-learning focuses on community needs, which students attempt to meet by applying their newly acquired academic knowledge.

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In reviews of service-learning literature, both Cone (2009) and Dorsey (2001) suggest there are many definitions of service-learning, though commonalities exist among those definitions. Specifically, service-learning includes pedagogies that bring together academics with meaningful community service in a way that enriches both (Cone, 2009; Ehrlich, 1996). The National Service-Learning Cooperative (1999) provides a two-page answer to the question “What is service-learning?,” including a description of service-learning as “... an educational method that involves students in challenging tasks that meet genuine community needs and requires the application of knowledge, skills and systematic reflection...” Students undertake projects in the community that go beyond the campus and require the use of specialized knowledge and skills

learned in the classroom and laboratory (Kalivas, 2008).

Descriptions of the elements of service-learning also vary. Scholarly reviews of service-learning typically characterize it as having at least four key elements: academics, reciprocity, reflection, and diversity (Cone, 2009; Dorsey, 2001; Education Commission of the States, 2002; National Service-Learning Cooperative, 1999). Service-learning is more than community service because of its academic component (Education Commission of the States, 2002). Service-learning projects must be designed based on learning outcomes (Cone, 2009) and to provide an opportunity for students to learn how to apply and/or convey their academic knowledge within the community.

One part of the academic aspect of service-learning is the element of reflection, including discussions, surveys, journals, and/or other opportunities for students to talk or write about their experiences. A study by Astin et al. (2000) demonstrated that the process of reflection is required for students to understand the relationship between their service-learning and classroom experiences.

Reciprocity refers to the relationship between the community and the university entities involved in service-learning (Kendall, 1990). It is expected that the students will learn from the community and that the community will benefit equally from this partnership (Cone, 2009; Dorsey, 2001). In addition to meeting the academic needs of students, service-learning projects must meet “genuine community needs” (National Service-Learning Cooperative, 1999). Projects are based on community needs, not university interests, and are, therefore, usually identified, modified, and sustained by a collaborative interaction between community leaders, faculty, and students (Brooks and Schramm, 2007; Education Commission of the States, 2002).

Diversity is also central to many service-learning projects because they provide students with opportunities to interact with people different from themselves. Many students possess minimal experience in sharing knowledge across different ages, cultures, experiences, etc., despite this being an important aspect of their professional career development (Cone, 2009). Brooks and Schramm (2007) reported

that economics students "...learned the personal skills required to ... work with a wide variety of people..." during the completion of their service-learning project.

The expected outcomes from participation in service-learning projects include improved academic performance (Astin et al., 2000; Montgomery, 2004), problem-solving skills (Brooks and Schramm, 2007; Eyler and Giles, 1999; Pinzon-Perez and Perez, 2005), communication skills (Kalivas, 2008; Pinzon-Perez and Perez, 2005), group-work skills (Brooks and Schramm, 2007; Pinzon-Perez and Perez, 2005), and positive changes in attitudes toward community involvement, leadership, and cultural diversity (Astin et al., 2000; Pinzon-Perez and Perez, 2005).

Billig (2002) asserted that the lack of a specific model for service-learning makes it an adaptable method that can be applied successfully to a variety of educational and community needs. Service-learning projects have been demonstrated to improve the depth and breadth of student comprehension in a wide variety of disciplines, including engineering (Pearce, 2006), health (Pinzon-Perez and Perez, 2005), economics (Brooks and Schramm, 2007), geography (Dorsey, 2001), biotechnology (Montgomery, 2004), and chemistry (Kalivas, 2008). Many horticulture programs now include a class or classes with service-learning projects, including those in which students develop and execute community landscaping projects (Berle, 2006; Davis, 1999; Knauff et al., 2008; Trader and Heiselt, 2009), install irrigation systems (Lavis and Brannon, 2010), teach horticulture to elementary school students (Knauff et al., 2008; Motsenbocker and Smith, 2005), or teach integrated pest management for the benefit of community members (Faust et al., 2000). Service-learning has even been integrated throughout the curriculum of horticulture programs at universities such as the University of Georgia (Berle, 2006) and Virginia Polytechnic Institute and State University (Niemiera et al., 2010). However, given the previously described impact of service-learning on learning objectives, such projects may be an underused pedagogical tool in many horticulture programs.

California Polytechnic (Cal Poly) State University, San Luis Obispo, CA, is a nationally ranked, 4-year, public university located among the major

agricultural regions of California. Its College of Food and Environmental Sciences is also nationally ranked and is the fourth largest undergraduate agricultural program in the United States. Cal Poly emphasizes "learn by doing" for all of its students. In keeping with that philosophy, students not only learn during lectures and laboratories but they also work on the campus' extensive orchards and vineyards and often participate in internships. However, opportunities to use these skills to give back to and/or learn from the community are not abundant because volunteer opportunities are typically limited to extracurricular activities. Therefore, the objective of this project was to assess whether the addition of service-learning to an introductory pomology class provided a sound pedagogical approach to teach horticultural techniques while also meeting broader university learning objectives, including fostering critical thinking, communication, teamwork, and community involvement.

Materials and methods

From 2007 to 2010, Cal Poly students in the introductory pomology course, Pomology I (Fruit Science 132), worked with the local chapter of the CRFG to teach grafting methods in San Luis Obispo County junior high and high schools, the Grizzly Youth Academy (GYA), and the Master Gardener Program. The CRFG began its annual grafting project in 1998. This event takes place during the winter quarter when the introductory pomology course is offered. Enrollment remained consistent during the 4 years in which this service-learning project was conducted, with 22, 24, 23, and 25 students in 2007, 2008, 2009, and 2010, respectively. The course syllabus for Pomology I included a statement that a service-learning project was required and would represent 10% of the course grade.

Before teaching grafting techniques to others, pomology students received a classroom lecture from the instructor, which described the basic principles of propagation, including budding and several grafting techniques. Students completed a laboratory during which they practiced cleft, whip, and whip-and-tongue grafted scion wood to potted apple (*Malus × domestica*) and stone fruit (*Prunus* spp.) rootstock trees. During the 2008 grafting

laboratory, the course instructor also provided a verbal description of what pomology students should expect when working with the CRFG. In 2009, this description included a demonstration of the key techniques used by the CRFG to teach grafting to community members. In 2010, an audio recording of a CRFG member's grafting instruction was used by the course instructor to enhance the verbal description and visual demonstration used to prepare students for their service-learning experience.

After the grafting lecture and laboratory, each student participated at a local school, the GYA, or Master Gardener Program to help teach grafting skills. Numerous locations and time frames were provided, allowing students to select a time and place that best fit their schedule. The majority of students chose to participate at the high schools because the CRFG arranged a larger number of teaching opportunities there.

At each site, CRFG members met with pomology students and community volunteers to explain what was expected of them and to provide a lecture and demonstration of grafting for the participants. Each school student, GYA participant, and member of Master Gardener program was provided with a bare root tree, a 1-gallon pot, scion wood for grafting, and a pocket knife. Knives were turned in at the conclusion of the grafting lesson. Pomology students helped CRFG members teach and supervise the potting of the trees and the cleft grafting of scion wood onto the pencil-thin rootstock. Rootstocks were disease resistant and scion wood was obtained from commercially viable cultivars. After grafting, each student, GYA member, or Master Gardener participant had an apple tree to take home, along with instructions for planting, pruning, and fruit thinning, allowing teaching and learning about the crop to continue.

To successfully complete the service-learning assignment, pomology students were required to reflect on their experience by completing a written assessment after grafting at a school, the GYA, or the Master Gardener Program (Fig. 1). Students were asked to rate 12 statements using the following scale: A = strongly agree, B = agree, C = neutral, D = disagree, or E = strongly disagree. Two open-ended questions asked what students liked about the

ASSESSMENT OF THE FRSC 132 APPLE GRAFTING PROJECT

This is due by Wednesday 3/12 at 5:30 pm.

1. Your name:

2. The name of the school(s) with which you grafted:

3. Assess each statement using the following scale:

A=Strongly Agree B=Agree C=Neutral D=Disagree E=Strongly Disagree

My knowledge of fruit tree grafting increased during my participation in this project. _____

My knowledge of fruit trees increased during my participation in this project. _____

My grafting skills improved during my participation in this project. _____

Teaching others to graft helped me to be a better grafter. _____

I am now more confident in my ability to graft fruit trees. _____

I am now more confident in my ability to learn new skills about fruit trees. _____

I am now more confident in my ability to learn new skills in general. _____

I enjoyed working with the members of the California Rare Fruit Growers. _____

I enjoyed working with the students. _____

Overall, I enjoyed the grafting project. _____

I would recommend that the grafting project remain a part of this class. _____

4. Would you like to participate in apple grafting with the high schools next year? _____

5. Describe what you liked about the project.

4

6. What would help to improve this project?

Fig. 1. Sample form completed by students enrolled in the introductory pomology course, Fruit Science 132, for assessment of a service-learning project, during which students taught grafting methods with the California Rare Fruit Growers to junior high or high school students or community members.

service-learning project and what they thought would improve it. During 2007, 2008, 2009, and 2010, assessments of the project were completed by 20, 16, 21, and 25 students, respectively. Throughout the duration of the project, solicited and unsolicited feedback was obtained from pomology students and from the CRFG by e-mail and verbal communication.

Results

Student assessments of the project indicated that students believed their participation in the grafting project increased their knowledge of fruit science (Table 1). In the 4-year period in which the service-learning project was conducted, 85% to 100% of the students “strongly agreed” or “agreed” that their “...knowledge of fruit tree grafting increased.” Students also

reported that their grafting skills increased (77% to 100% responding “strongly agreed” or “agreed”) and that their confidence in their grafting skills increased as a result of their participation (94% to 100% responding “strongly agreed” or “agreed”). Interestingly, students not only reported an increase in confidence in their “ability to learn new skills about fruit trees” (85% to 100% responding “strongly agreed” or “agreed”) but also “to learn new skills in general” (75% to 88% responding “strongly agreed” or “agreed”).

Results also indicated that students “enjoyed the project” (90% to 100% responding “strongly agreed” or “agreed”) and specifically enjoyed working with the high school students and the CRFG. A majority recommended that the project remain a part of the class, with 80% to 100% responding

“strongly agreed” or “agreed.” A willingness to participate in the grafting project in the future was the only statement with which any students “strongly disagreed” during the study (15% in 2007 and 13% in 2008). However, it was notable that the majority of students expressed an interest in volunteering their own time in the future (56% to 80% “strongly agreed” or “agreed”).

The percentage of students who rated statements about their grafting experience as “strongly agree” or “agree” in 2009 was often lower than that in the other 3 years of the study. This difference was due, in large part, to four students who reported communication issues with some of the CRFG members with whom they worked. The situation was confirmed by the CRFG and reflected in those students’ answers to the open-ended assessment questions.

Several themes emerged in response to the two open-ended questions. When describing what they liked about the project, students frequently responded that they enjoyed interacting with community members by teaching them how to graft (“...tested my skills ... by trying to teach others”), often remarking that the experience had improved their own grafting skills (“teaching other people helps you learn”). Students frequently stated that they enjoyed working with CRFG members [“the enthusiasm of the (CRFG) was contagious”] and several commented on how much they had learned from the community [“...enjoyed working with the (CRFG) because ... they taught me ... things that I didn’t know before.”]. Several students noted they enjoyed “representing Cal Poly.” In response to the question “What would help to improve this project?” students often stated that they would like to know more about what to expect before going to their site. Several students mentioned that the project was time consuming and/or that the times and locations of the grafting projects were not convenient, though some of those same students noted that they knew this “couldn’t be helped.”

Discussion

Self-reported increases in academic skills and technical abilities are characteristic of successful service-learning programs (Astin et al., 2000;

Table 1. Student response rates to statements on the assessment form (Fig. 1) for the service-learning project conducted during the introductory pomology course in 2007, 2008, 2009, and 2010.

Statements rated by students	Yr	n	Response rate (%)				
			Strongly agree	Agree	Neutral	Disagree	Strongly disagree
My knowledge of fruit tree grafting increased during my participation in this project.	2007	19	74	26	0	0	0
	2008	16	63	31	6	0	0
	2009	20	55	30	5	10	0
	2010	25	56	36	4	4	0
My knowledge of fruit trees increased during my participation in this project.	2007	20	45	40	15	0	0
	2008	16	31	69	0	0	0
	2009	21	33	33	24	10	0
	2010	25	40	52	8	0	0
My grafting skills improved during my participation in this project.	2007	20	75	25	0	0	0
	2008	16	75	25	0	0	0
	2009	21	43	33	19	5	0
	2010	25	60	32	8	0	0
Teaching others to graft helped me to be a better grafter.	2007	20	65	30	5	0	0
	2008	16	56	38	6	0	0
	2009	21	48	38	5	10	0
	2010	25	76	24	0	0	0
I am now more confident in my ability to graft fruit trees.	2007	20	70	25	5	0	0
	2008	16	56	38	6	0	0
	2009	21	43	52	0	5	0
	2010	25	72	28	0	0	0
I am now more confident in my ability to learn new skills about fruit trees.	2007	20	50	35	15	0	0
	2008	16	56	38	6	0	0
	2009	21	48	43	5	5	0
	2010	25	64	36	0	0	0
I am now more confident in my ability to learn new skills in general.	2007	20	25	50	25	0	0
	2008	16	63	19	19	0	0
	2009	21	52	29	14	5	0
	2010	25	64	24	12	0	0
I enjoyed working with the members of the California Rare Fruit Growers.	2007	20	60	40	0	0	0
	2008	16	81	19	0	0	0
	2009	20	45	25	25	5	0
	2010	24	92	8	0	0	0
I enjoyed working with the students.	2007	20	35	50	15	0	0
	2008	16	75	25	0	0	0
	2009	21	62	29	5	5	0
	2010	25	76	16	8	0	0
Overall, I enjoyed the grafting project.	2007	20	65	30	15	0	0
	2008	16	81	19	0	0	0
	2009	21	62	29	10	0	0
	2010	25	80	20	0	0	0
I would recommend that the grafting project remain a part of this class.	2007	20	70	20	10	0	0
	2008	16	75	25	0	0	0
	2009	20	50	30	10	10	0
	2010	25	80	20	0	0	0
I would like to participate in apple grafting with the high schools in the future. ^z	2007	20	40	20	25	0	15
	2008	16	44	13	25	6	13
	2009	19	26	47	26	0	0
	2010	25	60	20	20	0	0

^zIn 2007 and 2008, this item was a question (see Fig. 1), and in 2009 and 2010, it was a statement.

Montgomery, 2004). Grafting is among many horticultural techniques that can be challenging for students to learn; a lecture and 3-h laboratory are not sufficient. The addition of the service-learning project provided an additional opportunity for students

to practice and gain confidence in their skills. One reason for the success of the project reported herein may be the use of student-led teaching. Sánchez and Craig (2007) reported that students teaching undergraduate plant systematics laboratories stated

that teaching improved their understanding of the subject. Other successful university service-learning projects using a students-as-teachers model include undergraduate students providing elementary school students with lessons in chemistry (Kalivas, 2008) and plant

science (Knauff et al., 2008). To be able to explain grafting to others, students who participated in the project described herein had to think critically about how to put the theory of grafting into practice, work well in groups, and communicate effectively with peers, younger high school students, and older members of the community, who acted as teachers, mentors, and colleagues. Students' increased confidence in their abilities was consistent with the work of other researchers (Cone, 2009; Lavis and Brannon, 2010; Motsenbocker and Smith, 2005), who found that students had measurable increases in self-efficacy following participation in service-learning projects.

Though not tested empirically in the study reported herein, it was the instructor's observation that student's grafting skills and knowledge of grafting improved after participation in the service-learning project. This assessment was based on several observations. The instructor taught two additional classes in which grafting was taught either as a lecture topic only (introductory horticulture class) or in lecture and laboratory (non-majors fruit science class). In the quarters since adding the service-learning project to the pomology class, the instructor observed that confusion about grafting was minimal in that course, while the apparent frequency and nature of questions was unchanged in the two other classes, suggesting that this was the result of the service-learning project and not the increasing experience of the instructor in teaching grafting. One potential method for quantifying these observations would be to give a grafting laboratory practical both before and after the participation of students in the service-learning project. Increases in skill level after participation in a service-learning project have been empirically demonstrated by other researchers using skills tests administered pre- and post-participation in a service-learning project (Eyler et al., 1997; Montgomery, 2004; Pinzon-Perez and Perez, 2005).

The success of this project in meeting course and university learning objectives was dependent on three things: 1) selection of an appropriate community project, 2) responsiveness to feedback from students and the community partner, and 3) improvements in organization to increase student preparation and instructional efficiency. Working with the CRFG to teach grafting to

the local community met the criteria for a service-learning project for several reasons. Most importantly, participation in the CRFG grafting project was academically appropriate. This project allowed pomology students to meet a major course learning objective, that as a result of the course, students would be able to describe and perform specific pomology production practices, including grafting. The project also provided students with the opportunity to meet several Cal Poly learning objectives stated in the university catalog, including that students "think critically and creatively, communicate effectively, work productively as individuals and in groups, and use their knowledge and skills to make a positive contribution to society." Furthermore, this service-learning project met a genuine community need. The CRFG teaches community members how to graft ≈ 2000 trees every year and they spend considerable effort in recruiting sufficient volunteers for this project. Finally, this project was enjoyed by the vast majority of student participants, despite its time-consuming nature. Several students stated that they would like to devote more time to the CRFG apple-grafting project. In fact, some students volunteered at additional grafting sites after their own course-required participation was complete.

Instructor responsiveness to feedback was required to build and maintain a project that would run smoothly from the perspective of all parties (students, community members, and the instructor). During the first year of the project, students often questioned the point of the service-learning project, were uncertain what they were expected to do, and complained about the time needed to complete the project. These results were consistent with those of Pinzon-Perez and Perez (2005), who reported that common student criticisms of a service-learning project were lack of organization and too long of a time requirement. To address these issues in the present study, strategies were developed with the assistance of Cal Poly's Center for Teaching and Learning and were implemented beginning in the second year of the service-learning project. For example, the assignment was discussed in detail on the first day of class, including acknowledgment that each student's time is valuable and that this is reflected, in part, by the

percentage of their course grade dependent on the service experience. Written information was provided on the class website and updated as needed throughout the quarter. As described previously, detailed descriptions and demonstrations of how CRFG members teach grafting were provided to students before their work with the CRFG so that students knew what to expect when arriving at their project site. Other researchers have reported on the importance of providing proper training and demonstration before service-learning activities (Astin et al., 2000; Lavis and Brannon, 2010).

Conflict between four students and CRFG members in 2009 also required responsiveness by the instructor. It became obvious that exposure to more professional communication techniques would enhance student relationships with CRGF members, better prepare them to teach grafting techniques to others, and provide them with the skills to interact successfully as professionals in their field. Brooks and Schramm (2007) also described conflict mediation as a required component for a successful service-learning project. In the project reported herein, additional time was spent coaching students on professional communication techniques before they grafted as part of the 2010 service-learning project. During that year, no such communication problems were reported by students or the CRFG.

Improvements of the service-learning project also resulted from increased efficiency by the instructor. In the project's first year, lecture time was spent providing clarification and determining logistical details. Students were uncertain about when and where they were to participate and it was difficult for the instructor to determine the location at which each student was participating and to confirm that each student had successfully completed the assignment. Beginning in 2008, emphasis was placed on the need for individual responsibility for the logistical organization and professionalism required. Students coordinated when and where they participated. Each student was responsible for contacting a specific member of the CRFG so that they could sign up to participate. To confirm where each student participated, students were required to be in the group photo already scheduled to be taken of each class after trees were

grafted. A CRFG member emailed photos to students and to the instructor. This provided sufficient information to the instructor with minimal inconvenience to CRFG members. These changes allowed the project focus to be on student grafting and community involvement, as opposed to instructor-led problem solving and “hand-holding.” Billig (2002) has also reported that the overall impact of service-learning increases with increased student responsibility and autonomy during service-learning projects. Interestingly, in the fourth year of the project, 36% of students remarked on their surveys that no improvements were needed (“everything was extremely organized and well planned—not sure what else could be improved”). Class enrollment has not exceeded 24 students, making this assignment manageable from an instructional perspective. If the enrollment were to grow significantly, more fail-safe measures would need to be in place to assure that participation and grading would take place at expected levels while maintaining the benefits of this unique service-learning project.

The problems encountered during the first year of the project (2007) are a possible explanation for the drop that occurred in course evaluation response rates from 2006 to 2007 (Table 2). A similar reduction in course evaluation response rates was not seen in the instructor’s other courses that quarter (data not shown). After employing the previously described techniques to improve the service-learning project, an improvement was noted in the 2008 and 2009

student course evaluations (Table 2). For example, 95% to 100% “strongly agreed” or “agreed” that activities focused on goals and objectives in the syllabus, their interest in the topic had increased, or they would recommend the instructor or the course. Knauff et al. (2008) also reported an improvement in course evaluations after adding service-learning projects to courses.

Conclusions

Taken together, the results indicated that the four key elements of a successful service-learning project were met by the addition of the CRFG grafting project to the pomology course. The experience successfully reinforced academic learning; reflection allowed students to recognize the benefits of their efforts and helped to improve the project; learning was reciprocal, in that students both taught within the community and learned from the community; and students interacted with diverse groups of people. Therefore, the service-learning project aided students in meeting both the course learning objective of learning horticultural techniques and the university learning objectives of developing critical thinking, communication, and teamwork skills and increasing community involvement.

To date, 94 Cal Poly students have participated in the CRFG grafting project to fulfill the introductory pomology course’s service-learning requirement. At Cal Poly, this is a sustainable activity in the introductory pomology course. Students can and have continued to participate with the

CRFG grafting program beyond the course requirement, including coming back in future years. This increases community knowledge about the university and enhances its reputation as a leader in horticultural education. Continuous enhancement over successive years led to the development of a pedagogically sound service-learning project that was streamlined for the instructor, enjoyed by students, and beneficial to the community.

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Table 2. Student response rates to selected questions from course evaluations of an introductory pomology course in the year before implementing a service-learning project (2006) and in the first 3 years with a service-learning project.

Statements rated by students	Response rate [strongly agree + agree (%)]			
	2006	2007	2008	2009
In-class activities focused on the goals and objectives presented in syllabus.	92	76	100	95
The instructor encouraged student interactions and active involvement during class.	91	64	100	100
My interest in the course topic has increased as a result of this course.	92	71	95	100
I would recommend this instructor to other students.	91	72	100	100
I would recommend this course to other students.	83	72	96	100

In 2006, 2007, 2008, and 2009, n = 13, 17, 21, and 20, respectively.

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