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In the Classroom

Integrating Service Learning into the College Chemistry Curriculum

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Service learning can clearly illustrate the value of the campus as part of community and society.

General chemistry students often complain that they are unmotivated because they see no applications of chemical principles in "real life." Instructors become frustrated by these complaints because they see the world as nothing less than a cornucopia of applications of chemistry. How can students learn that chemistry does apply to real life? In this paper, we describe *service learning*, a powerful strategy for integrating chemistry, community service, and real-life applications in the general chemistry curriculum.

Introduction

Teaching, research, and service are all part of the stated mission of most colleges and universities. How do these tenants put forth in a mission statement manifest on campus?

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The teaching mission of a college campus is typically pretty clear and, perhaps, the ultimate purpose of any educational institution. The research mission helps contribute to generating knowledge for the common good and is typically measured in publication and grant procurement. What is less clear, however, is the service mission of higher education. Historically, service referred to public outreach to local communities. Campuses provided services and benefits to their communities through their very existence. Today, service often refers to institutional and disciplinary citizenship, such as committee work and professional consulting. As criticism and suspicion of higher education increases, many education leaders look to their service missions as a way to improve relations between campus and community. Higher education is in a unique position, perhaps more than any other type of institution, to contribute to the alleviation of social problems. Colleges and universities serve their communities not only by educating its citizens, but also by providing services to meet local needs. Faculty scholarship and service are instrumental in community problem solving. As teachers, faculty can also call on students to apply classroom learning in social settings beyond the campus to fulfill the service mission of higher education.

Service Learning

Service learning is the integration of community service with academic study. It is a pedagogical strategy that challenges students to apply theories and principles learned in the classroom to meet community needs. This experiential-based approach to learning requires students not only to *know* class material, but more importantly, it requires them to *apply* it in real-world contexts. Courses in the sciences that use service learning as a pedagogical tool can simultaneously train students in the discipline and promote scientific literacy to a communitywide audience [1]. The benefits to students of a service learning requirement in their science courses, especially when considering the emphasis on making interconnections between the physical and social worlds, include cognitive, moral, and psychosocial development [2, 3]. Additionally, given the struggle of many universities to interpret and apply the meaning of the public-service component of their missions, we believe that service learning provides a solution in that it is a vehicle to link the campus and its community in a direct way.

Campuses are typically a focal point of the communities in which they are located because, among other reasons, they provide services to community members. They

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educate citizens, host cultural events, and provide an arena for intellectual stimulation. They often form a geographic hub that serves as the center of a collection of smaller communities. Colleges and universities are criticized, however, for taking as much, if not more, than they give to their communities. Campuses that behave or are even perceived to behave as "ivory towers" enjoy the benefits of existing in a community without giving back significantly to that community. This ivory-tower existence can lead to significant tensions between "town and gown."

Service learning can clearly illustrate the value of the campus as part of community and society. By involving faculty and students in the community, the application of scholarly pursuits is made tangible and provides a counterpoint to the "widespread perception that academic institutions, most particularly universities, are disconnected from the concerns and needs of society" [4]. Finally, service learning helps to remind institutions that all of its students graduate to become citizens of their communities and that preparing individuals for both civic life as well as public service are long-standing traditions of higher education.

Principles of Service Learning

As service learning has gained popularity in all disciplines on college campuses throughout the country, several guidelines and principles have emerged to provide direction for how to implement service learning and assure its academic efficacy in the classroom [5]. Howard's ten principles for service learning [6] helped to shape the service component of our general chemistry curriculum, which was first implemented on a optional basis in the Fall of 1995 and was subsequently made mandatory in the Fall of 1997.

1. *Academic credit is for learning, not for service.* Credit in academic courses is assigned to students for demonstrated learning of academic content. Service learning is not different.

2. *Do not compromise academic rigor.* Course-based and service learning should demonstrate that students have learned how to merge and apply their community experience with classroom knowledge.

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3. *Set learning goals for students.* Learning objectives in a course that has a service component must explicitly focus on how the community experience will be integrated into course content.

4. *Establish criteria for the selection of community service placements.* Service experiences need to: (a) be meaningful and connected to course content, (b) be sufficient in terms of time to meet the learning objectives of the course, and (c) provide the potential to stimulate learning that is related to the course. Community placements must be tied to course objectives to be effective.

5. *Provide educationally-sound mechanisms to harvest the community learning.* Coursework needs to provoke analysis of the service experience within the academic context of the course. Research papers, discussions, presentations, journals, and other writing assignments can all be used as reflection devices for students to bridge service and learning.

6. *Provide supports for students to learn how to harvest the community learning.* Students need to be assisted in acquiring the skills necessary for making the link between coursework and the placement in the community.

7. *Minimize the distinction between the student's community learning role and the classroom learning role*. Student learning in the classroom and learning in the community needs to be synergistic.

8. *Rethink the faculty instructional role.* Service learning requires a shift from the sole use of traditional classroom and laboratory practices to more hands-on and applied strategies.

9. *Be prepared for uncertainty and variation in student learning outcomes.* For many students, service learning is a teaching strategy that can lead to different learning outcomes. Further, diversity in community placements leads to different learning outcomes.

10. *Maximize the community-responsibility orientation of the course.* Learning objectives and classroom formats need to encourage collaborative learning so students can learn from each other. Because students will be placed in different settings, the classroom will bring together the rich variation of these experiences.

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Curriculum

In our general chemistry courses, students are required to: (a) participate in at least one science-related service learning project, (b) write a paper analyzing their service experience, and (c) participate in an end-of-semester class discussion about their project. Potential choices for service learning projects are numerous. Projects with an environmental theme are popular among the students. Examples include participation in hazardous waste collection events, local litter clean-up, and volunteering to serve in community health events such as leadbased paint detection and correction for families with small children. Other examples include science fair judging and participation in public-awareness events such as those that often occur during National Chemistry Week.

With the increased use of service learning over the past few years, many campuses have developed service learning offices with directors and staff that help connect faculty and their classes with community projects. For example, at The University of Montana, Volunteer Action Services is a university service that helps to find appropriate placements for instructors who use service learning. An important principle of service learning is for projects to meet identified needs that exist within the community. The goal is not for faculty to come into community agencies and to tell them what they need, but instead, the goal is for the community, in partnership with students and faculty from higher education, to identify potential classroom projects to address existing community needs. At the start of each academic year, Volunteer Action Services conducts an assessment of community needs. The outcomes of this assessment are then used to identify appropriate placements for students in courses that have a service learning component.

Service learning administrators are crucial for bridging campuses and their communities because they can help identify suitable placements, assure that students have adequate supervision and training, and create meaningful academic experiences. Service learning should engage students in projects that are connected to the subject matter of the disciplines. At The University of Montana, service learning is used in many courses in addition to general chemistry. For example, in the course Communication Research Methods, students work with local agencies to identify research questions, conduct research, and write up results and implications. The agencies (e.g., Salvation Army, Food Bank) were able to use this information and incorporate it into the planning and evaluation of their programs. Other examples

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include courses such as Business and Society and Literacy Strategies in Education. Service learning is also being integrated into the science curriculum on many other campuses. For example, Deborah Wiegand is well known in the chemical education community for her extremely successful service learning course at the University of Washington [7]. Service learning is also integrated into the science curriculum at campuses such as the University of Utah, Montana State University–Bozeman, and Case Western Reserve University.

Once students have completed their service learning project, they are required to write a brief essay that includes: (a) the who, what, when, where, why, and how of their project; (b) a description of how the project is related to science; (c) the importance of the project to the community; and (d) a personal reflection about how participation in service affected the student. We reserve one discussion section near the end of the semester for students to give verbal reports on their service learning experiences and to engage in dialogue about the meaning of community service. These reflection sessions are critical to the success of service learning. Meaningful learning takes place through combinations of thought and action, reflection and practice, and theory and application [8]. For students, reflection is a vehicle that allows them to grapple with the complexities that exist in the community and to make connections between the concepts they learn in the chemistry classroom and the community projects. Reflection is crucial to successful service learning, especially in the sciences where the links between classroom concepts and the community may not be immediately apparent. For faculty, student reflections can provide an assessment tool to determine whether students are applying their chemistry knowledge to community-based problems.

Administration

We have had a great deal of success with having college students teach science to elementary students. We will use this project as an illustrative example of how we take on the seemingly cumbersome burden of the administration of hundreds of students in our general chemistry courses. We typically enroll about 240 students in the first-semester course in the Fall semester, and an additional 120 students begin the general chemistry sequence in the spring. An overview of the administrative structure is given in Figure 1.

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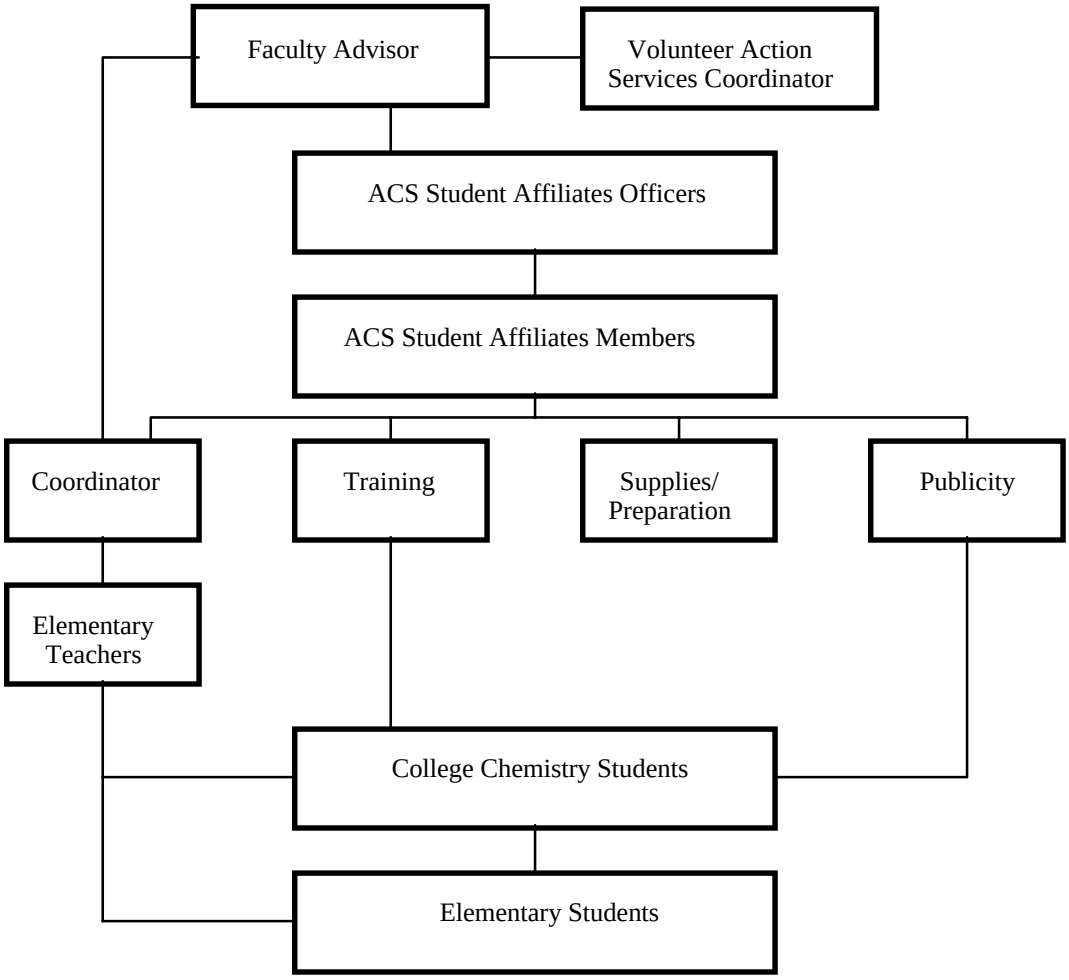

FIGURE 1. ADMINISTRATIVE STRUCTURE OF THE ELEMENTARY SCHOOL HANDS-ON SCIENCE PROJECT.

Our elementary school project involves bringing hands-on physical science into our local elementary school classrooms. The need for such a project in our community was made quite clear by faculty members with elementary-school-age children, who commented that science was a minor part of the curriculum, and, when it was taught, there tended to be a biological emphasis. We have developed a number of learning-cycle lessons [9] that are designed so that elementary students collect data using simple grocery store chemicals and then use their data to "invent" a scientific principle [10, 11].

The "secret" to our administrative procedure is that we have enlisted our campus Student Affiliates of the American Chemical Society (SAACS) Chapter (also known as

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the Chemistry Club) to bear much of the workload. Four members of the SAACS, working in conjunction with the chapter officers, coordinate the elementary school visits. Quite frequently, the chapter officers also take on roles in running the elementary science project.

The key SAACS administrator is the project coordinator. This is someone who contacts the local elementary schools, schedules classroom visits, and relays this information to other members of the club. Originally, we simply generated a list of all of the local elementary schools from the phone book, then we began calling and offering our services. We have generally been able to meet our academic-year goal of at least one visit to each school.

Second in our group of four project administrators is the publicity coordinator. The primary task of this person is to go to chemistry lectures and, with the permission of the instructor, announce the dates and times of the upcoming elementary school visits and the associated training sessions. We invite all students in as many chemistry courses as is practical to participate in our projects although we have found that, unless service learning is a required component of the course or unless it carries some extra credit, students rarely volunteer. There is an important exception to this observation, however. Many students who were required to perform a service project while they were enrolled in general chemistry voluntarily perform projects in subsequent semesters. In the past we have tried to publicize the project by distributing flyers, but we have found that placing a “live” student in the classroom promotes a greater degree of participation.

College chemistry students must be trained as teachers; thus, another SAACS member fills the role of training coordinator. This role is generally assigned to someone who participated in the project in the previous year, so that they have actual experience with working with the elementary students and a familiarity with the experimental exercises. We train groups of new students through role-playing where they act as elementary students and the training coordinator plays the role of student instructor. We have also developed a teaching guidebook that serves as an instructor’s manual and practical guide for classroom management.

The final administrative role filled by a SAACS member is that of supplies coordinator. Our elementary school experiments typically require a number of

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solutions, plastic cups, droppers, and of course, goggles. (Those of you who teach first-year college chemistry laboratories will be pleased to know that elementary students *enjoy* wearing goggles!) The supplies coordinator is in charge of recruiting help from the club members and making sure that all of the necessary supplies are prepared and ready for each elementary school visit. We generally assemble supplies into one-visit kits.

The funding requirements for our service learning activities are very small. We initially paid for the elementary school project by asking students to donate one item that costs less than one dollar, such as a box of baking soda, a bottle of vinegar, or a head of cabbage (to make indicator solution). The majority of the 240 students responded with donations, creating more than enough supplies to carry us through our first year. Subsequently, we have found that local businesses are very willing to make small donations. The elementary students frequently write thank-you notes to the donors, and the businesses often proudly display these notes in their stores. The Department of Chemistry has also been willing to donate supplies. When compared to the overall laboratory budget for general chemistry, the cost of partially supporting the elementary science project is extremely modest.

Whereas the elementary science project is relatively heavy in administration time, we have seen a number of other service learning projects that require little or no internal administration. An example is our work with Head Start, a national program for low-income preschool children designed, in part, to provide early educational experiences for these children. When college general chemistry students volunteer to work at Head Start, the agency coordinates, schedules, and places our students into their programs. Projects at Head Start have included reading to the children and their families (we require that the books be something that will kindle their interest in science) and working with the preschool teachers in conducting science lessons.

Evaluation

The overall service learning project—participation, essay, and discussion—is worth about the same number of points as a laboratory report in our overall grading scheme. This seems to be sufficient to get students to take the project seriously. Many students need some coaxing to believe in the importance of the project before they participate, but, once they get involved, they usually become enthusiastic supporters. We assign

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points for participation in a project (some documentation is required), participation in the reflection discussion, and the essay is assigned a letter grade based on its quality. As with the laboratory portion of many large general chemistry courses, our teaching assistants keep track of the grades and evaluate the essays based on a grading scheme that we design.

Feedback

We have received a great deal of positive feedback from elementary students, elementary teachers, Head Start teachers and social workers, other citizens of the community, and the college students themselves. Representative comments include:

Elementary Students

> “My favorite subject is science.”
>
> “Those were the best experiments I have ever done!”
>
> “Science rocks!”

Elementary Teachers

> “In today’s world it is critical that students become involved in community learning projects. The younger students learn many valuable things, not only from their age-group peers, but the modeling from the older students is critical to their development.”
>
> “I was impressed with the retention of information. We enjoyed…the chance to experiment with things we probably wouldn’t get a chance to experience.”

College Students

> “The feeling that I was making a difference in my own little way put me one step above the person I was before.”
>
> “The third grade trip is an experience that will reside in the back of my mind for years to come. I will remember the exuberance of the third graders every time I see the apathy around me at the University. Those points have been some of the most eye-opening that I have ever worked on. I wish that every student here could see, and remember, how it is to love to learn as a child.”

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Conclusion

We urge chemistry educators to seriously consider the introduction of service learning as a component in their courses. Modern education is evolving and becoming more than simply textbooks and laboratories. We need to increase our efforts at bringing the community and the university together as partners for providing services to the community members. Service learning provides a mechanism for college chemistry instructors to teach students the value of community service as well as the traditional content and process of chemistry, while at the same time making students aware of real-world applications of chemistry.

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