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Using Pamphlets To Teach Biochemistry: A Service-Learning Project

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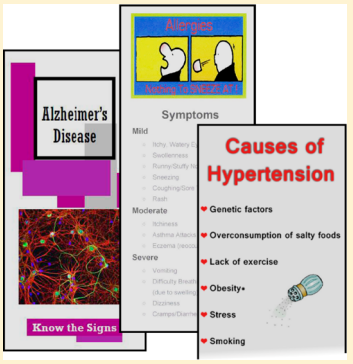
Supporting Information

ABSTRACT: A service-learning project appropriate for a biochemistry or advanced biochemistry course was designed and implemented. The project involved students partnering with a homeless shelter to design informational pamphlets to be displayed at the shelter for the clients' use. The pamphlet topics were based on diseases studied within the course. Students were required to present a rough draft of their project to the class for comments and revisions and give a brief presentation. The assignment allowed students to use their knowledge and expertise learned within the course and to apply their education by creatively designing a public-service pamphlet. Integrating service learning into an upper-level biochemistry course improved student communication, writing, and critical-thinking skills. Students reported that the service-learning component of the course increased motivation to learn course content.



KEYWORDS: *Upper-Division Undergraduate, Biochemistry, Public Understanding/Outreach, Collaborative/Cooperative Learning, Multimedia-Based Learning, Applications of Chemistry, Student-Centered Learning*

Serving learning has been integrated into courses through many disciplines.[1−6] Service learning involves students in activities that benefit the community through service while also connecting those activities to learning goals for a course.[7−9] Cavinato quotes Jacoby in defining this pedagogy as "a form of experimental education in which students engage in activities that address human and community needs together with structured opportunities intentionally designed to promote student learning and development".[9,10] The pedagogy is designed to encourage students to think outside the typical learning environment and provide students with skills to prepare them for future careers and endeavors in science.

A growing body of literature has shown the merits of service-learning projects in higher education. Research has shown that service learning aligns educators, institutions, and community partners.[11] Faculty benefit from working with more engaged students and opening opportunities for networking involvement with community partners.[9] Colleges and universities benefit from improved relationships with the community. Service learning continues to be recognized as a tool to actively engage students in learning.[9,12] Increasing interest in the course material, enhancing skills, and improving application of course concepts to real-world experience has been demonstrated.[13] Several articles have been published about incorporating service learning into elementary and middle schools,[3−6] introductory chemistry courses,[1,2,5] as well as analytical and environmental science courses,[8,9,14,15] but little has been written about incorporating service learning into upper-level biochemistry lecture courses.[8,16] However, Neena Grover has shown that incorporating service learning into an upper-level biochemistry course can be accomplished without sacrificing content, and students report that their service-learning presentations did not require additional preparation, as they already knew the material in greater depth than required for the presentation.[16]

In some service-learning approaches, it is often difficult to make the connection between the skills that communities need and the substantive material that students are expected to learn.[17] This service-learning project helps address this problem and serves as a case study "by drawing on the skills students are learning in order to address community-generated research questions".[18] The course also integrates the three elements as defined by the American Chemical Society that are essential in any service-learning project: partners, curricular connections, and civic goals for students. The American Chemical Society has recognized the need for educators to access information on service learning and contains a Web site devoted to service learning.[19]

Service learning should connect the community to the course while simultaneously fulfilling course goals and objectives. To explore the impact of service learning in an upper-level biochemistry course, we aimed to address two research questions in this study: (i) can a service-learning project successfully incorporate 5 key course learning objectives from an upper-level chemistry course and (ii) do students have increased enthusiasm and motivation to learn the course material because they have had a service-learning experience within an upper-level chemistry course? Here, we describe the structure of a service-learning project as well as survey results on student attitudes and motivation on learning content in an upper-level biochemistry course as a result of their service-

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learning experience. We document that service-learning can be successfully integrated into an upper-level biochemistry course as well as demonstrate student increased enthusiasm for course goals working with a community member on a service-learning project connected to human health.

PROJECT OVERVIEW

Participants

The course was open to science majors who had previously taken and successfully passed first-semester biochemistry. There were seventeen students enrolled in the course: a mixture of biology and chemistry majors who were all in their last semester of science coursework before graduating. The community service was carried out at a nonprofit day shelter for men, women, and children. The shelter's day center works diligently to alleviate chronic homelessness by offering living skills and educational courses funded through local donations and grants.

Course Content and Project Organization

The advanced biochemistry course focused on a variety of topics either not covered in the traditional first semester of the course (biochemistry I) or expands on these topics in more detail. Course objectives for this advanced biochemistry course are (i) to understand and apply biochemistry to human health and disease; (ii) to interpret and critically analyze biochemistry journal articles; and (iii) to communicate scientific data in both written and oral formats. The principle concepts covered in the course include lipids; carbohydrates; recombinant DNA and cloning; protein synthesis; and metabolism and regulation.

The intent of the service-learning project was to integrate course objectives into the student's life experience and to engage students in the course content. An educational pamphlet was used as the vehicle for the service-learning project. The course instructor worked with students and the shelter coordinator to ensure that a topic for a pamphlet was deliberately integrated with course content and learning objectives. The service-learning project had three parts: the pamphlet, a written paper, and an oral presentation.

A working draft of each pamphlet and PowerPoint presentation on the biochemistry specific relevance of the project were peer and instructor reviewed. Students presented their PowerPoint presentation to the class and then distributed a working draft of their pamphlet to their classmates for edits and comments. The final version of the pamphlet to be permanently housed at the shelter was presented to the shelter on the last day of the semester. Some selected topics with possible biochemistry links are listed in Table 1. Students were given the assignment details at the beginning of the semester and given deadlines to have the necessary portions of the assignment completed (Table 2). Students were encouraged to be imaginative and creative with their chosen topic, as they had to understand the topic presented and also summarize it in simple terms to the clients at the shelter. At the end of the project, students received a grade from their classmates, the instructor, and the shelter supervisor. The shelter supervisor received the pamphlet near the end of the semester, after the peer reviews. The supervisor was able to view the pamphlets from the client's perspective to ensure they were at the appropriate reading level and contained enough information for the clients to benefit from the material.

Table 1. Selected Project Topics and Biochemistry Relevance

Pamphlet Topic	Biochemistry Relevance
Herpes	Membrane transport
Hypertension	Lipids/ion transport
Weight management	Fatty acids and metabolism
Diabetes	Carbohydrates
Hepatitis	Heavy metal metabolism
Influenza	DNA/RNA/gene replication
HIV	DNA/RNA/gene replication
Arthritis	Antibodies
Influenza	Viral protein synthesis
Cold	RNA/viral cycle
Mononucleosis	Enzymatic assays
Allergies	Antibodies
Alzheimer's disease	Proteins/inhibitors

Measuring the Impact of the Service-Learning Project

To explore the impact of service learning in the biochemistry course on students' interests, a survey instrument was developed to measure the impact the service-learning project had on students' knowledge and understanding of biochemistry topics as well as student perceptions of their writing and oral skills improvement. The survey was administered during the last week of class after the project was completed, and it was taken by all seventeen students. The anonymous survey was based on a Likert scale to indicate the degree in which they either agreed with various statements or to indicate their degree of interest. Student respondents ranked their agreement with the statements on a scale of 1 (strongly disagree) to 5 (strongly agree). All survey results were analyzed using the independent group's t test.

RESULTS

Student Pamphlets and Presentations

Student pamphlet topics were selected based on biochemistry relevance and ideas gathered from a tour of the hospitality shelter. The topics selected included Alzheimer's disease, hypertension, allergies, mononucleosis, cold, influenza, arthritis, herpes, diabetes, HIV/AIDS, and weight management. The first part of the 3-fold project was a paper that contained the following sections: an introduction, biochemistry explanation of disease or health concern, preventative measure or treatment, conclusion, and references including a minimum of seven peer-reviewed articles pertaining to the topic selected. The second part of the project was an oral presentation summarizing to the class the information reported in the paper. After approval from the shelter supervisor, color copies were made by the instructor and the final pamphlets were presented to the shelter on the last day of class. The final products were displayed on a shelf at the entrance of the shelter and copies were made of each topic.

An example of one of the topics chosen, Alzheimer's disease (AD) is discussed in more detail. This paper initially discussed the different types of dementia and then focused on AD. The biochemistry explanation of AD and the health concerns were highlighted by the discussion of the accumulation of amyloid-beta plaques or abnormal tangles formed from Tau protein in the brain. The current treatment options followed, including the use of inhibitors and other experimental drug therapies. Peer-reviewed journals selected for this topic could include evaluating the enzyme, neprilysin: its sequence variation,

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Table 2. Service-Learning Project Timeline for Students, Course Instructor, and Shelter Supervisor

Course Week	Student Part	Faculty Part	Classmate Part
Before course	—	Meet with service supervisor	—
1	—	Organize transportation to shelter	—
2	Site visit to shelter		
3	—	Project guidelines distributed	—
4	—	—	—
5	Topic selection	—	—
6	—	Topic approval	—
7	Research topic	—	—
8	Research topic	—	—
9	Research topic	—	—
10	Submit rough draft to instructor	Receives draft of project, corrects and adjusts pamphlet	
11	*Presentation to class*	—	*Presentation of classmates*
	-Biochemistry overview of topic or project		-Receive working draft; make comments and suggestions
	-Pass out a working draft of pamphlet		-Peer assessment
12	Feedback received from classmates and instructor and project correction	—	—
13	Draft to shelter supervisor	—	—
14	—	—	—
15	Final revisions received and final product prepared	Organize transportation to shelter; Assist students in printing color copies of projects	
Finals	Projects presented to shelter to be permanently on display		

overexpression, and use as a candidate to slow the progression of AD. The pamphlet for this topic was designed based on a fifth-grade reading level to ensure clients at the shelter could read and understand the material. The pamphlet contained the following sections "What is AD"; "Diagnosis and Treatment Options"; "Risk Factors"; "Where to Turn"; Ten Warning Signs"; and "Who to Contact for Help". The AD pamphlet and other examples are found in the Supporting Information.

Increased Motivation To Learn Course Content Through Service-Learning

One overriding concern with the service project was whether students would be motivated to achieve desired learning outcomes as mandated in the college catalog for an upper-level biochemistry course. The survey results showed that students reported favorably that the service-learning project was a good way to integrate course content and learning outcomes. For instance, the responses (Figure 1) indicate that students felt the service-learning exercise in this course was a good way to learn about the subject matter (4.38). Furthermore, students strongly agreed (4.31) that the service-learning part of this course "changed the way I think about biochemistry in a more positive way Students reported that the project motivated them to search for scientific information (4.13). These results indicated that the service-learning component contributed to student motivation and desire to learn course material.

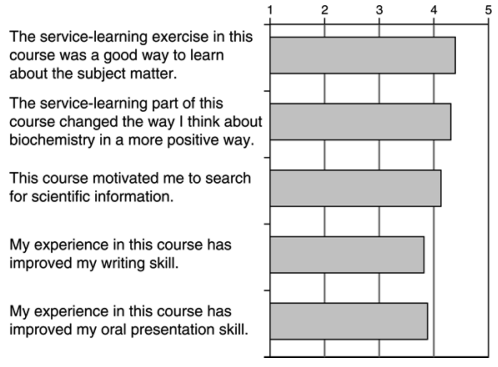

Figure 1. Learning outcomes reported by undergraduate students involved with a service-learning project. Students evaluated a series of statements according to a scale that ranged from 1 (strongly disagree) to 5 (strongly agree).

A key learning objective of upper-level biochemistry is for students to gain increased proficiency in written and oral communication skills. To this end, student reported benefits from the writing and oral components of the service learning project. For instance, student responses (Figure 1) indicated that their experience in this course has improved their writing skill (3.81) as well as their oral communication skill (3.88). Students went through several drafts of their projects and received feedback from their instructor and classmates as well as the shelter director. Thus, two of the courses learning goals were met with the service project in improving writing and oral presentation skills. These results confirm earlier work demonstrating an increased confidence and experience in written and oral communication of scientific concepts in service-learning courses.[1,4]

Increased Personal Satisfaction Through Service-Learning

We wanted to know if students gained more personal satisfaction with the course because the service-learning component directly connected course concepts with human health. Student satisfaction with a service-learning project embedded within a course is deemed highly favorable at this institution as service-learning is built into the core curriculum.[1] Student responses (Figure 2) indicated that they get personal satisfaction when combining scientific information with human health concepts related to their service-learning experience (4.44) as well as when they find a potential application of their service project to human health (4.38). Students did, however, score slightly lower on the statement asking them if science courses become more interesting for them when they connect

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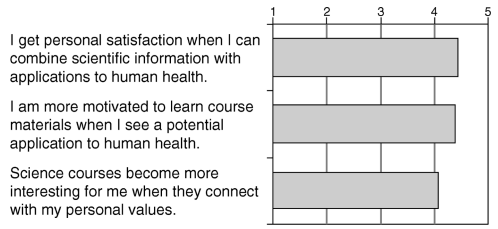

Figure 2. Service-learning relevancy to course content as reported by undergraduate students in a biochemistry course. The responses ranged from 1 (strongly disagree) to 5 (strongly agree).

with their personal values (4.06). This could be interpreted to mean that some students felt the service project connected to the course was beneficial for their learning even when it did not connect with their individual personal values. In all, this data indicates that allowing students to explore a topic related to health in their service project motivated them to search for scientific information. Similar results were also reported by LaRiviere and co-workers in their service-learning partnership with elementary students. Undergraduate students commented that they learned not only from their experiments but also from the children with whom they worked.[3] Saitta also reports positive results from undergraduate students in terms of their Internet-based service project increasing their ability to understand and apply the course material.[20]

Pamphlet Use by the Shelter Clients

Students were tasked to design pamphlets for clients at a homeless shelter for their information and use. Six months after the pamphlets were displayed at the shelter, the shelter supervisor reported that most pamphlets have been taken by the clientele. The pamphlet topics were displayed with 25 copies each and only 4 on influenza, 1 on HIV/AIDS, and 1 on mononucleosis remain. The supervisor has not received comments from clients but mentioned that is not unusual. The staff may have heard and not reported the information.

DISCUSSION

A service-learning project was implemented in an advanced biochemistry course as a way to communicate scientific data to students; to understand and apply biochemistry to human health and disease; and to give back to the community. Students designed their own pamphlet to be used at a homeless shelter for clients as information and as a resource. Students visited the shelter at the beginning of the semester with their classmates and instructor before the topics were assigned to meet the shelter supervisor and also to visualize the needs of the clients. The first time the course included the service-learning project, the student responses were not that favorable. For instance, from the limited assessment conducted, many students felt the project did not enhance their learning in the course and many felt it was just extra work. Therefore, the service-learning project when implemented the second time and assessed for this article was adjusted the following two ways: students were asked to discuss the biochemistry relevance of the project topic and students were given the previous year students' projects as examples to help them get started. Making these critical adjustments helped to more fully integrate the service-learning project with course objectives and students responded favorably. The course instructor was also encouraged by her ability to cover course content as mandated for the course with the service-learning project working with a community partner.

The choice of the community partner for the project was critical. The partner needed to be flexible and understanding of the semester time constraints and to student's communication and writing skills. The partner was a "client" receiving a "service" but, more importantly, an entity that actively contributes to the learning experience.[9] Perhaps the most essential component tying the entire project together was the shelter supervisor, as this person was able to critique the project and make adjustments to ensure the shelter's clients could benefit from the final product. The supervisor has a critical eye as to what the clients would understand on the various pamphlets and also made suggestions to draw them visually to the information. Some of these suggestions included the use of colors, mini-quizzes, and basic statistics directly involving the health topic to be placed on the pamphlets. Also, the pamphlets needed to be designed simply so that clients would not be discouraged from reading and understanding the topic content. More information on this process is available in the Supporting Information.

The assessment results reinforced the course objectives as integrating service learning into an upper-level classroom improved student communication skills, writing skills, and critical thinking skills. Students also reported that the service-learning component of the course was a good way to learn about the subject matter.

CONCLUSION

A service-learning project was successfully incorporated into an advanced biochemistry course to engage students in the course content and to integrate course objectives into the student's life experience. Assessment results show that students have increased enthusiasm and motivation to learn course material as a result of their service-learning project. Equally as important, the service-learning component was incorporated into an advanced biochemistry course without sacrificing content. The next step will be to conduct pre- and postcontent tests appropriate for an upper-level biochemistry course to critically analyze whether students have an increased mastery of the content with their service learning experience. Also, having students reflect on their experience will be helpful. Lastly, we plan to survey the staff and clients at the shelter to evaluate the use of the pamphlets and opinions on the utility of the pamphlets.

ASSOCIATED CONTENT

Supporting Information

Samples of three pamphlets. This material is available via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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