RESEARCH ARTICLE

Integrating SENCER into a Large Lecture General Education Chemistry Course

Jeffrey A. Webb, Ph.D.
Southern Connecticut State University

Abstract

Students in a large lecture general education chemistry course at Southern Connecticut State University (SCSU) were required to design their own SENCER-based research project. The students were tasked with researching chemical topics found anywhere within the campus/local community, resulting in projects that were extremely diverse. These projects ranged from students researching the feasibility of opening an on-campus can/bottle redemption center to students exploring the disposal procedures of supplies in the art department. The SENCER-SALG assessment tool was used to evaluate the success of the projects and showed that the majority of students reported a gain in their understanding of the multidisciplinary nature of societal issues and in their perception of how studying chemistry helps people address real world issues.

Introduction

One of the major obstacles to the implementation of anything novel into the course curriculum of a large lecture class (the size of the course as currently taught at SCSU is approximately 130 students in one large lecture hall) is the substantial amount of organization and assessment required. The class size, coupled with the lack of funding for teaching assistants make the proper implementation and assessment of novel coursework a monumental task. In addition to the large lecture sizes, the motivation of "general education" students in required lecture courses has always been a significant obstacle to learning (Glynn et al. 2005; Ward and Bodner 1993).

Recently, SCSU transformed its general education program (referred to as all-university requirements [AUR]) into its new Liberal Education Program (LEP). Because one of the main requirements of the LEP is that the courses involve some relevance to contemporary societal issues, the teaching approaches advocated by Science Education for New Civic Engagements and Responsibilities (SENCER) are an ideal way to integrate community issues into a science course

(Burns 2011). Another required component of a LEP science course is that the students understand the nature of scientific inquiry (Natural World: Area of Knowledge and Experience).

In an effort to keep the students motivated while integrating these new key elements into the curriculum, a flexible, modular SENCER project was developed where students could, with minimal guidance, develop a project related to their own interests. Although there was still a significant amount of grading involved in properly assessing a SENCER project in a class of this size, the SENCER-SALG (Student Assessment of Learning Gains) survey helped to minimize the workload on the instructor as well as to evaluate the project.

Methods

During the Fall 2012 semester a SENCER project was introduced into the curriculum for the CHE 101—Chemistry in Contemporary Issues—course at SCSU. The course is offered either as a day class or as a night class. While the day lecture class has a much larger enrollment (128 students) than the night class (32 students), both courses integrated the modular SENCER research project into the curriculum. The students were taught about the SENCER ideals and the SENCER project during the first class, and were asked to divide themselves into groups of four. They were then given a project description, including a grading rubric for each module. This description included an outline and an approximate timeline of due dates throughout the semester. The SENCER-SALG assessment tool was utilized to evaluate how much the SENCER project assisted their learning. In an effort to alleviate any student concerns about group work, individual group participation was self-evaluated twice throughout the course.

Group Formation/Project Proposal

In this initial part of the project, the students worked in groups of four to develop a SENCER-based project involving chemistry and the local and/or campus community. The students were asked to submit a group narrative outlining their projects, with a focus on the purpose, civic connection, and science connection. The students were also asked to perform the baseline survey for the SENCER-SALG assessment. In the documents provided to the students about the project proposal, several examples of a possible SENCER project were offered, such as

1. Exploring the science of recycling on campus
2. Exploring the science of community gardens
3. Exploring the campus shuttle bus program and its impact on the environment
4. Exploring the energy consumption of buildings on campus

Module 1: Background Investigation/ Planning and Preparation

After receiving instructor approval for their topic, each group began to work on the first portion of their project. In module 1, each group was tasked with submitting a two-page report summarizing their progress. The report consisted of three sections: a summary (with references) of their background research, a summary of their research plan, and a summary of the chemistry topics involved in the project. Each student was asked to submit an individual student response, the purpose of which was to evaluate their fellow group members' abilities to work within the group based on how much each student contributed to the project and what each one did.

Module 2

Upon completion of module 1, each group began the research component of their project. In this module, the students were required to submit a copy of their data and any calculations done, as well as any graphs or charts produced to summarize their data. In addition, the students were asked to submit a data analysis summary and a brief conclusion statement.

Module 3

In the last module of the SENCER project students were asked to submit a final written report (3-5 pages) of their project. The report consisted of a(n)

1. *Title Page* – Project title, group members, and an outline of the report
2. *Introduction* – Short paragraph(s) that outline the issue and the goal of the project
3. *Main Body* – Organized summary of all the relevant data and a discussion of the results that lead the reader to the conclusion
4. *Conclusion* – Summary of the conclusions of the project including a discussion of related topics and possible future work
5. *Bibliography* – Complete documentation of all sources used in the report

6. *Data and Calculation Appendices* – Copies of all raw data collected and calculations required for the report
7. *Response Appendix* – Description of a short action plan that the group would recommend as a result of their project; an example might be a memo to an administrator recommending a corrective action.

Results

The SENCER project implemented in this course was utilized as a way to build into the curriculum a connection between the chemistry content presented in the course and the issues/needs of the local and university community. The majority of the reports that the students produced focused on environmental chemistry/science. This was expected because of the somewhat obvious connections between chemistry and the environment as well as the topic of the course textbook (Schachter and Edgerly 1999; Middlecamp et al. 2012). (Table 1)

Predictably, because they were provided with several project topic examples, the students produced a large number of projects centered around recycling on campus (4 projects), shuttle bus pollution (3 projects), and energy consumption of buildings on campus (7 projects) (35 percent of the 40 graded SENCER projects). In addition to the students who used the examples provided as project ideas, the students also produced a large variety of projects with 25 different themes.

Three particularly notable projects stand out among the 40 submitted for this course. (Table 2) Two of these noteworthy projects are good examples of students with similar majors coming together and developing a project wherein they take advantage of their common interests to investigate a chemical topic, and impact the campus community in the process.

Project #3 was an interesting collaboration of students majoring in Communication Disorders. While the students initially struggled to decide on a topic, they ultimately decided to study tobacco. The students learned a great deal about the large number of chemicals in cigarettes and discovered that there had been some research done on the effects of tobacco use on people with communication disorders, and they developed a brochure where they could inform SCSU students about the harmful effects of tobacco on communication disorders. The students then handed out their brochures on campus to the SCSU student/faculty population to inform the campus community about their project. Project #4 looked at

TABLE 1. SENCER Group Projects and Topics

Project #	Project Description:
1	Quantifying Sodium in Foods on Campus
2	Gatorade versus Water Hydration
3	SCSU Tobacco Trends on Campus
4	Chemistry in Oil Paints/Solvents and their Waste Disposal
5	What Are the Easiest Elements to Find in CT?
6	Recycling: Student Opinion vs. Fact
7	Chemistry of Crimes on Campus
8	Single Stream Recycling
9	Community Gardens
10	The Dihydrogen Monoxide Hoax
11	Composting on Campus
12	Indoor Swimming Pool Water Study
13	From Soil to Wine
14	Garbage on Campus
15	Redemption Centers on Campus
16	Organic vs. Nonorganic Foods
17	Plastic vs. Reusable
18	Going Green with Solar Panels
19	Polystyrene: A Threat to the Environment
20	SCSU Shuttle Buses
21	Coffee Consumption
22	Mold in Dorms?
23	Campus Gazebos
24	Fountain Drinking Water
25	Air Conditioning Conservation

TABLE 2. Notable SENCER Projects

Project #	Project Description:	Short Explanation
3	SCSU Tobacco Trends on Campus	Communication Disorders majors studying the effect of tobacco on speech
4	Chem./Waste Disposal in Paints/Solvents	Art majors studying the chemistry of oil paints and their proper waste disposal
15	Redemption Centers on Campus	Students researching the feasibility of an on-campus redemption center where students could add bottle deposits to their accounts

the disposal procedures used (or not used) for various creative works made in the Art Department. These students were amazed to find the general lack of awareness among art majors of the importance of properly disposing their various chemical waste products.

Project #15 was one of the most ambitious projects taken on by any of the students in CHE 101. These students looked into the chemistry behind recycling aluminum cans and plastic bottles. They called up several local recycling centers and asked about the costs of on-site recycling machines. One of the most interesting aspects of their proposal was the ability to add the bottle deposits to the students' campus accounts. The students even estimated the costs of a staff member for the proposed center. The students then surveyed the SCSU student body about the likelihood that they would utilize an on-campus recycling center. The group members then wrote an eloquent letter to the administration outlining their findings.

During the development/implementation of the SENCER project into the CHE 101 curriculum, we thought that leaving the project topic open for students to develop would allow them to devise a project based on their common interests and truly take ownership of it. While this did happen, it happened to a much smaller degree than was originally expected (4/40 projects; 10%). We suggest this is because of the large lecture class enrollment coupled with a general lack of instructional time available to devote to forming well-organized SENCER groups involving students with similar majors or interests. (Currently, the course lecture time is limited to two hours per week for the semester.) Ideally, instructor familiarity with the project will allow for better organization, and this would result in better groups in future semesters. Despite the lack of groups composed of students with common interests and majors, the students expressed their satisfaction and general approval of the project. (See SENCER-SALG student comments below.)

Student Comments

"The labs helped me understand and retain what we were learning. The group project helped me appreciate the subject."

"I enjoyed the SENCER project."

"The SENCER project really helped me to bring up my grade. I really enjoyed the project and the group work went really well."

"The group project was a lot of fun. It was a good way to work on something to help the university."

"I like the SENCER project, it helped me apply the concept to the world and the people."

When the project was originally designed, we assumed the students would enjoy cooperative learning and be prepared for working together (Shibley and Zimmaro 2002; Felder and Brent 2007). Additionally, in order to encourage student enthusiasm and participation, students were informed about the benefits that the cooperative project would have on their learning and appreciation of chemistry (Bowen 2000; Kogut 1997). Even with our initial assumptions/information, we believed that some students might be reluctant to work in a group. In an effort to preclude any issues with group work, the SENCER project evaluation did take the students' group work into account. This was accomplished by allocating 10 points of the overall project grade for group evaluations. Despite this, a few students still commented on the SENCER-SALG about their displeasure working in groups with their classmates. (See student comments below.)

Student Comments

"I do not like working in groups. Everyone has lives outside of class and to get together to work on this project seemed difficult."

"Group activities can be frustrating."

"Good idea for a group project but it was very difficult to stay in contact and work together and with our schedules."

After analyzing the few negative group work SENCER-SALG student comments, as well as informal questioning of students, we theorize that the students were dissatsified because of two factors: The students needed further specific instruction about how to work effectively in groups, and SCSU's large commuter student population (~75%) was resistant to spending additional time

on campus for group work. In an effort to alleviate this, two changes will be implemented:

1) In order to quell frustrations about scheduling group meetings with commuter students, students will be asked to create Facebook or Twitter accounts to facilitate group interactions.

2) Additional course time will be devoted to instruction on how to effectively work together as a group, and there will be additional group work assignments outside the SENCER project.

While one instructor found the size of the large lecture class to be a significant obstacle to assessing the large number of student projects, by allowing the students the flexibility to develop their own project as well as utilizing a modular approach, the faculty workload was manageable and the students produced a large number of unique projects, increasing the impact on the local campus community as well as the students' general interest in the project.

SALG-Survey

The SENCER-SALG was utilized to analyze the students' learning gains and the students' assessment of how the group project fit into their learning. The relatively low N (86) can partially be explained by student attrition. It also appears that some students simply did not complete the SALG and were willing to take a small point deduction. In future semesters, to rectify the low response rate additional points in the grading rubric will be allocated for completion of the survey. (See selected SALG question analysis below.)

Question: *How much did the SENCER group project help your learning in this course?*

The students reported that the SENCER group project was somewhere between little and moderate at helping their learning in this course. (N = 86; Mean = 2.6; Std. Dev. = 1.29) While this is lower than expected, the question did have the highest standard deviation among all the questions asked on the post-project SALG assessment. A more detailed look at this question revealed that 44 percent of the students ranked the SENCER project as little or no help at helping their learning. The other 56 percent ranked the SENCER project as either moderate, much, or a great help to their learning in this course. The statistical mode (31 percent) for this question was a response of the project being a moderate help to their learning. (N = 27)

Question: *As a result of your work in this class, what gains did you make in your understanding of the multi-disciplinary nature of social issues and the importance of science in solving these issues?*

The students reported that they made a moderate gain in their understanding of the complexity of societal issues and their relation to science. (N = 86; Mean = 3.3; Std. Dev. = 1.07) A more detailed look at this question revealed that 24 percent of the students ranked their gains in understanding as little or none. The other 76 percent of students ranked their gains in understanding as moderate, good, or great. The statistical mode (33 percent) for this question was a response of a good gain in their understanding of the multi-disciplinary nature of social issues. (N = 28)

Question: *As a result of your work in this class, what gains did you make in your understanding of how studying this subject area helps people address real world issues?*

The students reported that they made a moderate gain in their understanding of how studying this subject area helps address real world issues. (N = 85; Mean = 3.3; Std. Dev. = 1.09) A more detailed look at this question revealed that 20 percent of the students ranked their gains in understanding as little or none. The other 80 percent ranked their gains in understanding as either a moderate, good, or great gain. The statistical mode (35 percent) for this question was a response of a moderate gain in their understanding of how studying this subject area helps people address real world issues. (N = 30)

The SENCER project aimed at integrating a relevance to contemporary societal issues into the course. The last two SALG questions discussed above were focused on assessing this particular aspect of the course. Both questions revealed that the majority of students (76 percent and 80 percent, respectively)

reported a moderate, good, or great gain in their understanding of both the multi-disciplinary nature of societal issues and of how studying chemistry helps people address real world issues. This result demonstrated that the integration of this SENCER project into the CHE 101 curriculum helps meet one of the key requirements for placing a course in the Liberal Education Program at SCSU.

Conclusions

It will take several semesters to assess the overall success of the integration of a SENCER project into the curriculum of this class. Nevertheless, after the project was taught for just one semester, several questions on the SENCER-SALG revealed that the project was already successful at instilling a relevance to contemporary societal issues into the course. Furthermore, the majority of students asked (56 percent) ranked the SENCER project as a moderate, good, or a great help to their learning in this course. This SENCER project demonstrated that a large lecture class—while difficult to manage especially for one instructor—could be a venue for students to integrate their personal interests into chemistry, not only to enhance their understanding of course content but also to improve their understanding of chemistry's place in society. This project also provides a working model for instructors to integrate SENCER ideals into a large lecture-based chemistry class for non-majors while providing an enhanced experience for students studying general education chemistry. In future semesters additional instructional time will be allocated to teaching students about working in groups in an effort to improve that aspect of the course.

Acknowledgements

The author would like to acknowledge Kim Lippman for her efforts in implementing this project in the night section of CHE 101.The author would also like to acknowledge Dr. Ericka Barnes and Dr. James Tait for their input into the manuscript.

About the Author

Jeffrey A. Webb has been an assistant professor at Southern Connecticut State University since 2011. He teaches General Chemistry, Chemical Education, and non-majors courses. He has been a lecturer at the University of New Haven as well as the advanced placement chemistry teacher at Fairfield-Warde High School. His research interests lie in developing apps. for chemical education, studying the effects of meta-cognitive study skills on student performance, and studying students' grade perceptions in chemistry. After completing his Ph.D. at Stony Brook University, he did post-doctoral work at the University of Michigan in Ann Arbor as well as working with the Chemical Engineering Department at Yale University.

References

Burns, W. 2011."But You Needed Me." SECEIJ 3(2): 5–12. http://seceij.net/seceij/summer11/burns_part_1_yo.html (accessed March 4, 2013).

Bowen, C.W. 2000."A Quantitative Literature Review of Cooperative Learning Effects on High School and College Chemistry Achievement." Journal of Chemical Education 77(1): 116–119.

Felder, R.M., and R. Brent. 2007."Cooperative Learning." In ACS Symposium Series Vol. 970, P.A. Mabrouk, ed., 34–53. Washington, DC: ACS Press.

Glynn, S.M., L.P. Aultman, and A.M. Owens. 2005."Motivation to Learn in General Education Programs." The Journal of General Education 54(2): 150–170.

Kogut, L.S. 1997."Using Cooperative Learning to Enhance Performance in General Chemistry." Journal of Chemical Education 74(6): 720–722.

Middlecamp, C.H., S.W. Keller, K.L. Anderson, A.K. Bentley, M.C. Cann, and J.P. Ellis. 2012. Chemistry in Context: Applying Chemistry to Society. 7th ed. New York: McGraw-Hill.

Natural World: Area of Knowledge and Experience. http://www.southernct.edu/faculty-staff/faculty-senate/ucf/lep/forms/areas-of-knowledge-checklist.html (accessed July 15, 2013).

SCSU: Liberal Education Program. http://www.southernct.edu/offices/first-year-experience/lep.html (accessed July 15, 2013).

Shachter, A.M., and J.S. Edgerly. 1999."Campus Environmental Resource Assessment Projects for Non-Science Majors." Journal of Chemical Education 76(12): 1667-1670.

Shibley, I.A., Jr., and D.M. Zimmaro. 2002."The Influence of Collaborative Learning on Student Attitudes and Performance in an Introductory Chemistry Laboratory." Journal of Chemical Education 79(6): 745-748.

The SENCER-SALG. http://www.sencer.net/Assessment/sencersalg.cfm (accessed March 4, 2013).

Ward, R.J., and G.M. Bodner. 193."How Lecture Can Undermine the Motivation of Our Students." Journal of Chemical Education 70(3): 198-199.