Creative Teaching Award
Application Cover Sheet 2015-16
Center for Teaching Excellence, Duquesne University

Name(s) of Applicant(s): Sarah Woodley

School/Department: Bayer School of Natural and Environmental Sciences, Dept. of Biological Sciences

☑ By checking here, you affirm that applicants have taught at Duquesne as full-time faculty one year or more

<table>
<thead>
<tr>
<th>Course # &amp; Title</th>
<th># of Students</th>
<th>Semester/Year Taught</th>
<th>Instructor</th>
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<tr>
<td>BIOL 372W SL1: Cell &amp; Systems Physiology Laboratory</td>
<td>16</td>
<td>SP 2013</td>
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List other contributors and their roles, where pertinent
Chris Fonner, graduate teaching assistant from 2012-2015
David Lopatto, PhD, Grinnell University, analysis of CURE results
Christine Pribbenow, PhD, University of Wisconsin, introduction to qualitative data analysis
Nancy Trun, PhD, Duquesne colleague, developed the ABSL pedagogy that I adapted for use in my course

Title of Project
Innovations in a Physiology Laboratory Course: Combining Novel Research and Service-Learning Around a Community-Based Problem

Abstract:
Starting in 2013, I incorporated novel research and service-learning into a junior-level physiology laboratory course. The novel research experiments and the service-learning were tied to the theme of water quality, a community-based problem. Combination of these high-impact practices in this way in a physiology laboratory course is innovative, as described in my letters of support. I assessed student learning with surveys, critical thinking assessment tests, and student reflections. Compared to previous years, students reported widespread gains related to the research process. Gains exceeded those of students nationwide, as well as compared to students participating in Duquesne’s summer undergraduate research program. The service resulted in better scientific outreach skills, and students recognized the need to give back to the community by sharing their scientific expertise. Together, these results indicate the power of incorporating high-impact practices into a physiology laboratory course to foster both scientific development and civic engagement in our students.

Applicant Signature(s) _____________________________________________Date_____________

Department Chair's Name Dr. Joseph McCormick

Department Chair's Signature ________________________________________Date_____________

Dean's Name Dr. Phillip Reeder

Dean's Signature _________________________________________________Date_____________
Course and context:

Over the last 3 years, I have tested a novel pedagogy called Application Based Service-Learning\(^1\) in Cell and Systems Physiology Laboratory (BIOL 372W SL1), a junior-level advanced physiology laboratory course. Traditional science laboratory courses emphasize learning techniques by repeating experiments with known outcomes. ABSL seeks to improve student learning in laboratory courses by creatively combining high-impact practices such as undergraduate research, writing-intensive work, and service-learning, all oriented around a community-based problem. ABSL was developed and tested in a microbiology laboratory course by my colleague, Dr. Nancy Trun, centered on the community problem of potential disease risks of feral cats. Here, I tested whether ABSL could be adapted into a physiology course (Cell and Systems Physiology Laboratory, BIOL 372W SL1) centered on water quality, a concern for both human and animal sustainability. I revamped the course to adopt 2 components of ABSL into the course: 1) undergraduate research, where students do novel research experiments on the impact of water quality on human and animal physiology, and 2) service-learning, where students designed science activities based on water quality which they share with K-8 children at an after-school tutoring program. The theme connecting the innovations was water quality.

Motivation for innovation and evidence for innovation:

I have taught Cell and Systems Physiology Laboratory for many years and was proud of its emphasis on developing scientific reasoning and communication skills in the context of human and animal physiology. However, students typically ran experiments with known outcomes, limiting their opportunity for an authentic research experience. Therefore, I was eager to implement ABSL by adding novel research projects thematically linked to a real-world issue like water quality. Furthermore, the vast majority of the students in this course aspire to careers in medicine and public health where they will need to engage with a diverse public. By adding a service-learning component, I was able to provide students with opportunities to hone engagement skills and develop civic responsibility related to their roles as future scientists.
I know of no other physiology laboratory course that combines novel research and service-learning inspired by a community-based problem (see the letters of support from Drs. Carruth and Staub attesting to the novelty of my approach in my field (Appendix A)). Although the ABL pedagogy was developed by my Duquesne University colleague, Dr. Trun, for use in a microbiology context, my implementation is very different from hers. Second, my course is the only stand-alone, service-learning-designated course in the Department of Biological Sciences. The current model in the Bayer School of Natural and Environmental Sciences is for all students to enroll in the 0 credit Science in the Service of Society course, where students participate in different service projects. Although some of the projects stem from courses within the Department of Biological Sciences, the learning aspect of the service is elaborated in the 0 credit Science in the Service of Society course, divorced from the Department of Biological Sciences course that inspired the project.

**Scope of the innovation:**

Thus far, the innovations have impacted 48 Duquesne undergraduates and up to 75 children enrolled in Fusion program of the Hazelwood Center of Life\(^2\), our community partner. The graduate teaching assistant is now an assistant professor at Thiel College and plans to adopt some of these innovations into his courses. To implement the innovations, I designed five new research experiments, established a sustainable relationship with our community partner, created service-learning exercises, assessed and statistically analyzed student learning with multiple tools, and received an official service-learning designation for the course. See Appendix B for an abridged copy of the syllabus with the innovations highlighted.

**Learning goals of the innovation:**

1. By conducting the novel research experiments, students will engage in all aspects of the scientific method, improving analytical skills and critical thinking.
2. Through involvement with community-outreach service project, students will apply their academic knowledge and communication skills, experience personal growth, evaluate the civic duty of scientists, and recognize reciprocity between learning and community service.

**Description of the Innovation:**

The main themes of the course were novel research and service-learning centered on a real-world problem of water quality. The theme of water quality was introduced at the start of the course and was revisited with each of the 4-5 novel research experiments and the service-learning project.

**Novel research projects:** After I provided the basic concept and materials, and students worked in groups of 4 to design and conduct novel research experiments on the effects of common water contaminants on human and animal physiology. Students formed hypotheses based on their reading of primary literature, designed experiments, collected results, graphed and analyzed results, and wrote 10 page lab reports summarizing the research.

As part of my implementation of ABSL, I created 5 new research experiments: Water Acidity and Salamander Microbiomes (2013); Pesticides and Aquatic Invertebrates (2014, 2015); Heavy Metals and Crayfish Stress Responses (2014, 2015); Endocrine Disrupting Compounds and Fish and Tadpole Brain and Behavior (2014, 2015), and Hydration and Human Exercise Performance (2015).

**Service-Learning:** Students created science activities based on the physical, chemical, and biological properties of water that they shared with primarily African-American K-8 children at Fusion (a branch of the Center of Life), an after-school tutoring program located in Hazelwood, an underserved Pittsburgh community. Students spent approximately 8 hours in class creating lesson plans, demonstrating the activities, and reflecting on the service-learning. They spent 5 hours with the community partner over 3 afternoons. Reflection activities were incorporated into the syllabus and occur pre-service, throughout the service, and post-service. I also used the Community Partner Survey from the Office of Service-Learning to get formal feedback from the community partner.

Below I list examples of the science activities developed by Duquesne students:
Plants and Water-BFF – Measuring how water quality affected plant growth
Phastinating Phacts – Acid-base chemistry and measuring water pH
Invisible Creatures – Culturing bacteria present in water from different sources
Get Loose and Diffuse- Illustrating the physical properties of water
Gummy Bear Osmosis – Examining the effects of temperature on water movement
Fun with Filters – Demonstration how water is cleaned by filtering
What’s Happening to our Water? – Effects of water pollution on invertebrates
The Amazing Properties of Water – Demonstrating the physical properties of water

Innovation's contribution to student learning:

Learning Goal 1: By conducting the novel research experiments, students will engage in all aspects of the scientific method, improving analytical skills and critical thinking.

Indirect evidence:

Assessment method: To indirectly assess student learning, I used the CURE (classroom-based undergraduate research experience) survey\(^3\), which is a validated, widely used assessment of student-reported learning gains related to novel research. Students took the CURE at the start and end of the semester both before the innovation (2010 and 2012) and after (2015). In addition, I used the SURE (summer undergraduate research experience)\(^4\) survey to assess student learning in Duquesne biology students participating in our 10 week summer undergraduate research program in 2013. Planned contrast tests (parametric statistics) compared responses among groups. Finally, I compared responses in Duquesne students in 2015 with mean responses of students across the country participating in CUREs and SUREs.

Evidence of learning: Compared to nation-wide cohort of students that participated in CUREs and SUREs, my students reported greater learning gains in 20 out of 21 gains (Appendix C, Figure 1). Compared to my students enrolled in BIOL 372W in 2010 and 2012, students in 2015 reported greater gains in almost all of the 21 CURE domains (Appendix C, Figure 2). Gains in 2015 were significantly greater in understanding how scientists think, understanding science and the research process, integrating theory and practice, and data...
analysis compared to 2010/2012. Also, students reported greater gains in almost all domains relative to Duquesne students involved in the 2013 summer undergraduate research program (Appendix C, Figure 3). Gains were statistically significant for areas including integration of theory and practice, understanding science, and communication skills. These results indicate that the innovations added to Cell and Systems Physiology Laboratory course provides an authentic research experience.

Direct evidence:

Assessment methods: To directly measure critical thinking in 2012, 2013, and 2014, I used the Critical Thinking Assessment test (CAT)\(^5\), a widely used, validated tool. In 2015, I created my own critical thinking assessment. Students were evaluated at the start and end of the semester-long course.

Evidence of learning: As measured by the CAT, students showed a significant increase in 2012 but not in 2013 or 2014 (Appendix C, Table 1). As measured by my critical thinking assessment, students showed a gain in 2015 (Appendix C, Figure 4). It is important to note that in 2012 and 2015, the class and I explicitly discussed several examples of critical scientific thinking over the course of the semester whereas in 2013 and 2014, I did less of that. My conclusion is that novel research over a few months is not enough to show substantial gains in critical thinking as measured by the CAT test. However, explicit practice of critical thinking does improve students’ skills.

Conclusions:

By use of direct and indirect assessment methods of student learning, I provide evidence that students are gaining many important skills related to research. In some cases, gains exceed those found in our summer undergraduate research program. There is less evidence for gains in critical thinking over the semester. Rather, explicit practice of critical thinking is a better strategy to achieve gains in critical thinking over a single semester.

Learning Goal 2: Through involvement with community-outreach service project, students will apply their academic knowledge and communication skills, experience personal growth, evaluate the civic duty of scientists, and recognize reciprocity between learning and community service.
Indirect evidence:

Assessment methods: As an indirect measure of service-learning, students were surveyed at the start and end of the semester to assess attitudes related to academics, civic responsibility, career, and empowerment using the Higher Education Service-Learning Survey\(^6\). The survey consists of Likert-items that cluster into the learning categories of academics, empowerment, career, and civic responsibility. For analysis, values for each student were summed within each cluster and pre- versus post-course scores were compared using paired t-tests\(^7\).

Evidence of student learning: In 2015, attitudes related to civic responsibility showed a significant decrease post versus pre-survey (Appendix C, Figure 5). When examining the individual Likert-items that pertained to civic responsibility, means for most of the questions related to civic responsibility dropped after the course relative to before the course. There were no changes in the other clusters for 2015 or in any of the clusters in 2014.

Direct evidence:

Assessment methods: Students wrote a 10 page reflective essays where they were prompted to ponder learning gained in the realms of academic achievement, personal growth, and civic responsibility. Results were analyzed using a qualitative analysis\(^8\). Briefly, I read each paper multiple times to identify recurrent themes of learning related to academic achievement, personal growth, and civic responsibility across the students. I then re-read each paper one more time, counting the learning themes discussed by each student.

Evidence of student learning: I identified 10 themes that emerged across multiple students (Appendix C, Figure 6). The learning described by most students related to improved communication skills (88%), feeling discomfort (56%), and realization that they had expertise that they could and should share with others (56%). Other common learning themes were improved understanding of academic concepts (44%), increased self-confidence (44%), evidence that the experience was personally rewarding (38%), and recognition that they had made incorrect assumptions based on initial appearances (38%). A few students stated that they probably learned much more from the service-learning than did the Fusion children (13%), which indicates that students understood the reciprocal nature of the service-learning effort.
Conclusions:

As measured by the Higher Education Service-Learning Survey, there was little evidence that students’ attitudes towards service-learning improved over the semester-long course. In fact, in 2015 (although not in 2014), means for many of the questions related to civic responsibility dropped after the course relative to before the course. Without more qualitative information, it is hard to interpret why scores dropped in 2015. In contrast to student attitudes survey data, essays provided direct examples of learning from the service-learning project. For example, students learned that service learning helps them academically, in particular by improving communication skills related to science outreach. By feeling discomfort, students experienced personal growth. In terms of civic responsibility, students learned that as scientists, they had expertise that they could and should share with others.

Conclusions

With the implementation of ABSL, I incorporated novel research and service-learning into Cell and Systems Physiology Laboratory (BIOL 372W SL1), tied together by a common theme of water quality. My approach of combining these high-impact practices in this way is highly innovative within Duquesne and in my field at large (see the letters of support, Appendix A). I assessed the impact of my teaching innovations quantitatively and qualitatively, using validated student surveys, critical thinking assessment tests, and student essays. Compared to previous years, students that conducted novel research experiments reported widespread gains related to the research process. Gains exceeded those of students nationwide, as well as compared to Duquesne students participating in Duquesne’s summer undergraduate research program. The service project resulted in learning related to scientific outreach skills, and students recognized the need to give back to the community in a way that used their scientific expertise. Together, these results indicate the effectiveness of incorporating two high-impact practices into a physiology laboratory course to create richer learning opportunities.
References:

1. http://www.abslnews.net/
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4. https://www.grinnell.edu/academics/areas/psychology/assessments/sure-iii-survey
5. https://www.tntech.edu/cat
8. A simple primer about educational research, analyses, and data collection. Presentation by Dr. Christine Pribbenow, PhD, at the July, 17th, 2015 ABSL Workshop, Duquesne University.