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Integration of the Biology and Organic Chemistry Laboratories through a Huntington's Disease Research Practicum

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Extended Abstract

A loss of over half of the students who enter college intending to pursue majors in science, technology, engineering, and mathematics (STEM) occurs within two years of taking their first college science class (Seymour and Hewitt, 1997; Mervis, 2010). Among the many reasons why students decide to leave the sciences within the first two years are that (1) introductory courses are uninspiring, and (2) courses fail to foster a sense of scientific identify in students and (3) immersion in the sciences means sacrificing an education that incorporates teaching practices from multiple non-science disciplines (Seymour and Hewitt, 1997). Many universities have recognized the need to advance introductory science teaching for undergraduates. Introductory laboratory courses have employed interdisciplinary project-based labs that address real-world problems and grant students the independence to influence experimental methodologies. Some non-majors courses approach science from a liberal arts perspective; however, few initiatives intended for science majors have combined these approaches into one course. To address this, a multidisciplinary research practicum was developed for Brandeis University's Introductory Biology and Organic Chemistry laboratories.

Students were granted considerable independence in the design and implementation of an experiment to target polyglutamine protein aggregates in Huntington Disease. Huntington 's Disease is an inherited autosomal dominant neurodegenerative disorder caused by aggregation of the huntingtin (Htt) protein (The Huntington's Disease Collaborative Research Group, 1993). One therapeutic approach involves the synthesis of a variety of small polymers, which can selectively bind to biological molecules, providing a way to explore and manipulate protein aggregation (Herbst and Wanker, 2006). Recently, several huntingtin fragments containing varying lengths of expanded polyQ repeats have been expressed in different strains of Drosophila melanogaster, which display a range of ages of onset of neurodegeneration (Apostol, et al., 2003). Students use the scientific literature and collaborate with their peers to design and synthesize their own polymer in the Organic Chemistry laboratory. They then evaluate the effect of their synthesized polymers on aggregation (Boltax, et al., 2014) in vitro using right angle light scatter analysis, and they collaborate to design a method of analysis in vivo in Drosophila.

Over two years, students synthesized and tested nineteen unique polymers. In Spring 2013, students chose to quantify the wing unfurling process by measuring wing surface area using the image analysis program, ImageJ. They hypothesized that protein aggregation is related to the degree to which the wings unfurl. They used photographing light microscopes and ImageJ to quantify the area of wings and compared percent changes across treatment groups. In Spring 2014, students hypothesized that the extent of aggregation was indicated by fly motility. They designed and built a motility apparatus and recorded the distance that flies reached in 60 seconds. After learning the basics of statistics, they compared average distances across treatment groups.

Students also engaged with the material from a sociological perspective through literary analysis of a graphic novel and screening of a documentary. As shown in Table 1, responses to feedback surveys indicated that having ownership of their work in a collaborative, multidisciplinary environment resulted in a heightened appreciation of and interest in experimental processes, awareness of the connections between disciplines, recognition of the sociological context of scientific content, and increased focus, camaraderie, and engagement in the course. Future course design initiatives are intended to incorporate this model into other introductory science courses. Additionally, elements of the practicum such as coordinated concurrent enrollment in lab courses and engagement with the sociological context of course content can be used as a model for interdisciplinary projects at other schools and can be scaled

for large enrollment courses.

Table 1. Course Feedback; Learning outcomes are demonstrated by responses to course feedback surveys.

Interdisciplinary Connections			
Relevant Survey Question (1 = Strongly Disagree, 5 = Strongly Agree)	Average Rank	Standard Deviation	Median
This practicum has had a positive impact on my perspectives of Biology and Organic Chemistry	4.5	0.8	5
"Taking the practicum course really allowed me to see the deeper connections between organic chemistry and biology, which I would not have seen simply from taking introductory science courses"			
The Scientific Process			
Having the opportunity to design a unique experimental treatment and method of analysis had a positive impact on my experience in the labs	4.7	0.6	5
"I really enjoyed the opportunity to design experiments and collect new data. I also have a much greater understanding of the research process and feel I can more easily look critically at scientific literature to determine whether or not it was a well done study"			
Fluidity, Collaboration, and Community			
Being co-enrolled in the same group for both Biolab and Orgolab was beneficial to me	4.9	0.4	5
"I had a chance to really get to know the people who were in lab with me, and this made me feel more comfortable asking them for help. It also led to more working together which aided our understanding"			
Sociological Context			
The It's a Bird… assignments were beneficial to me	4.3	1.2	5
Screening the documentary Do You Really Want to Know? was beneficial to me	4.5	0.8	5
"This helps put understanding of the sciences in context and helps you see why it is important in real life"			
Overall Course Experience			
Participating in the practicum was a positive experience	4.7	1.2	5
"This semester was exponentially more enjoyable. Labs did not seem like a tedious test, but rather it felt like we were accomplishing something new each week"			

Keywords: Research practicum, Huntington's Disease

Link to Original Poster:
http://www.ableweb.org/volumes/vol-36/poster?art=57

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