

Design, Implementation, Assessment and Professional Development Training of Faculty for Innovative Pedagogical Approaches to Biology Foundation Instruction

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Project Abstract

The purpose of this project is the first phase in a multi-year effort to redesign the foundation biology courses in innovative evidence-based pedagogical methods in a step-wise iterative process. The rationale is that new pedagogical methods reach a greater array of adult learning styles, increase the frequency and immediacy of faculty-student interactions, engage students in working with career-oriented organizations and assist students in developing career networking skills so that they can gain experience starting at the end of the freshman year. The goal of the project is to increase student mastery of biology concepts and skills and increase freshman retention. Project implementation for redesign of BIOL 104 lecture start in Summer 2014 with materials development on a shared blackboard site, followed by faculty workshops in Fall 2014 and refinement with implementation and assessment in Spring 2015. Results will be shared in a NEXUS campus workshop in Spring 2015. Redesign of BIOL 103 lecture is scheduled for the following year cycle. Laboratory redesign for both BIOL 103 and BIOL 104 will be in conjunction with Hayward Hall Laboratory renovations which are on the larger University capital campaign and strategy plan agenda.

Project Overview

Our proposal is the first phase in a multi-year revision of the freshman year foundation two-course sequence in biology to engage students in active discovery-based learning with career-based examples following National Research Council recommendations on *How Students Learn* (1). All science majors (BIOL, BIOCHEM, CHEM, HSCI, PREMED, OT and PA) enroll in BIOL 103 Biology I and BIOL104 Biology II. These 150 students are taught using lecture-based instruction with a required laboratory. The volume of material covered is daunting with a 56 chapter textbook spanning from the biochemical level to landscape analysis of global nutrient cycles. Students use Learning and Advising Center peer tutors, however many struggle with how to effectively learn at the college level the concepts and skills they will need for their future career. The outside evaluator assessing the Biology Major recommended that active learning methods taught by trained tenured faculty be used (2).

Adults learn best from pedagogical methods aimed at the strengths of their particular learning style. Millennial students prefer: research-based methods, real world relevance, a rationale behind why they are learning, a relaxed informal atmosphere with peers and frequent individual positive interactions from faculty (3). Traditional lecture and laboratory exercises do not do this. For example, the respiratory system is taught using diagrams, tissue slides and plastic models to illustrate the anatomy and students memorize it all. A NEXUS approach has students use interactive on-line learning tools on how the respiratory system functions. Students work in teams with a client who is a smoker to develop a treatment plan of smoking cessation with data on success rates for recovery from national public health agencies that they will use in their future careers.

Retention of freshman in the sciences relies upon a positive learning experience with a skilled and enthusiastic instructor and foundational mastery of concepts and skills upon which upper level coursework is built.

We propose using a NEXUS approach that will increase mastery of key concepts and skills, enhance engagement and increase retention in the BIOL104 lecture period (Three 50 minute sessions per week). This evidence-based research effort will assess mastery based on published success in SCI 102 Exploring Science and ECBIO 201 Biodiversity (4,5). We are starting this multi-year project with BIOL104 because NEXUS materials exist that match the content taught (Evolution, Plant and Animal Form and Function and Ecology) and the Hayward Hall laboratories are slated for renovations in 2016 as part of the University Strategic plan.

Three specific interactive methods will be used:

- 1) **On-line interactive guided inquiry.** An evidence-based program **MASTERING BIOLOGY** (Pearson) combined with project-based learning as outlined above). This on-line approach engages students with the material. Students answer a series of interactive questions. If they get a question wrong, the computer provides a prompt. On the second attempt they are directed to text, visual or video and on the third attempt the faculty member is emailed. Faculty can be highly responsive and delve into misconceptions immediately.
- 2) **Civic Engagement** with national coordinated local efforts such as TOAD DETOUR with Schuylkill Center for Environmental Education, STREAM WATCH with Delaware River Keeper, Friends of the Wissahickon and the PA Fish and Boat Commission. Data is collected working alongside staff from these organizations. Students learn not only the process of science, but also the socio-political framework of how data are used in addressing relevant issues. Two National Science Foundation initiatives (Science Education for New Civic Engagements and Responsibilities (SENCER) and the Network of Conservation Educators and Practitioners (NCEP) at the American Museum of Natural History have both used these pedagogical methods to track science mastery (4,5,6).
- 3) **Peer-Reviewed Career Development:** A peer- reviewed career development unit has been used in ECBIO 101 Environmental Issues (7). Included are resume development, career path comparisons, informational interviews, professional shadowing and career focused internship/ job applications. All assignments are peer-reviewed and shared so the skills and contacts one student is finding are disseminated to all. Every student who has completed this process added either a career-focused volunteer opportunity or internship to their resume in the freshman year. Research indicates student who have internships in college are more likely to have a career-related job within a year after graduation (8).

Project Advances NEXUS learning

This project advances NEXUS learning at two levels:

Student Learning: All teaching activities inserted into BIOL 104 will be active, collaborative, real-world and career-based examples and networking and infused with skills and knowledge from the Liberal Arts and Sciences. Core content will be retained and enhanced by engaging students and increasing mastery.

Faculty Professional Development:

Curricular development training in NEXUS methods will be taught to all faculty teaching BIOL 104. There will be two faculty workshops in the fall: 1) on-line learning using MASTERING BIOLOGY and 2) A How To Do It modeling of hands-on, peer-reviewed and civic engagement pedagogy.

Specific Project Goals and Learning Outcomes

The goals of the project are to redesign BIOL 104 with:

- 1) On-line MASTERING BIOLOGY. The learning outcome is that 100% of biology faculty will use the available on-line tools to improve student performance
- 2) Civic Engagement. The learning outcome is 75% of biology faculty will use the available exercises to improve student performance.
- 3) Career Development. The learning outcome is the 100% of biology faculty will use the career development unit to improve student success in obtaining job experience.

Description of Activities and Timeframe

The present grant application is for Phase I: 2014-15 of the curricular revisions planned in Biology. Phase II: 2015-16 will focus on BIOL 103 Lecture, Phase III: 2016-17 BIOL 104 Laboratory and Phase IV: 2017-18: BIOL103 Laboratory. The timeline is:

Summer 2014:

- Redesign BIOL 104 lecture with NEXUS materials to shared Blackboard site

Fall 2014:

- Pedagogical workshops for faculty (described above).
- Human subjects review submitted
- Assessment materials developed and reviewed

Spring 2015:

- Implement NEXUS learning in five sections of 26-30 students of BIOL 104
- Assessment and data collected on student learning and faculty use of materials
- NEXUS workshop for faculty on preliminary results
- Final report written used for Phase II development

Project Assessment

There are two levels of assessment:

Student Learning: The Student Assessment of Learning Gains (SALG) pre and post- test will be used to assess changes in student engagement. The MASTERING BIOLOGY on-line assessment tools will be used to measure changes in student content mastery. Average retention data for science freshman for the past five years will be compared to 2014-2015. The number of career experience applications versus acceptances will be tracked per student.

Faculty Learning

Faculty attendance and participation in workshops, blackboard training, report submission and a classroom visit to observe use of NEXUS pedagogy will be tracked.

Documentation and Dissemination

We will hold two training workshops and one dissemination workshop for faculty on campus as described above. For future phases of this effort, results will be presented at a Regional SENCER or National Science Teachers Association (NSTA) meeting and a national Lilly Conference on Teaching (competitive peer-reviewed). Publications will be to science teaching journals such as *Science Education and Civic Engagement: An International Journal* or *Teaching Issues and Experiments in Ecology*.

Project Personnel

Dr. Anne Bower will lead the NEXUS learning curriculum development and faculty training in pedagogical methods. She has lead curriculum development efforts at Philadelphia University over a 15 year period in multiple science courses and has collaborated with and published results from two separate National Science Foundation education initiatives: SENCER and NCEP.

As the Biology Coordinator, Frank Wilkinson will lead the assessment efforts. He will supervise Adjunct faculty. He will liaise with science major coordinators.

Budget Narrative and Worksheet (attached excel file)

The budget consists of summer stipends for the two principal investigators Bower and Wilkinson (\$2,000 each), public health and ecological equipment (\$847) and supplies (\$847) (pilot only). The total is: \$6000 for two faculty.

References

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