Discipline-Based dB-SERC Science Education Research Center

DISCIPLINE-BASED SCIENCE EDUCATION RESEARCH CENTER FUNDS PROPOSALS FOR INNOVATIVE TEACHING PROJECTS IN THE NATURAL SCIENCE DEPARTMENTS

The Discipline-Based Science Education Research Center (dB-SERC) in the Dietrich School of Arts and Sciences, has given awards to ten faculty members this year who are developing projects that intend to bring innovation to the teaching and learning in the natural sciences. Course transformation awards fund projects that seek to improve student learning outcomes by adopting and adapting evidence-based teaching practices. Mentor-mentee awards fund projects in which a faculty member mentors a graduate student or postdoctoral student in using evidence-based teaching approaches to transform at least a two week segment of a natural science course.

Transforming "Introduction to Physics 2" into a flipped classroom course

Project Director: Dr. Matteo Broccio, department of physics and astronomy

Research has shown that knowledge is not "passed on" but actively constructed by learners. The "flipped classroom" has been shown to result in greater gains in student learning and attitudes. In the flipped format, lectures are delivered in the form of short videos and the time in class is freed up for the use of evidence-based active learning techniques. Dr. Broccio has already flipped his Physics 1 courses with great success. Therefore, he will also flip Physics 2 courses in the upcoming years. In the flipped format, the students will be asked to watch pre-recorded lectures and do self-diagnostic pre-class activities. In class, the students will be asked to make predictions on the outcome of live demonstrations, work on sample problems, and discuss ideas with peers.

Development of a teaching assistant training program for introductory physics labs

Project Director: Dr. Russell Clark, department of physics and astronomy

Teaching assistants' interaction with students in introductory physics labs is extensive. Furthermore, several introductory physics labs have recently been converted to an inquiry-based format. Inquiry-based labs do not have a set procedure that every student follows. Instead, they give some background for a given topic and then provide some guidance on how the student could explore that topic with the experimental equipment provided. These labs are much less structured than traditional labs, so the TAs must take a somewhat different approach to teaching these labs. Therefore, the TA training program for these labs will need to be different as well. Therefore, Dr. Clark will develop a more effective training program for the introductory lab TAs that helps them effectively facilitate physics labs. The teaching assistants will also be observed while they interact with students during the physics labs, and the findings of the observations will be used to refine and fine-tune an effective training program for the teaching assistants.

Using TopHat to personalize student learning and expand the scientific skillset in a large biological science classroom

Project Director: Dr. Candice Damiani, department of biological sciences

Personalized learning is rarely attained in large, introductory biological science courses. Although this is often an environment where personalized learning is most needed due to the diverse student population, the size of the course, the logistics of providing individualized content and assessment, and the grading demands make personalized learning difficult to achieve. Dr. Damiani plans to incorporate personalized learning in a large enrollment biology course through the use of TopHat, an in-class, online learning platform. TopHat will allow for personalized student skill assessment and skill building as it allows for secure, digital tests that students can take on their own devices during class. The professor will be able to identify each student's strengths and weaknesses and homework assignments will be created via TopHat that focus on enhancing students' scientific skills.

The effect of in-class activities and web-based homework on exam performance in a large-enrollment, lecture-based course

Project director: Dr. Jennifer Ganger, department of psychology

Research shows that deeper engagement with material increases learning, as does more frequent contact with material, particularly when that contact forces recall in the form of test-like questions. Dr. Ganger is taking these learning principles into account in her large enrollment developmental psychology course by adding in-class activities to increase depth of processing and twice-weekly, web-based, multiple choice homework assignments to increase exposure to course material and provide opportunities to recall it. She will assess the efficacy of these changes and further modify them based upon in-class evaluations.

Storytelling in cell biology: Vertically integrating a very complicated class

Project director: Dr. Kirill Kiselyov, department of biological sciences

Cell biology integrates biochemistry of molecular interactions into an understanding of cell-wide or tissue-wide function. It provides the knowledge base for understanding tissue development, disease pathology, and the effects of drugs. Cell biology involves many complex concepts and heavily relies on primary research literature. Dr. Kiselyov will transform his cell biology course to involve several "storylines" that will be assigned to groups of students for development through the entire semester. Each storyline will integrate several concepts discussed during the semester. The storyline development will be shared between the groups. Parallels, differences and complementary concepts will be discussed. The assessment includes quantitative student feedback and graded assignments testing completeness of the story and its understanding by the students.

Creating a comprehensive bank of materials for use in statistics and probability for business management

Project directors: Dr. Bryan Nelson and Dr. Nancy Pfenning, department of statistics

Dr. Nelson and Dr. Pfenning propose to transform instructional materials for the course "Statistics and Probability for Business Management." This project will consolidate and enhance existing instructional materials in order to ensure fair and appropriate content for all instructors, especially those who are newly hired. These include PowerPoints, assignments, projects that require use of Excel, quizzes, midterms, and finals, as well as conceptual questions created for in-class use. This collection of materials will make it possible for less experienced lecturers to "hit the ground running" with high-quality assessment tools that are consistent with our department's goals for instruction in that course. These materials will serve as a valuable resource in the future, especially to new instructors.

Aligning teaching methods and students' learning needs: Active learning vs. traditional classrooms

Project director: Dr. Armin Schikorra, department of mathematics

Most students in science and engineering programs start their university career by enrolling in the calculus sequence. In addition, the student body of the University of Pittsburgh is heterogeneous: students come to the university with a wide array of learning needs, from different cultural backgrounds, and from different educational systems. Dr. Schikorra plans to personalize calculus education by tailoring the educational approach to the individual traits, needs, and levels of each student. He is developing a group-work and active-learning based Calculus I course, and he will investigate what kinds of students thrive in which teaching environment. The goal is to offer a variety of Calculus courses which have consistent learning goals yet allow for different teaching approaches while making reliable recommendations to new students which teaching methods would suit them best.

Utilizing technology to advance engagement and availability in large lecture general chemistry courses

Project director: Dr. Michelle Ward, department of chemistry

Although instructors offer office hours, some students have a packed schedule where it is in the evening hours that they really have the opportunity to focus on working on the course material – and even the most dedicated professors do not have the ability to be in the office from early morning through late evening. With the right technology platform, professors can improve student engagement and instructor availability. Dr. Ward will integrate the platform "Shindig" in her general chemistry courses. Shindig allows for a multitude of features ranging from applications in scheduled virtual review sessions and office hours in evenings, breaking students up into groups to work on problems then come back to the "class" to report and/or ask questions, posting recordings of sessions that students could not attend, and one-on-one instructor-student and student-student interactions. This platform also provides tracking student involvement, which could be compared to performance, providing a means of assessment to support and enlighten faculty looking to incorporate innovative means of engaging students in large lecture courses.

Transforming lecture demonstrations to enhance student performance and engagement

Mentor: Dr. David Nero,
department of physics and astronomy

Mentee: Dr. Rashid Williams-García,
department of neurobiology

The Department of Physics and Astronomy has an impressive collection of lecture demonstration equipment. Dr. Nero and Dr. Williams-Garcia plan to enhance the collection of demonstrations by creating demonstrations to be used in an active learning context. They will create four new lecture demonstrations using LabView software program, which allows instructors to assemble complex experimental setups ahead of time that will work reliably in the lecture. Therefore, the focus of the demonstrations will be on the results of the experiment, rather than on the equipment itself. They hypothesize that these interactive lecture demonstrations will significantly improve student learning outcomes.