Challenges for Implementing Vision and Change in Science Classrooms

Colored Cards to Coursera: The Role of In-house Education Research in Supporting Instructional Innovation, **DIANE K. O'DOWD* and ADRIENNE E. WILLIAMS** (Department of Developmental and Cell Biology, University of California Irvine, Irvine, CA, 92697-1280; dkodowd@uci.edu).

Our biology education research, funded by an HHMI-Professor grant, originally focused on developing strategies for engaging students and faculty in large lecture halls. We have identified activities that can 1) be implemented incrementally by research faculty, 2) result in significant increases in learning and attitudes and 3) be used in large lecture halls. Recently, there has been widespread interest in increasing the use of digital learning tools and online coursework in higher education. We are currently conducting studies to evaluate the effectiveness of a number of digital tools in online instruction and in enhancing face-to-face lectures. I will discuss our research on lecture podcasts, flipped classes, online classes, and MOOCs and how this has influenced our face-to-face teaching and interactions with other faculty on campus. Finally, I will discuss progress in coordinating scientific teaching efforts across disciplines and institutionalizing these programs to support sustained innovation in higher education.

Re-Considering Biology Student Assessment: Development of a Biology Card Sorting Task in Alignment with Vision and Change, **KIMBERLY D. TANNER[1,*], JULIA I. SMITH[2], ELIJAH D. COMBS[1], PAUL H. NAGAMI[1], VALERIE M. ALTO[2], HENRY G. GOH[2], MURYAM A. A. GOURDET[2], CHRISTINA M. HOUGH[2], ASHLEY E. NICKELL[2], ADRIAN G. PEER[2], and JOHN D. COLEY[3]** ([1]San Francisco State University, San Francisco, CA; [2]Holy Names University, Oakland, CA; [3]Northeastern University, Boston, MA; kdtanner@sfsu.edu).

How do biology experts structure their thinking and how might this differ from how students organize biological ideas? Understanding and measuring biological expertise are strongly tied to accomplishing the goals put forward in *Vision and Change for Undergraduate Biology Education*. While there are widespread aspirations to focus undergraduate biology education on teaching students to think conceptually like biologists, there is a dearth of assessment tools designed to measure progress from novice to expert biological conceptual thinking. We present the development of a novel assessment tool, the Biology Card Sorting Task, designed to probe how individuals organize their conceptual knowledge of biology. While modeled on tasks from cognitive psychology, this task is unique in its design to test two hypothesized conceptual frameworks for the organization of biological knowledge: 1) a surface feature organization focused on organism type, and 2) a deep feature organization focused on fundamental biological concepts. In this initial investigation of the Biology Card Sorting Task, each of six analytical measures showed statistically significant differences when used to compare the card sorting results of putative biological experts (biology faculty) and novices (non-biology major undergraduates). Consistently, biology faculty appeared to sort based on hypothesized deep features, while non-biology majors appeared to sort based on either surface features or non-hypothesized organizational frameworks. Results suggest that this novel task is robust in distinguishing biology experts and novices and may be an adaptable tool for biology programs interested in tracking emerging biology conceptual expertise among students, as described in *Vision and Change.*

Providing First-year Undergraduate Scientific Research Experiences in the Teaching Laboratory, **JAMES M. BURNETTE III** (Neil A. Campbell Science Learning Laboratory and Dynamic Genome Program, University of California, Riverside, Riverside, CA 92521; james.burnette@ucr.edu).

Engagement in scientific research in the freshman year can result in persistence in a STEM major. Large research colleges struggle to place the hundreds of first-year students in faculty labs. Additionally graduate students, post-docs, and faculty need training to effectively mentor students. To address these needs UCR established the Neil A. Campbell Science Learning Laboratory to develop effective course based research experiences.

Renovated with a major donation from Rochelle Campbell in recognition of Dr. Campbell's dedication to education, the facility contains two teaching laboratories outfitted with state-of-the-art equipment, a bioinformatics lab, a break-out room, and a preparation room. The facility was personalized by Ms. Campbell with photographs and "Campbell Biology" textbook artwork. The facility is used by: 1. First-year students to learn how to conduct scientific research and conduct research projects by taking the Dynamic Genome course, providing a portal into research labs. 2. Faculty and post-docs who develop research projects based on their research and offer sections of the DG course. 3. Modules are developed, assessed, and published for use by any college. At capacity, eight sections/quarter will be offered serving up to 400 students/year. Many of these well-trained students will enter faculty labs and become productive researchers. The facility is also used for community STEM outreach. The Campbell lab serves as a model to effectively engage many students and faculty in productive research experiences based on active research programs. Examples of research projects will be presented along with evaluation data that demonstrate effectiveness.

Strategies for Implementation of Vision and Change at Community Colleges, **PAMELA PAPE-LINDSTROM (**Everett Community College, 2000 Tower Street, Everett, WA, 98201; ppape@everettcc.edu).

Nationwide, about 46% of undergraduates are enrolled in community colleges, which have become integral to improving affordability and access to higher education. Students at community colleges are more likely to be those historically under-represented in STEM fields, relative to students at four year schools. Accordingly, ensuring success of all STEM students at community colleges is vital if the scientific community is to achieve the goal of one million additional STEM college graduates in the next decade as called for in the PCAST 2012 report *Engage to Excel*. The recommendations of this report coincide with those of the 2011 *Vision and Change* report, in that both focus on increasing the use of evidence based pedagogy in the science classroom. Challenges at community colleges include substantial teaching loads and limited resources for faculty development. However, the smaller class size of the traditional community college classroom can become an advantage as faculty incorporate student-centered teaching practices, inquiry based labs and authentic research experiences for their students. This presentation will introduce some effective approaches for improving the pedagogy of individual instructors. Additionally, low cost approaches to systems-level modifications

at the departmental level which enable long-term transformational change achievable in a community college environment will be emphasized.

The Change in Demographics and STEM: How PULSE Strategies Can Increase URM participation in STEM Careers, **EDWIN J. BAREA-RODRIGUEZ* and DANIELLE GORDON** (Department of Biology, University of Texas at San Antonio, San Antonio, TX 78249; Edwin.Barea@usta.edu).

The U.S. population is diversifying so quickly that by 2060, underrepresented minorities (URMs) will represent 50% of the population. Concurrently, STEM-based jobs will also grow rapidly (17% over the next 10 years). Although the URM population is growing, they are not entering STEM careers at the same rate as whites. Altogether, this may portend a decline in the STEM workforce, impacting the economic vitality of the U.S. The disproportionate number of URMs in STEM careers is not due to lack of interest. Many begin pursuing college degrees but are deterred after taking introductory STEM courses. Recently, AAAS published the Vision and Change in Undergraduate Education: A Call to Action. The report advocated for inclusion of active learning techniques to engage students in life sciences courses (and applied in all STEM disciplines). Unfortunately, very little changes have occurred in pedagogy even though studies have shown that URM students particularly benefit from active learning techniques in the classroom. To support and promote these changes, NSF, NIH, and HHMI created the Partnership for Undergraduate Life Science Education (PULSE) and identified a cadre of 40 Vision & Change Leadership Fellows who were charged with developing strategies to promote adoption of the recommendations in the report. Here we will argue that, when implemented, the strategies developed by the PULSE fellows will result in an increase number of URMs students succeeding in STEM careers, thus making a positive impact on the number of the URMs expected to be represented in STEM careers in the future.

A Partnership for Undergraduate Life Science Education (PULSE): An Initiative to Promote Vision and Change, **GARY REINESS** (Department of Biology, Lewis & Clark College, Portland, OR 97219; reiness@lclark.edu).

The Howard Hughes Medical Institute, National Institute of General Medical Sciences, and National Science Foundation formed the Partnership for Undergraduate Life Science Education (PULSE) to promote the recommendations in the 2011 AAAS report "Vision and Change in Undergraduate Biology Education: A Call to Action". With over 1200 current members of the national PULSE community (pulsecommunity.org), this initiative promises to have a powerful impact on the teaching of life sciences in the United States.

In 2012, HHMI, NIGMS, and NIH selected 39 Leadership Fellows from a diverse range of locations and institutions types—community colleges, liberal arts colleges, comprehensive universities, and research universities—and charged them with designing programs to foster the implementation of the recommendations of Vision and Change. I will report on the activities and projects that have been designed, and in some cases carried out, by the PULSE Leadership Fellows in the last two years to promote departmental-level change in life science education for undergraduates. These include on-line workshops and a toolkit, regional workshops for departmental teams, a rubric for assessing a department's alignment with Vision and Change, a Certification program, and an Ambassadors program to help guide departments through the process of transforming their curricula to align with the Vision and Change recommendations. There will be time for discussion of ways in which individuals and departments can engage with the PULSE initiative.