# CBE-LIFE SCIENCES EDUCATION

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#### **BOOK REVIEW**

#### You'll Find Answers Here

Rachel Fink

Dany Spencer Adams has written an excellent guide to all things quantitative, from calculating molarity to understanding statistics. This useful book should be on every laboratory bench.

#### **ESSAY**

#### Lighten the Load: Scaffolding Visual Literacy in Biochemistry and Molecular Biology

Erika G. Offerdahl, Jessie B. Arneson, and Nicholas Byrne

The development of visual literacy is examined through the lenses of disciplinary discourse and cognitive load, and the need for examining discrete elements of representations independently to reduce the cognitive load of learners is rationalized.

#### **RESEARCH METHODS**

#### Fidelity of Implementation: An Overlooked Yet Critical Construct to Establish Effectiveness of Evidence-Based Instructional Practices

Marilyne Stains and Trisha Vickrey

This *Research Methods* essay describes a framework for measuring fidelity of implementation of evidence-based instructional practices in discipline-based education research and provides general guidelines, as well as a specific example using peer instruction, for how this framework should be employed to characterize the impact of evidence-based instructional practices.

#### ARTICLES

#### Using the Biology Card Sorting Task to Measure Changes in Conceptual Expertise during Postsecondary Biology Education

Sarah A. Bissonnette, Elijah D. Combs, Paul H. Nagami, Victor Byers, Juliana Fernandez, Dinh Le, Jared Realin, Selina Woodham, Julia I. Smith, and Kimberly D. Tanner

Assessment of conceptual biology expertise using the Biology Card Sorting Task among university students with various biology education experiences revealed that advanced biology majors do not develop their own expert-like framework as a result of biology education, but can use this framework if it is provided.

#### Small Changes: Using Assessment to Direct Instructional Practices in Large-Enrollment Biochemistry Courses

#### Xiaoying Xu, Jennifer E. Lewis, Jennifer Loertscher, Vicky Minderhout, and Heather L. Tienson

The use of assessment to inform instruction with the goal of improving learning in undergraduate biochemistry is detailed. Student performance related to three foundational concepts—hydrogen bonding, bond energy, and  $pK_a$ —was analyzed. Results support the use of assessment data to inform instructional change, especially in large-enrollment classes.

#### Weekly Formative Exams and Creative Grading Enhance Student Learning in an Introductory Biology Course

E. G. Bailey, J. Jensen, J. Nelson, H. K. Wiberg, and J. D. Bell

A course format with a creative grading scheme and weekly formative midterms produced large gains in student success with test items requiring higher-order cognitive skills. This format is designed to provide multiple opportunities to attempt demanding problems on exams, immediate feedback, and incentives to improve.

## Efficacy of a Meiosis Learning Module Developed for the Virtual Cell Animation Collection

Eric E. Goff, Katie M. Reindl, Christina Johnson, Phillip McClean, Erika G. Offerdahl, Noah L. Schroeder, and Alan R. White

This study tests the efficacy of an animation-based learning module for conveying basic conceptual understanding of meiosis in introductory biology. Student achievement on a meiosis assessment was significantly higher for students who viewed the learning module than for students who received instruction in a traditional lecture setting alone.

#### Life Science Professional Societies Expand Undergraduate Education Efforts Marsha Lakes Matyas, Elizabeth A. Ruedi, Katie Engen, and Amy L. Chang

Support provided by scientific societies for undergraduate education and changes during the *Vision and Change* era were explored and documented. Society representatives described programs, awards, meetings, membership, teaching resources, publications, staffing, finances, evaluation, and collaborations that address undergraduate faculty and students.

#### The Deaf Mentoring Survey: A Community Cultural Wealth Framework for Measuring Mentoring Effectiveness with Underrepresented Students Derek C. Braun, Cara Gormally, and M. Diane Clark

We describe the development of a next-generation mentoring survey drawing from prior surveys, capital theory, and critical race theory, with the goal of improving mentoring for students from underrepresented groups in science, technology, engineering, and mathematics. This survey focused on deaf mentees. The results show that the mentor's cultural competence affected mentoring experiences.

#### A Comparison of Internal Dispositions and Career Trajectories after Collaborative versus Apprenticed Research Experiences for Undergraduates

Kyle J. Frantz, Melissa K. Demetrikopoulos, Shari L. Britner, Laura L. Carruth, Brian A. Williams, John L. Pecore, Robert L. DeHaan, and Christopher T. Goode

Doing scientific research benefits undergraduates, but relatively few research mentors are available. Using stratified random assignment of students to conditions, this study shows that a collaborative learning model produces student outcomes just as positive as a traditional apprenticeship.

## Why Work with Undergraduate Researchers? Differences in Research Advisors' Motivations and Outcomes by Career Stage

Charles N. Hayward, Sandra L. Laursen, and Heather Thiry

In interviews, many undergraduate research advisors stated intrinsic motivations, but some early-career advisors expressed only instrumental motivations. This study explores what this means for how advisors work with undergraduate researchers and the implications for training and retaining advisors who can provide high-quality research experiences.

#### Student Performance along Axes of Scenario Novelty and Complexity in Introductory Biology: Lessons from a Unique Factorial Approach to Assessment Kirsten K. Deane-Coe, Mark A. Sarvary, and Thomas G. Owens

Using questions on a summative assessment designed using a factorial framework, the authors simultaneously tested whether a learning objective was met in an undergraduate introductory lab course and discovered that students struggle with application of course content to more complex situations compared with novel situations.

## Time-to-Credit Gender Inequities of First-Year PhD Students in the Biological Sciences

#### David F. Feldon, James Peugh, Michelle A. Maher, Josipa Roksa, and Colby Tofel-Grehl

A national sample of female PhD students logged significantly more hours conducting research than their male counterparts. However, males were 15% more likely to be listed as authors on journal articles per 100 hours of research time, reflecting inequality on an essential metric of scholarly productivity that directly impacts competitiveness for academic positions.

#### A Bridge to Active Learning: A Summer Bridge Program Helps Students Maximize Their Active-Learning Experiences and the Active-Learning Experiences of Others

Katelyn M. Cooper, Michael Ashley, and Sara E. Brownell

This interview study of students who participated in a summer bridge program unexpectedly found that these students are maximizing their active-learning experiences and take an equitable approach to group work.

#### A Program Aimed toward Inclusive Excellence for Underrepresented Undergraduate Women in the Sciences

Laura A. Katz, Kathryn M. Aloisio, Nicholas J. Horton, Minh Ly, Sara Pruss, Kate Queeney, Cate Rowen, and Patricia Marten DiBartolo

This paper describes an evaluation of Smith College's Achieving Excellence in Mathematics, Engineering, and Science Scholar program, developed to improve outcomes for underrepresented women in science. AEMES Scholars' academic record data reveal benefits over time and relative to peers.

#### Deaf, Hard-of-Hearing, and Hearing Signing Undergraduates' Attitudes toward Science in Inquiry-Based Biology Laboratory Classes Cara Gormally

Positive attitudes are important for students' engagement with science. This study explores the development of students' attitudes toward science and scientific attitudes in inquiry-based biology laboratory classes. The study focuses on deaf, hard-of-hearing, and signing hearing students in bilingual (American Sign Language and English) classes.

#### What's in a Name? The Importance of Students Perceiving That an Instructor Knows Their Names in a High-Enrollment Biology Classroom Katelyn M. Cooper, Brian Haney, Anna Krieg, and Sara E. Brownell

This study investigated whether instructors know student names and the importance of instructors knowing names. Nine reasons that students feel having their names known is important were identified. It was also found that instructors can use name tents to call students by name and do not have to know student names in order for students to perceive that their names are known.

#### Experiences of Judeo-Christian Students in Undergraduate Biology

M. Elizabeth Barnes, Jasmine M. Truong, and Sara E. Brownell

From 28 interviews with religious students in biology classes, the authors find that students from Judeo-Christian backgrounds report subtle negative experiences in biology classes that could influence their sense of belonging and subsequent persistence in biology.

#### A SCALE-UP Mock-Up: Comparison of Student Learning Gains in High- and Low-Tech Active-Learning Environments

Paula A. G. Soneral and Sara A. Wyse

This quasi-experimental study identifies specific features of the SCALE-UP classroom space most helpful for teaching and learning and directly tests the impact of classroom technology on student learning, attitudes, and satisfaction.

## What's in a Prerequisite? A Mixed-Methods Approach to Identifying the Impact of a Prerequisite Course

Brian K. Sato, Amanda K. Lee, Usman Alam, Jennifer V. Dang, Samantha J. Dacanay, Pedro Morgado, Giorgia Pirino, Jo Ellen Brunner, Leanne A. Castillo, Valerie W. Chan, and Judith H. Sandholtz

The impact of a prerequisite course was examined using both quantitative (exam data analyzed with a "familiarity" scale) and qualitative (surveys and semistructured interviews) data. These data affirmed a recent program change and highlighted the importance of collecting and analyzing student feedback in development of curricula.

#### How Is Science Being Taught? Measuring Evidence-Based Teaching Practices across Undergraduate Science Departments

Michael J. Drinkwater, Kelly E. Matthews, and Jacob Seiler

The adoption of evidence-based teaching practices across a bachelor of science program at a large research-intensive Australian university was measured. The results at the Australian university were compared to those from a Canadian institution to identify areas to prioritize for future development. The use of evidence-based teaching practices differed by discipline, and adoption was higher in first-year classes. Central university policy has supported the use of certain evidence-based practices.

#### CORRECTIONS

Student Buy-In to Active Learning in a College Science Course

Andrew J. Cavanagh, Oriana R. Aragón, Xinnian Chen, Brian Couch, Mary Durham, Aiyana Bobrownicki, David I. Hanauer, and Mark J. Graham

## Do We Need to Design Course-Based Undergraduate Research Experiences for Authenticity?

Susan Rowland, Rhianna Pedwell, Gwen Lawrie, Joseph Lovie-Toon, and Yu Hung

#### Bridging the Undergraduate Curriculum Using an Integrated Course-Embedded Undergraduate Research Experience (ICURE)

James E. Russell, Allison R. D'Costa, Clay Runck, David W. Barnes, Alessandra L. Barrera, Jennifer Hurst-Kennedy, Elizabeth B. Sudduth, Erin L. Quinlan, and Mark Schlueter

#### On the Cover

Fluorescent image of serum-starved fibroblasts created from four images stitched together. Image shows the microtubules (green) and nucleus (red). Image credit: Jan Schmoranzer, Ninth Prize, 2007 Olympus BioScapes Digital Imaging Competition. This image is licensed under a Creative Commons Attribution, Non-Commercial, No Derivatives License. https://creativecommons.org/licenses/by-nc-nd/3.0/