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APPROACHES TO BIOLOGY TEACHING AND LEARNING

Language Matters: Considering Microaggressions in Science

Colin Harrison and Kimberly D. Tanner

Language matters and can have profound effects on individuals' sense of belonging, self-efficacy, and science identity. This article explores identifying and addressing microaggressions in the everyday language of scientific environments that may be key to making science classrooms, laboratories, and conferences inclusive professional contexts.

CURRENT INSIGHTS

Alternative Perspectives on Students' Reasoning about Emergent Processes

Julia Gouvea

This installment of *Current Insights* highlights two recent and different perspectives on elementary and secondary school students' reasoning about emergent processes.

EVIDENCE-BASED TEACHING GUIDES

Helping Practitioners and Researchers Identify and Use Education

Research Literature

Kristy J. Wilson and Cynthia J. Brame

This article introduces the *Evidence-Based Teaching Guides* feature. Each guide links to and summarizes research on a specific pedagogy and associated practical recommendations. Each guide consists of a website with a visual map of instructional choices, linked pages with relevant research, and an instructor checklist of recommendations.

Group Work

Kristy J. Wilson, Peggy Brickman, and Cynthia J. Brame

This essay introduces an evidence-based teaching guide presenting research and resources related to group work. The guide provides links to key articles accompanied by summaries organized by teaching challenge and an instructor checklist. In addition to describing the guide, the article identifies areas for further research.

RESEARCH METHODS

Benefit–Cost Analysis of Undergraduate Education Programs: An Example Analysis of the Freshman Research Initiative

Rebecca L. Walcott, Phaedra S. Corso, Stacia E. Rodenbusch, and Erin L. Dolan

Economic evaluation can help administrators and institutions make informed decisions on how to allocate resources in higher education. This essay describes methods for conducting one type of economic evaluation, benefit–cost analysis, using an example of an existing undergraduate education program, the Freshman Research Initiative at the University of Texas Austin.

ESSAY

Scientific Presenting: Using Evidence-Based Classroom Practices to Deliver Effective Conference Presentations

Lisa A. Corwin, Amy Prunuske, and Shannon B. Seidel

Scientific presenting is the use of scientific teaching principles—active learning, equity, and assessment—in conference presentations to improve learning, engagement, and inclusiveness. This essay presents challenges presenters face and suggestions for how presenters can incorporate active learning strategies into their scientific presentations.

ARTICLES

Understanding the Complex Relationship between Critical Thinking and Science Reasoning among Undergraduate Thesis Writers

Jason E. Dowd, Robert J. Thompson, Jr., Leslie A. Schiff, and Julie A. Reynolds

This study empirically examines the relationship between students' critical-thinking skills and scientific reasoning as reflected in undergraduate thesis writing in biology. Writing offers a unique window into studying this relationship, and the findings raise potential implications for instruction.

Visual Literacy in Bloom: Using Bloom's Taxonomy to Support Visual Learning Skills

Jessie B. Arneson and Erika G. Offerdahl

The development of a Bloom's-based tool that can be used to structure activities and assessments to target the development of visual literacy skills in undergraduate science is described. Findings indicate that merely increasing practice with visual representations does not improve student performance and may lower success on higher-order tasks.

Energy Connections and Misconnections across Chemistry and Biology

Kathryn P. Kohn, Sonia M. Underwood, and Melanie M. Cooper

To inform future interdisciplinary course reform, undergraduate students coenrolled in introductory chemistry and cell and molecular biology were interviewed regarding their perceptions of the integration of energy both within and across the disciplines and how they attempted to accommodate and reconcile different disciplinary approaches to energy.

Enhancing Conceptual Knowledge of Energy in Biology with Incorrect Representations

Ulrike Wernecke, Kerstin Schütte, Julia Schwanewedel, and Ute Harms

An instructional approach that combines learning through representations and learning from errors to foster conceptual knowledge of energy is proposed. It involves inserting an error in a biological energy flow diagram that addresses misconceptions. An intervention study tests the approach's effect on students' conceptual knowledge of energy.

How Four Scientists Integrate Thermodynamic and Kinetic Theory, Context, Analogies, and Methods in Protein-Folding and Dynamics Research: Implications for Biochemistry Instruction

Kathleen A. Jeffery, Nancy Pelaez, and Trevor R. Anderson

We conducted a qualitative analysis of how four experts conducting research involving protein folding and dynamics explain their work in the context of their research goals and methods. Results reveal similarities and differences in explanation construction and purpose and multiple ways of explaining theoretical thermodynamic/kinetic concepts.

Arrows in Biology: Lack of Clarity and Consistency Points to Confusion for Learners

L. Kate Wright, Jordan J. Cardenas, Phyllis Liang, and Dina L. Newman

Biology education relies heavily on visual representations, many of which contain arrow symbols. Many different styles of arrows are used, with no correlation to their underlying meaning. This creates a problem for students, who struggle to interpret and learn from figures containing arrows in biology.

Pathways over Time: Functional Genomics Research in an Introductory Laboratory Course

Todd D. Reeves, Douglas M. Warner, Larry H. Ludlow, and Clare M. O'Connor

Introductory students in a large, multisection course-based undergraduate research experience acquired content knowledge and research skills while studying the evolutionary conservation of enzymes involved in methionine synthesis. The course research project is designed to be sustainable and easily adapted to other research questions and institutional settings.

A Longitudinal Study of How Quality Mentorship and Research Experience Integrate Underrepresented Minorities into STEM Careers

Mica Estrada, Paul R. Hernandez, and P. Wesley Schultz

This longitudinal study examines how undergraduate research experience and quality mentorship experiences in college predict the growth of scientific efficacy, identity, and values. Results also show how growth trajectories predict students who stay in STEM, pursue medical/health degrees, or leave STEM careers 4 years after graduation.

Trust, Growth Mindset, and Student Commitment to Active Learning in a College Science Course

Andrew J. Cavanagh, Xinnian Chen, Meghan Bathgate, Jennifer Frederick, David I. Hanauer, and Mark J. Graham

Predictors of student commitment and engagement in an undergraduate science course featuring active learning are explored. The study identified student trust in the instructor as an important predictor of student commitment and engagement in an active-learning context.

Āwhina Revolution: A Bayesian Analysis of Undergraduate and Postgraduate Completion Rates from a Program for Māori and Pacific Success in STEM Disciplines

Ken Richardson, Zaramasina Clark, Michael Gaines, Hautahi Kingi, Sonja Miller, Willie Pearson, Jr., and Liz Richardson

Te Rōpū Āwhina (Āwhina), an equity initiative in a New Zealand university, aimed to produce Māori and Pacific science, technology, engineering, and mathematics professionals who contribute to Māori and Pacific community development and leadership. Standardized completion rates for 3-year undergraduate and 2-year postgraduate degree students were consistent with a positive Āwhina effect.

Moving Evolution Education Forward: A Systematic Analysis of Literature to Identify Gaps in Collective Knowledge for Teaching

M. A. Ziadie and T. C. Andrews

A systematic analysis of the literature undertaken to identify gaps in collective knowledge for teaching undergraduate evolution is reported. A total of 316 peer-reviewed papers were analyzed to determine: evolutionary topics addressed; whether the focus was student thinking, assessment, instructional strategies, or goals; and the type of work. Future research priorities are proposed.

Internship Experiences Contribute to Confident Career Decision Making for Doctoral Students in the Life Sciences

Alexandra M. Schnoes, Anne Caliendo, Janice Morand, Teresa Dillinger, Michelle Naffziger-Hirsch, Bruce Moses, Jeffery C. Gibeling, Keith R. Yamamoto, Bill Lindstaedt, Richard McGee, and Theresa C. O'Brien

An internship program model that supports life sciences doctoral students' pursuit of a broad range of careers is described. Evaluation of the program model at two institutions finds that participation increases students' confidence in career decision making without extending time to degree and may help some trainees avoid "default postdocs."

Does Context Matter? Convergent and Divergent Findings in the Cross-Institutional Evaluation of Graduate Teaching Assistant Professional Development Programs

Todd D. Reeves, Laura E. Hake, Xinnian Chen, Jennifer Frederick, Kristin Rudenga, Larry H. Ludlow, and Clare M. O'Connor

This study examines the role of contextual factors in the efficacy of professional development for graduate teaching assistants by comparing presemester workshops for graduate teaching assistants at three Northeastern research universities.

The Effects of Doctoral Teaching Development on Early-Career STEM Scholars’ College Teaching Self-efficacy

Mark R. Connolly, You-Geon Lee, and Julia N. Savoy

To help prepare future faculty in science, technology, engineering, and mathematics fields to teach undergraduates, more research universities are offering teaching development (TD) programs to doctoral students who aspire to academic careers. This study found that participation in TD programs is positively associated with college teaching self-efficacy.

Teacher Knowledge for Active-Learning Instruction: Expert–Novice Comparison Reveals Differences

A. J. Auerbach, M. Higgins, P. Brickman, and T. C. Andrews

This study examined teacher knowledge important to effective active-learning instruction in large college biology courses by comparing expert and novice thinking. Experts paid attention to particular aspects of instruction more frequently than novices and reasoned more deeply as they evaluated and made suggestions about how to improve lessons.

Collectively Improving Our Teaching: Attempting Biology Department–wide Professional Development in Scientific Teaching

Melinda T. Owens, Gloriana Trujillo, Shannon B. Seidel, Colin D. Harrison, Katherine M. Farrar, Hilary P. Benton, J. R. Blair, Katharyn E. Boyer, Jennifer L. Breckler, Laura W. Burrus, Dana T. Byrd, Natalia Caporale, Edward J. Carpenter, Yee-Hung M. Chan, Joseph C. Chen, Lily Chen, Linda H. Chen, Diana S. Chu, William P. Cochlan, Robyn J. Crook, Karen D. Crow, José R. de la Torre, Wilfred F. Denetclaw, Lynne M. Dowdy, Darleen Franklin, Megumi Fuse, Michael A. Goldman, Brinda Govindan, Michael Green, Holly E. Harris, Zheng-Hui He, Stephen B. Ingalls, Peter Ingmire, Amber R. B. Johnson, Jonathan D. Knight, Gretchen LeBuhn, Terrye L. Light, Candace Low, Lance Lund, Leticia M. Márquez-Magaña, Vanessa C. Miller-Sims, Christopher A. Moffatt, Heather Murdock, Gloria L. Nusse, V. Thomas Parker, Sally G. Pasion, Robert Patterson, Pleuni S. Pennings, Julio C. Ramirez, Robert M. Ramirez, Blake Riggs, Rori V. Rohlf, Joseph M. Romeo, Barry S. Rothman, Scott W. Roy, Tatiane Russo-Tait, Ravinder N. M. Sehgal, Kevin A. Simonin, Greg S. Spicer, Jonathon H. Stillman, Andrea Swei, Leslie C. Timpe, Vance T. Vredenburg, Steven L. Weinstein, Andrew G. Zink, Loretta A. Kelley, Carmen R. Domingo, and Kimberly D. Tanner

A collaborative professional development program that engaged nearly 90% of faculty in a biology department in more than 40 hours of training on scientific teaching was instituted. Participating instructors integrated active learning in their courses, as shown through a variety of methods, and reported positive effects on teaching and departmental community.

CORRECTION

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On the Cover

Polarized light micrograph of a diatom *Arachnoidiscus*. Honorable Mention, 2010 Olympus BioScapes Digital Imaging Competition®. Photo by Michael Shribak. Attribution Non-Commercial; No Derivatives.