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## FEATURE

### *Approaches to Biology Teaching and Learning*

#### **A Portal into Biology Education: An Annotated List of Commonly Encountered Terms**

Sarah Miller and Kimberly D. Tanner

Exploring a new discipline can be daunting in any field, and biology education is no exception. The authors provide a resource for those who are new to explorations of the biology education and biology education research worlds, including key terminology, brief definitions, and links to literature for further explorations.

## LETTER TO THE EDITOR

### **Overcoming the Barrier to Implementing Authentic Research Experiences through Faculty Mentorship**

Christine M. Goedhart and Jacqueline S. McLaughlin

## ESSAY

### **Test-Enhanced Learning: The Potential for Testing to Promote Greater Learning in Undergraduate Science Courses**

Cynthia J. Brame and Rachel Biel

Testing can be a learning event. Research from cognitive science suggests that repeated retrieval using various formats can enhance long-term learning, that feedback enhances this benefit, that testing can potentiate further study, and that benefits of testing go beyond rote memory. These observations open opportunities for teaching and research.

## ARTICLES

### **The Grass Isn't Always Greener: Perceptions of and Performance on Open-Note Exams**

Brian K. Sato, Wenliang He, Mark Warschauer, and Pavan Kadandale

The performance and perception of open- and closed-note testing environments were investigated. Exam scores did not vary under these conditions, but small differences were uncovered for students with experience taking open-note exams. This implies that increased exposure to open-note testing is required to understand the impact of this intervention.

### **Examining the Impact of Question Surface Features on Students' Answers to Constructed-Response Questions on Photosynthesis**

Michele Weston, Kevin C. Haudek, Luanna Prevost, Mark Urban-Lurain, and John Merrill

One challenge in science education assessment is that students often focus on question surface features rather than the underlying scientific principles. The authors investigated how student responses to photosynthesis constructed-response questions vary based on two surface features of a question and found no significant difference in the content of responses.

### **Differences in Metacognitive Regulation in Introductory Biology Students: When Prompts Are Not Enough**

Julie Dangremond Stanton, Xyanthe N. Neider, Isaura J. Gallegos, and Nicole C. Clark

Metacognition correlates with learning outcomes and student performance. In this study, the authors examined the metacognitive-regulation skills used by introductory biology students. They found that prompting students to use these skills is effective for some students, but other students need additional help with learning strategies to respond optimally.

### **Helping Struggling Students in Introductory Biology: A Peer-Tutoring Approach That Improves Performance, Perception, and Retention**

Zachary Batz, Brian J. Olsen, Jonathan Dumont, Farahad Dastoor, and Michelle K. Smith

This study examines an optional peer-tutoring program offered to students who are struggling in a large-enrollment, introductory biology course. Students who regularly attended had increased exam performance, more expert-like perceptions of biology, and increased persistence relative to their struggling peers who were not attending.

### **Increasing Persistence in Undergraduate Science Majors: A Model for Institutional Support of Underrepresented Students**

Brit Toven-Lindsey, Marc Levis-Fitzgerald, Paul H. Barber, and Tama Hasson

This study uses a matched comparison group design to examine PEERS, an academic support program for undergraduates at the University of California, Los Angeles. PEERS students earned higher grades in science courses, had higher cumulative GPAs, completed more science courses, and persisted in a science major at significantly higher rates than students in the comparison group.

### **A High-Enrollment Course-Based Undergraduate Research Experience Improves Student Conceptions of Scientific Thinking and Ability to Interpret Data**

Sara E. Brownell, Daria S. Hekmat-Scafe, Veena Singla, Patricia Chandler Seawell, Jamie F. Conklin Imam, Sarah L. Eddy, Tim Stearns, and Martha S. Cyert

The authors developed and assessed an innovative course-based undergraduate research experience that emphasized collaboration among students and focused on data analysis.

### **The Synthesis Map Is a Multidimensional Educational Tool That Provides Insight into Students' Mental Models and Promotes Students' Synthetic Knowledge Generation**

Ryan A. Ortega and Cynthia J. Brame

Synthesis mapping uses a novel, multidimensional presentation tool to allow students to create a detailed map of their hierarchical knowledge structures. It can be used as formative assessment to reveal students' strengths, misconceptions, and organizational schema and as a summative assessment to test students' understanding of course material.

### **A Model of How Different Biology Experts Explain Molecular and Cellular Mechanisms**

Caleb M. Trujillo, Trevor R. Anderson, and Nancy J. Pelaez

This study used a literature review and interviews with practicing biologists to develop the MACH model, a Venn diagram of the components research scientists include when explaining molecular and cellular mechanisms. Seven biologists from different subdisciplines included research Methods, Analogy, Context, and How the mechanism works to explain the systems they investigate.

### **Beyond the GRE: Using a Composite Score to Predict the Success of Puerto Rican Students in a Biomedical PhD Program**

Wendy I. Pacheco, Richard J. Noel, Jr., James T. Porter, and Caroline B. Appleyard

A composite score (CS) using measurable indicators of research aptitude was developed. They compared the CS and the Graduate Record Examination General Test (GRE) of incoming students with students' achievement of specific graduate-program milestones. Results showed that the composite score is a better predictor of successful outcomes for this population of biomedical PhD students than the GRE.

### **PORTAAL: A Classroom Observation Tool Assessing Evidence-Based Teaching Practices for Active Learning in Large Science, Technology, Engineering, and Mathematics Classes**

Sarah L. Eddy, Mercedes Converse, and Mary Pat Wenderoth

PORTAAL, a new evidence-based classroom observation tool, identifies 21 elements of classroom best practices for active learning that have been correlated with positive student outcomes in the education literature. After only 5 h of training, instructors can reliably use this tool to determine their alignment with these teaching practices.

**The Best of Both Worlds: Building on the COPUS and RTOP Observation Protocols to Easily and Reliably Measure Various Levels of Reformed Instructional Practice**

Travis J. Lund, Matthew Pilarz, Jonathan B. Velasco, Devasmita Chakraverty, Kaitlyn Rosploch, Molly Undersander, and Marilynne Stains

The authors performed a cluster analysis using observational data from 269 class periods and including 73 science, technology, engineering, and mathematics (STEM) faculty from 28 research universities. They used eight of the 25 Classroom Observation Protocol in Undergraduate STEM codes to produce 10 clusters of instructional styles across a range of Reformed Teaching Observation Protocol scores. A description of the clusters and their distribution across various STEM courses are provided.

**The Faculty Self-Reported Assessment Survey (FRAS): Differentiating Faculty Knowledge and Experience in Assessment**

David I. Hanauer and Cynthia Bauerle

The Faculty Self-Reported Assessment Survey, or FRAS, is an easy to use, reliable, and validated instrument for evaluating and differentiating levels of science faculty assessment knowledge and experience.

**Building National Capacity for Research Mentor Training: An Evidence-Based Approach to Training the Trainers**

Christine Pfund, Kimberly C. Spencer, Pamela Asquith, Stephanie C. House, Sarah Miller, and Christine A. Sorkness

This article describes the development, implementation, evaluation, and impact of a train-the-trainer workshop designed to promote widespread dissemination of an evidence-based research mentor training curriculum.

**Breaking the Cycle: Future Faculty Members Begin Teaching with Learner-Centered Strategies after Professional Development**

Diane Ebert-May, Terry L. Derting, Timothy P. Henkel, Jessica Middlemis Maher, Jennifer L. Momsen, Bryan Arnold, and Heather A. Passmore

The authors investigated the extent to which postdoctoral fellows believed in and implemented evidence-based pedagogies after completion of a 2-yr professional development program, FIRST IV. Postdocs reported greater use of learner-centered compared with teacher-centered instruction, and video ratings further documented learner-centered instruction.

*On the Cover*

During a supplementary part of a molecular biology course taught by Professor Shuping Zhang and Dr. Peng Li at the School of Life Sciences, Tsinghua University (China), student Cui Gao cultured the "flower" on the cover using bacteria expressing green or red fluorescent proteins. The flower is accompanied by two Chinese characters meaning the month of May.