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### GENERAL ESSAYS AND ARTICLES

#### ESSAY

##### **Integrating Critical Approaches into Quantitative STEM Equity Work**

*Meaghan I. Pearson, Sarah D. Castle, Rebecca L. Matz, Benjamin P. Koester, and W. Carson Byrd*

A primer of reflective questions to assist researchers with framing, analysis, and interpretation of student-level data frequently used to identify disparities and assess course-level and programmatic interventions is provided to support the scientific community with enhancing how we understand and address systemic inequity in STEM fields.

#### ARTICLES

##### **Drawing on Internal Strengths and Creating Spaces for Growth: How Black Science Majors Navigate the Racial Climate at a Predominantly White Institution to Succeed**

*Julie Dangremond Stanton, Darris R. Means, Oluwadamilola Babatola, Chimezie Osondu, Omowunmi Oni, and Birook Mekonnen*

A participatory action research approach was used to identify the community cultural wealth Black science majors use to navigate the racial climate at a predominantly white institution (PWI). Black science students use their internal strengths to succeed in their majors, and they create spaces where they share support and resources to thrive at a PWI.

##### **Factors Influencing Retention of Transgender and Gender Nonconforming Students in Undergraduate STEM Majors**

*Jeffrey Maloy, Monika B. Kwapisz, and Bryce E. Hughes*

Science, technology, engineering, and mathematics (STEM) majors do not retain transgender and gender nonconforming (TGNC) students and cisgender students at similar rates. This article explores TGNC retention in STEM majors and describes factors that contribute to differential retention of cisgender and TGNC students.

##### **A Cultural Impostor? Native American Experiences of Impostor Phenomenon in STEM**

*Devasmita Chakraverty*

Interviews with seven Native Americans in STEM identified aspects of impostor phenomenon in relation to their minority identity: 1) cultural differences and lack of understanding of indigenous culture, 2) lack of critical mass and fear of standing out, 3) academic environment, 4) family background and upbringing, and 5) looks and diversity status.

**The Instructor’s Role in a Model-Based Inquiry Laboratory: Characterizing Instructor Supports and Intentions in Teaching Authentic Scientific Practices**

*A. C. Cooper, K. M. Southard, J. B. Osness, and M. S. Bolger*

An investigation of instructional intentions and teaching actions of experienced inquiry instructors was conducted. Analysis of classroom recordings and interviews provides insight into how laboratory instructors can support students in the scientific practices of modeling and experimental design. Implications for adapting teaching are discussed.

**Improving Students’ Understanding of Biological Variation in Experimental Design and Analysis through a Short Model-Based Curricular Intervention**

*Jessica Dewey, Jenna Hicks, and Anita Schuchardt*

A model of variation in experimental design and analysis is presented. Using a quasi-experimental design, this research shows that a curriculum that uses a model-based approach to variation in experimental design and analysis improves student understanding when compared with peers who receive more traditional siloed instruction on these topics.

**Secondary Students’ Reasoning on Pedigree Problems**

*Justin Timm, Katharina Wools, and Philipp Schmiemann*

In this qualitative analysis, propositions concerning pedigrees from two groups of secondary students with varying degrees of experience in genetics were categorized. Differences in strategic approaches between groups demonstrate graphically which family members the students used to make their decisions. A variety of typical but unreliable arguments made by students are discussed.

**“Moving the Science Forward”: Faculty Perceptions of Culturally Diverse Mentor Training Benefits, Challenges, and Support**

*Damani K. White-Lewis, Ana L. Romero, Justin A. Gutzwa, and Sylvia Hurtado*

This study applied social exchange theory to examine 74 faculty members’ perceptions of culturally diverse mentor training activities at 10 undergraduate institutions in the early stages of implementing grant-funded interventions focused on determining the most effective ways to engage and retain racially diverse students in biomedical research.

**A Course-Based Teaching Experience for STEM Undergraduates Improves Student Perceptions of Teaching Self-Efficacy and Attitudes Toward Teaching Careers**

*Seth Bush, Ashley Calloway, Emily Bush, and Ed Himelblau*

In the Learn By Doing Lab, STEM majors teach hands-on science to third- through eighth-grade students visiting the campus. Participants develop confidence in their ability to teach science and a more positive view of the teaching profession. Participants recognize that the experience builds 21st-century competencies.

**Talking Science: Undergraduates’ Everyday Conversations as Acts of Boundary Spanning That Connect Science to Local Communities**

*Hana Shah, Josue Simeon, Kathleen Quardokus Fisher, and Sarah L. Eddy*

Undergraduate biology majors are engaging in conversations about science with people in their personal networks. They engage in, and struggle with, translating science into common language and providing sufficient background information for laypeople to understand the concepts. Lack of credibility with their audiences was sometimes a problem.

**Accuracy and Idea Consideration: A Study of Small-Group Interaction in Biology**

*Andy R. Cavagnetto, Joshua Premo, Zachary Coleman, and Kate Juergens*

The study examines the relationship between scientific accuracy of contributions, peer idea consideration, one’s ability to direct the conversation, and learning outcomes of students engaged in small-group work in an introductory undergraduate biology lab course.

### **Using the Intended–Enacted–Experienced Curriculum Model to Map the Vision and Change Core Competencies in Undergraduate Biology Programs and Courses**

*Alexa W. Clemmons, Deborah A. Donovan, Elli J. Theobald, and Alison J. Crowe*

This study applies the intended-enacted-experienced curriculum model to map the *Vision and Change* core competencies across undergraduate biology courses. A five-department pilot of a curriculum mapping survey is followed by a deep dive of 10 courses to provide a rich snapshot of current core competency teaching and assessment practices.

### **“How Do We Do This at a Distance?!” A Descriptive Study of Remote Undergraduate Research Programs during COVID-19**

*Olivia A. Erickson, Rebecca B. Cole, Jared M. Isaacs, Silvia Alvarez-Clare, Jonathan Arnold, Allison Augustus-Wallace, Joseph C. Ayoob, Alan Berkowitz, Janet Branchaw, Kevin R. Burgio, Charles H. Cannon, Ruben Michael Ceballos, C. Sarah Cohen, Hilary Collier, Jane Disney, Van A. Doze, Margaret J. Eggers, Stacy Farina, Edwin L. Ferguson, Jeffrey J. Gray, Jean T. Greenberg, Alexander Hoffmann, Danielle Jensen-Ryan, Robert M. Kao, Alex C. Keene, Johanna E. Kowalko, Steven A. Lopez, Camille Mathis, Mona Minkara, Courtney J. Murren, Mary Jo Ondrechen, Patricia Ordoñez, Anne Osano, Elizabeth Padilla-Crespo, Soubantika Palchoudhury, Hong Qin, Juan Ramírez-Lugo, Jennifer Reithel, Colin A. Shaw, Amber Smith, Rosemary Smith, Adam P. Summers, Fern Tsien, and Erin L. Dolan*

This study describes the design and implementation of remote Summer undergraduate research programs during the COVID-19 pandemic, including program strengths and recommendations for improvement from the perspectives of undergraduate researchers.

### **Instructional Models for Course-Based Research Experience (CRE) Teaching**

*David I. Hanauer, Mark J. Graham, Rachel J. Arnold, Mary A. Ayuk, Mitchell F. Balish, Andrea R. Beyer, Kristen A. Butela, Christine A. Byrum, Catherine P. Chia, Hui-Min Chung, Kari L. Clase, Stephanie Conant, Roy J. Coomans, Tom D’Elia, Jason Diaz, Arturo Diaz, Jean A. Doty, Nicholas P. Edgington, Dustin C. Edwards, Elyira Eivazova, Christine B. Emmons, Kayla M. Fast, Emily J. Fisher, Christine L. Fleischacker, Gregory D. Frederick, Amanda C. Freise, Maria D. Gainey, Chris R. Gissendanner, Urszula P. Golebiewska, Nancy A. Guild, Heather L. Hendrickson, Christopher D. Herren, Margaret S. Hopson-Fernandes, Lee E. Hughes, Deborah Jacobs-Sera, Allison A. Johnson, Bridgette L. Kirkpatrick, Karen K. Klyczek, Ann P. Koga, Hari Kotturi, Janine LeBlanc-Straceski, Julia Y. Lee-Soety, Justin E. Leonard, Matthew D. Mastropaolo, Evan C. Merkhofer, Scott F. Michael, Jon C. Mitchell, Swarna Mohan, Denise L. Monti, Christos Noutsos, Imade Y. Nsa, Nick T. Peters, Ruth Plymale, Richard S. Pollenz, Megan L. Porter, Claire A. Rinehart, German Rosas-Acosta, Joseph F. Ross, Michael R. Rubin, Anne E. Scherer, Stephanie C. Schroeder, Christopher D. Shaffer, Amy B. Sprenkle, C. Nicole Sunnen, Sarah J. Swerdlow, Deborah Tobiason, Sara S. Tolsma, Philippos K. Tsourkas, Robert E. Ward, Vassie C. Ware, Marcie H. Warner, Jacqueline M. Washington, Kristi M. Westover, Simon J. White, JoAnn L. Whitefleet-Smith, Daniel C. Williams, Michael J. Wolyniak, Jill H. Zeilstra-Ryalls, David J. Asai, Graham F. Hatfull, and Viknesh Sivanathan*

A report on research that explicates three models of pedagogical practice that underpin and characterize inquiry instruction in a course-based research experience.

### **A Revised Measure of Acceptance of the Theory of Evolution: Introducing the MATE 2.0**

*M. Elizabeth Barnes, Taya Misheva, K. Supriya, Michael Rutledge, and Sara E. Brownell*

An updated version of the most popular survey used to measure student evolution acceptance in education studies, the Measure of Acceptance of the Theory of Evolution (MATE), is provided. Process, structural, and concurrent validity evidence for the new measure, the MATE 2.0, are supplied.

**SPECIAL SECTION ON CROSS-DISCIPLINARY RESEARCH IN BIOLOGY  
EDUCATION**

**Scalable Science Education via Online Cooperative Questioning**

*Courtney B. Hilton, Micah B. Goldwater, Dale Hancock, Matthew Clemson, Alice Huang, and Gareth Denyer*

How can the scalable powers of peer learning and online technologies be most effectively used to support conceptual understanding in science education? This paper reviews cognitive science research on how people learn via question answering and authoring and evaluates a promising novel learning design that applies these principles.

*On the Cover*

Form and Fate in the Embryonic Chameleon Lung, 3rd Place (Images) 2021 ASCB Image and Video Contest, Katharine Goodwin, Princeton University. The embryonic chameleon lungs consist of epithelial sacs surrounded by smooth muscle mesh (magenta). Epithelial protrusions that emerge through the mesh express the same fate marker (green) as epithelial bud tips in the mouse. This fate marker also labels cartilage precursors that surround the trachea and primary bronchi - in the lizards we've studied, cartilage wraps all the way around these upper airways, instead of only halfway around like it does in the mouse.