11th Annual SABER National Meeting Conference Materials

Virtual Conference Dates
July 19, 2021; July 16, 2021; July 23, 2021; and July 30, 2021

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SABER National Meeting Schedule

Friday, July 9th, 2021

Note: All times CDT

12:00 PM	Introductions **Keynote: Closing the Metacognitive Equity Gap: Research Shows Us How** Dr. Saundra McGuire, Professor (Emerita) of Chemistry and Director (Emerita) of the Center for Academic Success, Louisiana State University, and author of the best-selling books Teach Students How to Learn and Teach Yourself How to Learn				
1:35 – 1: 45 PM	Break				
1:45 – 2:30 PM	Affinity Groups/Mentoring Groups/Breakout with speaker				
	Short Talks (5 concurrent sessions)				
	Session A: Conceptual Understanding & Process of Science	**Session B: Groupwork & Citizen Science**	**Session C: Evolution Education**	**Session D: A Random Gathering of Great Stuff!**	**Session E: Diversity, Equity, & Inclusion**
2:30 - 2:50 PM	**10: Natural selection does not come naturally: Getting mired in pattern & process and proximate & ultimate causality** Lucy Delaney (University of Illinois at Chicago)*	**79: Citizen science in undergraduate education: Current practices and knowledge gaps** Heather D. Vance-Chalcraft (East Carolina University)*; Allen Hurlbert (University of North Carolina); Jennifer Styrsky (University of Lynchburg); Terry Gates (North Carolina State University); Gillian Bowser	**196: Evolution acceptance and understanding among community college students** Meredith Dorner (Irvine Valley College)*	**17: A systematic review of change theory in STEM higher educational change efforts** Tessa C Andrews (University of Georgia)*; Daniel L Reinholz (San Diego State University); Isabel White (San Diego State University)	**25: Coming out to the class: Students benefit from instructor revealing LGBTQ+ identity in a large-enrollment biology course** Carly A Busch (Arizona State University)*; K Supriya (Arizona State University); Sara Brownell (Arizona State University); Katelyn M Cooper (Arizona State University)

		(Colorado State University); et al.			
2:50 - 3:10 PM	**18: Item-feature context influences the content and architecture of student-constructed models** Joelyn de Lima*; Tammy Long (Michigan State University)	**89: Group work and student performance in biology: A meta-analysis.** Emily P Driessen (Auburn University)*; Sara Beth Ramsey (Auburn University); Sara Wood (Auburn University); Alan Wilson (Auburn University); Cissy Ballen (Auburn University)	**77: Introducing the Measure of Acceptance of the Theory of Evolution 2.0 (MATE 2.0)** Elizabeth Barnes (Middle Tennessee State University); Taya Misheva (Arizona State University)*; Sara Brownell (Arizona State University); Michael Rutledge (Middle Tennessee State University)	**11: What's in a word? Exploring graduate student definitions of "success"** Maryrose Weatherton (University of Tennessee, Knoxville)*; Beth Schussler ("University of Tennessee, Knoxville")	**42: Experiences of trans, gender non-conforming, and genderqueer students in biology courses** Nicole A Rebolledo (Florida International University)*; Aramati Casper (Colorado State University); A. Kelly Lane (University of Minnesota Twin Cities); Sarah L Eddy (Florida International University)
3:10 - 3:30 PM	**111: Partial, temporary, induced: Student knowledge of terms that contribute to conceptual understanding of structure and function** Gretchen King (University of Georgia)*; Cheryl Sensibaugh (University of Georgia); Paula P. Lemons	**185: A challenge in teaching scientific communication: Academic experience does not improve undergraduates' ability to accurately assess their own or their peers' work** Mark A. Sarvary (Cornell University)*; Megan Biango-Daniels (Cornell University)	**220: Reconciliation approaches are effective at increasing evolution acceptance, and here's why.** Danny Ferguson (Brigham Young University)*; Jamie L Jensen (Brigham Young University)	**122: Motivation in reading primary scientific literature: how to assess student self-efficacy, competence, interest, and expectancy-value in reading disciplinary literature** Melissa R McCartney (Florida International University)*; Kyriaki Chtazikyriakidou (Florida International University)	**40: Instructor conceptions of diversity in higher education** Nicole A Suarez (San Diego State University/University of California, San Diego)*; Song Wang (San Diego Statue University/ University of California San Diego); Stacey Brydges (University of California San Diego); Stanley M Lo (University of California San Diego)

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	(University of Georgia)				
3:30 - 3:50 PM	**175: Biology undergraduates' beliefs about creative abilities and the role of creativity in science** Taylor A Farragut (University of Georgia)*; Robel Yohannes (University of Georgia); Halle Mastronardo (University of Georgia); Lisa B Limeri (University of Georgia); A. Kelly Lane (University of Minnesota Twin Cities)	**99: Understanding longitudinal change in small-group dynamics through social network analysis** Brock Couch (Middle Tennessee State University)*; Grant E Gardner (Middle Tennessee State University)	**115: Crossing Cultural borders: Community college biology students' understanding and acceptance of evolution** Kathryn Green (University of Georgia)*; Cesar Delgado (North Carolina State University)	**200: Anxiety- Eustress or Distress? Community college students report benefits of being called on in class, including paying attention, participation, increasing understanding and developing confidence** Gwen Shlichta (Edmonds Community College)*; Stacy M Alvares (Bellevue College); Jenny McFarland (Edmonds Community College); Elli J Theobald (University of Washington)	**207: A community-building co-mentoring (coco cafe) model used to promote diversity, equity, inclusion, and retention in STEM** Beverly L Smith-Keiling (University of Minnesota)*; Katrina Paleologos (University of Minnesota); Hari Gopalakrishnan (University of Minnesota); Mahesh Mathews (University of Minnesota); Ellie Vraa (University of Minnesota; et al.
3:50 – 4:00 PM	Break (10 Minutes)				
4:00 – 5:00 PM	Poster Session 1				

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Friday, July 16th, 2021

Note: All times CDT

12:00 – 1:00 PM	Roundtable Session 1				
1:00 – 2:00 PM	**Long Talk: Why we need to consider religious identity and build religious cultural competence in biology education** Dr. Elizabeth Barnes, Assistant Professor, Middle Tennessee State University				
2:00 – 3:00 PM	Poster Session 2				
3:00 – 3:10 PM	Break				
	Short Talks (5 concurrent sessions)				
	Session A: DEI & Identity	**Session B: Remote Assessment & Student Beliefs**	**Session C: Instructor Practices**	**Session D: Active Learning**	**Session E: Instrument Development**
3:10 - 3:30 PM	**159: Examining the Sources of Teaching Self-efficacy for Science International Teaching Assistants: A Cross-Sectional Survey Study** Zhigang Jia (Midddle Tennessee State University)*; Grant E Gardner (Middle Tennessee State University)	**194: R-COPUS: Transitioning to Remote COPUS** Tea Pusey (University of California, Merced)*; Andrea Presas (University of California, Merced); Petra Kranzfelder ("University of California, Merced"); Adriana Signorini (University of California Merced)	**95: Exploring the Relationship between Instructor Epistemological Beliefs and Classroom Discourse Practices in Undergraduate Biology Classrooms Ashley Laskowski (University of Minnesota); Abdi Warfa (University of Minnesota)***	**43: Taking Active Learning to the Next Level: Student-Thinking-Centered Instruction** Jessica Gehrtz (University of Texas at San Antonio)*; Molly Brantner (University of Georgia); Tessa C Andrews (University of Georgia)	**20: The Plant Awareness Disparity Index: An Assessment to Measure Plant Awareness Disparity in Undergraduate Students** Kathryn M Parsley (University of Memphis)*; Bernie Daigle (University of Memphis); Jaime L Sabel (University of Memphis)
3:30 - 3:50 PM	**116: Understanding the Unique Experiences of South Asian International**	**134: Barriers to Online Formative Assessments in Introductory Biology Courses**	**141: Investigating Undergraduate Student Memories and Perceptions of**	**215: Systematically Evaluating Evidence-based Teaching Practices in Undergraduate**	**114: Exhaustive Coding of Assessment Items with Bloom's Taxonomy: A Novel**

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	Students as They Transition into a PhD in the US: An Interpretative Phenomenological Analysis Muhammad Zaka Asif (University of Georgia)*; Erin Dolan (University of Georgia); Chaitya Jain (University of Georgia)	Allison M Upchurch (University of Nebraska-Lincoln)*; Dana Kirkwood-Watts (University of Nebraska-Lincoln); Gabrielle Johnson (Southeast Community College); Sarah Spier (Southeast Community College); Brian Couch (University of Nebraska-Lincoln)	**Instructor Talk in Biology Classrooms** Dax Ovid (San Francisco State University)*; Mallory Marie Rice (San Francisco State University); Karen Tabayoyong (San Francisco State University); Joshua C. Vargas Luna (San Francisco State University); Parinaz Lajevardi (VA Palo Alto Health Care System); et al.	**Anatomy and Physiology Education** Emily Royse (University of Northern Colorado)*; Nicholas Pullen (University of Northern Colorado); Emily Holt (University of Northern Colorado)	**Teaching and Learning Practice using a Conventional Tool** Tori Larsen (University of California San Diego)*; Bianca Endo (University of California San Diego); Tiffany Hinchey (University of California San Diego); Ivan Chim (University of California San Diego); Stanley M Lo (University of California San Diego)
3:50 - 4:10 PM	**131: Experiences of supports, barriers, and belonging in Community College Faculty participating in Biology Education Research** Miranda M Chen Musgrove (University of Colorado, Boulder)*; Alyssa Cooley (University of Tennessee, Knoxville); Savannah Nied (University of Colorado, Boulder); Jeff Schinske	**91: Untangling mindset, universality, and brilliance beliefs in science and math undergraduates** Lisa B Limeri (University of Georgia)*; Nathan Carter (University of Georgia); Franchesca Lyra (University of Texas Austin); Joel Martin (University of Georgia); Halle Mastronardo	**142: First Day & First Impressions: What do students take with them besides the syllabus?** Lillian Senn (Cornell University); Clara Meaders ()*; Michelle Smith (Cornell University)	**127: Influence of social supports from learning assistants and faculty on student engagement in active learning in-person STEM classes** Krista Donis (Florida International University)*; Uma Swamy (Florida International University); Sarah L Eddy (Florida International University)	**155: A Conclusion Assessment Rubric (CAR) for assessing a key experimentation competency** Tawnya Cary (Beloit College)*; Seung Hong (University of Delaware); Anna Kowalkowski (UW - Madison Biocore Program); Michelle A Harris (UW - Madison Biocore Program)

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	(Foothill College); Lisa A Corwin (University of Colorado Boulder)	(University of Georgia); et al.			
4:10 - 4:30 PM	**168: How does student ethnicity influence student science identity in undergraduate biology classes?** Rebeka AF Greenall (Brigham Young University)*; Jose Gasper de Alba (Brigham Young University); Elizabeth G Bailey (Brigham Young University)	**26: Do Students Follow Through on Their Study Plans?** Elise Walck-Shannon (Washington University in St. Louis)*; Shaina Rowell (Washington University in St. Louis); Grace Yuan (Washington University in St. Louis); Ashton Barber (Washington University in St. Louis); Regina Frey (University of Utah)	**36: What do faculty want non-majors to know? Characterizing content, skills, and stated learning expectations from non-major biology course syllabi** Austin Heil (University of Georgia)*; Cara L Gormally (Gallaudet University); Peggy Brickman (University of Georgia)	**151: Search strategies: Answering biology questions using the internet** Dana Kirkwood-Watts (University of Nebraska-Lincoln)*; Allison M Upchurch (University of Nebraska-Lincoln); Sarah Spier (Southeast Community College); Gabby Johnson (Southeast Community College); Brian Couch (University of Nebraska-Lincoln)	**162: Congruence testing to validate narrow-band concept inventories in genetics** Nancy Boury (Iowa State University)*; Rebecca Seipelt-Theiman (Middle Tennessee State University); Audrey McCombs (Iowa State University); Brock Couch (Middle Tennessee State University); Patrick Armstrong (Iowa State University); et al.
4:30 - 4:50 PM	**198: Ph.Depression: Examining how graduate research and teaching affect depression in life sciences Ph.D. students** Logan Gin (Arizona State University); Nicholas Wiesenthal (University of Central Florida); Isabella Ferreira (University of	**208: Value for Learning Communication Skills in Undergraduate Biology Students** Christina M Cline (Northern Illinois University)*; Alecia Santuzzi (Northern Illinois University); Karen Samonds (Northern Illinois	**70: Undergraduate genetics assessments: What are we assessing and how?** Kelly M Schmid (Cornell University)*; Dennis Lee (BSCS); Monica Weindling (BSCS); Awais Syed (BSCS); Stephanie-Louise Yacoba	**178: How undergraduates engage with tradeoffs when solving complex issues using a structured decision-making tool** P. Citlally Jimenez (University of Nebraska - Lincoln)*; Jenny M Dauer (University of Nebraska-Lincoln)	**73: Does your department evaluate your teaching well? Research-based guides to support STEM departments develop robust and equitable teaching evaluation practices** Sandhya Krishnan (University of Georgia)*; Tessa C Andrews (University of

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	Central Florida); Katelyn M Cooper (Arizona State University)*	University); Nicole LaDue (Northern Illinois University); Heather E Bergan-Roller (Northern Illinois University)	Agyemang (Cornell University); et al.		Georgia); Jessica Gehrtz (University of Texas at San Antonio); Paula P. Lemons (University of Georgia); Erin Dolan (University of Georgia); et al.
4:50 – 5:00 PM	Break (10 minutes)				
5:00 – 6:00 PM	Affinity/Mentoring Groups				

Friday, July 23rd, 2021

Note: All times CDT

12:00 - 1:00 PM	Roundtables Session 2				
1:00 - 2:00 PM	**Long Talk: Biology education and COVID-19: Faculty experiences, cheating, and student engagement during a pandemic** Lisa L Walsh*; Emma Wester; Sandra Arango-Caro; Kristine L Callis-Duehl (Donald Danforth Plant Science Center)				
2:00 - 3:00 PM	Poster Session 3				
3:00 - 3:10 PM	Break (10 minutes)				
	Short talks (5 concurrent sessions)				
	Session A: Conceptual Understanding	**Session B: Research - CUREs**	**Session C: DEI - inclusive teaching**	**Session D: Pandemic Instruction**	**Session E: Diversity, Equity, & Inclusion**
3:10 - 3:30 PM	**16: ATP as an activator: developing a consistent approach to the mechanism by which ATP drives unfavorable reactions**	**64: How different Course-based Undergraduate Research Experience models impact student perceptions**	**94: Student and instructor perceptions of inclusive and exclusive teaching practices in**	**59: Motivations and concerns influencing faculty choices about online instructional practices during the COVID-19 pandemic**	**72: It's not the title, it's the teaching: Comparing the effects of different types of instructors on equity gaps and**

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	across chemistry and biology Keenan Noyes (Michigan State University)*; Clare Carlson (Michigan State University); Melanie Cooper (Michigan State University)	**of the scientific research culture** Jessica Dewey (University of Minnesota)*; Alaina Evers (University of Minnesota); Anita Schuchardt (University of Minnesota)	**undergraduate biology classrooms** Mallory Rice (San Francisco State University)*; Maurina Aranda (Southern Illinois University Edwardsville); Kimberly Tanner (San Francisco State University)	Catherine Ishikawa (California State University, Sacramento)*; Eric Pennino (California State University, Sacramento); Navneet Singh (California State University, Sacramento); Sayonita Ghosh Hajra (California State University, Sacramento); Kelly McDonald (California State University, Sacramento)	**students' sense of community** Austin Zuckerman (University of California, San Diego)*; Rebecca A Hardesty (University of California, San Diego); Trinh Phung (The Preuss School); Kameryn Denaro (University of California Irvine); Stanley M Lo (University of California San Diego); et al.
3:30 - 3:50 PM	**106: Assembly required: How students and instructors define and connect biological processes** Sharleen Flowers (Purdue University)*; Stephanie M Gardner (Purdue University); Gabrielle Rump (Purdue University)	**112: An Effective CURE in Introductory Biology at a Regional Comprehensive University** Anne Casper (Eastern Michigan University)*	**107: Training Faculty-Teaching Assistant Dyads in Anti-Racist Science Teaching** Hillary Barron (University of Minnesota)*; Grace Devine Boutouli (University of Minnesota); Theresa Hallman (University of Minnesota); Sehoya Cotner (University of Minnesota)	**191: Participation and Performance by Gender in Live Zoom Classrooms** Sierra C Nichols (Brigham Young University)*; Elizabeth G Bailey (Brigham Young University); Yongyong Xia (Brigham Young University); Mikaylie Parco (Brigham Young University)	**86: Isolation, Resilience, and Faith: Experiences of Black Christian Students in Biology Graduate Programs** Angela Google (Middle Tennessee State University)*; Chloe Bowen (Middle Tennessee State University); Lisa Hanson (Middle Tennessee State University); Elizabeth Barnes (Middle Tennessee State University)

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3:50 - 4:10 PM	**176: The Conceptual Analysis of Disciplinary Evidence (CADE) Framework as a Guide for Evidentiary Reasoning during a Hardy-Weinberg Equilibrium (HWE) Laboratory Investigation** Chaonan Liu (Purdue University)*; Dayna Dreger (National Institute of Health); Shiyao Liu (Purdue University); Ala Samarapungavan (Purdue University); Stephanie M Gardner (Purdue University); et al.	**206: Challenges and opportunities for students with disabilities in life science undergraduate research experiences** Logan E Gin (Arizona State University)*; Danielle Pais (Arizona State University); Katelyn M Cooper (Arizona State University); Sara E Brownell (Arizona State University)	**123: Meta-analysis of gender performance gaps in undergraduate natural science courses** Sara E Odom (Auburn Universitiy)*; Halle Boso (Auburn University); Scott Bowling (Auburn University); Sara E Brownell (Arizona State University); Sehoya Cotner (University of Minnesota); et al.	**164: Perceived supports and barriers during COVID-19 emergency remote teaching** Cristine Donham (University of California Merced)*; Erik Menke (University of California, Merced); Hillary Barron (University of Minnesota); Maya Changaran Kumarath (University of California, Merced); Jourjina Alkhouri (University of California Merced); et al.	**30: First-Year Students from Marginalized Groups Report Decreases in Task Value, Self-Efficacy, and Metacognition in an Introductory Biology Course** Holly J Swanson (University of Rhode Island)*; Bryan M Dewsbury (University of Rhode Island)
4:10 - 4:30 PM	**184: Exploring Undergraduate Chemistry and Biology Students' Understanding of Enzymes** Emma Grace N Micer (University of Memphis)*; Jaime L Sabel (University of Memphis); Nathan DeYonker (University of Memphis)	**108: Who do Students Talk to About their Course Research? An Investigation of CURE Students' Ego Networks** David Esparza (Cornell University)*; Amy Wagler (The University of Texas at El Paso); Aimee Hernandez (University of Texas at El Paso); Jocelyn Zachariah (The University of Texas at El Paso); Jeffrey T. Olimpo (The University of Texas at El Paso)	**169: Science faculty's conceptions of equity and their relationship to teaching practices** Tatiane Russo-Tait (UT Austin)*	**172: Access to Learning Resources in Introductory Biology Courses, Their Effectiveness, and the Consequences of the Pandemic** Shima Salehi (Stanford University)*; Cissy Ballen (Auburn University)	**171: Improving outcomes for transfer students through pre-transfer exposure to problem-based learning** Jen Teshera-Levye (East Carolina University)*; Heather D. Vance-Chalcraft (East Carolina University); Tammy Atchison (Pitt Community College); John Stiller (East Carolina University); Jean-Luc Scemama (East Carolina University)

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4:30 - 4:50 PM	**201: Improving Introductory Biology Students' Population Modeling Mastery Through Visualizing Population Growth Models** Samantha R Wasson (Brigham Young Univeristy)*; Channing Hudson (Brigham Young University); Dallan Carlson (Brigham Young University); Elizabeth G Bailey (Brigham Young University)	**57: Advancing CURE Graduate Teaching Assistants' Professional Development Through an Online Learning Community Intervention** Amie Kern (University of Texas at El Paso); Christina D'Arcy (University of Texas at El Paso); Jeffrey T. Olimpo (The University of Texas at El Paso)*	**181: Future Implications of Participatory Action Research on Black Science Majors** Christin Walls* (University of Georgia); Darris Means (University of Georgia); Julie Dangremond Stanton (University of Georgia)	**103: Authentic assessment for all – Including remote learning!** Justine Hobbins (University of Guelph)*; Kerry Ritchie (University of Guelph); Emilie N Houston (University of Guelph); Bronte Kerrigan (University of Guelph)	**44: High stakes exams exacerbate disparities in scores between students across the lines of gender, race/ethnicity, and socioeconomic class in introductory biology courses.** K Supriya (Arizona State University)*; Min Li (University of Washington); Christian D Wright (Arizona State University); Sara Brownell (Arizona State University)
4:50 – 5:00 PM	Break				
5:00 - 6:00 PM	Affinity/Mentoring groups				

Friday, July 30th, 2021

Note: All times CDT

12:00 - 1:10 PM	Announcement of Bill Wood Award and Keynote **Closing Keynote: Anti-racism in STEM Classrooms: Putting Theory into Practice** Dr. Niral Shah, Assistant Professor of Learning Sciences and Human Development, University of Washington				
1:10 - 1:30 PM	Break				
	Short talks (5 concurrent sessions)				
	Session A: Instrument Development	**Session B: Research**	**Session C: Evolution Education**	**Session D: Collaborative Practice**	**Session E: Science Skills**

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		Experiences - Field work			
1:30 - 1:50 PM	**52: Measuring critical thinking using the Biology Lab Inventory of Critical Thinking for Ecology: How recency effects may influence students' abilities to make comparisons** Ashley B Heim (Cornell University)*; David Esparza (Cornell University); Cole Walsh (Cornell University); Natasha Holmes (Cornell University); Michelle Smith (Cornell University)	**28: How do field experiences in the natural sciences affect undergraduate outcomes: results from a scoping review** Xoco A Shinbrot (Cornell University)*; Kira Treibergs (Cornell University); Lina M Arcila_Hernandez (Cornell University); David Esparza (Cornell University); Kate Ghezzi-Kopel (Cornell University); et al.	**124: The contribution of family-level variables to evolution education outcomes and degree pursuits in minoritized biology majors** Ross Nehm (Stony Brook University)*; Gena C Sbeglia (Stony Brook University)	**39: Social Metacognition in Small Group Problem-Solving** Stephanie M Halmo (University of Georgia)*; Emily Bremers (University of Georgia); Sammantha Fuller (University of Georgia); Julie Dangremond Stanton (University of Georgia)	**226: Exploring student construction of causal mechanistic explanations across chemistry and biology courses: connecting intermolecular forces, protein structure and function, and phenotypic variation.** Keenan Noyes (Michigan State University); Clare Carlson (Michigan State University); Joelyn de Lima (Michigan State University); Devin Babi (Michigan State University); Elijah Persson-Gordon (Michigan State University); et al.
1:50 - 2:10 PM	**75: Evaluating problem solving in biochemistry:**	**68: Half-century of student data reveal benefits of biology field course**	**211: Using evidence to target and dismantle barriers to**	**233: Framing Active Learning in terms of Sociocultural Mediation of Learning**	**228: Frames matter: How task structure affects student use of resources in argumentation** Jessie Arneson (Washington State University); Brett Baerlocher (Idaho State

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	a decisions-based framework Argenta Price (Stanford University)*; Roshan Bhaskar (Stanford University); Carl Wieman (Stanford University)	Lina M Arcila_Hernandez (Cornell University)*; Cinnamon Mittan (Cornell University); Todd C Lamb (Auburn University); Katherine Holmes (Cornell University); Caitlin McDonald (Cornell University); et al.	**evolutionary biology degree interest in introductory courses** Gena C Sbeglia (Stony Brook University)*; Ross Nehm (Stony Brook University)	Laurel M Hartley (Cu Denver)*; Andrew L McDevitt (University of Colorado Denver); Jeff Boyer (North Dakota State University); Sarah Hugg (University of Colorado); Paul Le (Red Rocks Community College); et al.	University); Jeffery Erickson (Washington State University); Guraustin Brar (Washington State University); Andy Cavagnetto (Washington State University); et al.
2:10 - 2:30 PM	**84: Applying Ecological Diversity Methods to Improve Quantitative Examination of Student Language in Constructed Responses** Megan M Shiroda (Michigan State University)*; Michael Fleming (CSU Stanislaus); Kevin Haudek (Michigan State University)	**61: Experiences in undergraduate, campus-based field biology: fostering connection towards a Critical Pedagogy of Place** Jeannie Yamazaki (Cornell University)*; Kira Treibergs (Cornell University); David Esparza (Cornell University); Michelle Smith (Cornell University); Marc Goebel (Cornelly University)	**177: Enabling nonscientists' transformative experiences regarding evolution** Rachel A Sparks (Illinois State University)*; Rebekka Darner (Illinois State University)	**219: A class structure with collaborative bones results in increased student learning** Pavan Kadandale (University of California Irvine)*; Vivian Chi (University of California, Irvine)	**80: The Decision is in the Details: Justifying the Selection of Knowledge Sources Across Two Socioscientific Issues** Jordan D Bader (University of New Hampshire)*; Melissa L Aikens (University of New Hampshire); Andrew Coppens (UNH); Kelsey Ahearn (UNH); Diya Anand (UNH); et al.
2:45 - 3:00 PM	Break (15 minutes)				
	Short talks (5 concurrent sessions)				

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	Session A: Concept-oriented pedagogy	Session B: Science Identity	Session C: Scientific understanding	Session D: Virtual Learning	Session E: Institutional Change
3:45 - 4:05 PM	**23: Relationships between prediction accuracy, metacognitive awareness, and performance in introductory genetics students** Jenny Knight (MCDB)*; Melanie Peffer (University of Colorado Boulder)	**46: How do introductory field biology students feel in the field? Student reflections provide a window into affective outcomes** Kira Treibergs (Cornell University)*; David Esparza (Cornell University); Jeannie Yamazaki (Cornell University); Michelle Smith (Cornell University); Paul Rodewald (Cornell University); et al.	**174: Integrating critical thinking into an advanced biology course** Stewart Frankel (University of Hartford)*	**82: Automated Writing Assessment of Undergraduate Learning After Completion of a Computer-based Cellular Respiration Tutorial** Juli Uhl (Michigan State University)*; Kamali Sripathi (UC Davis); Eli Meir (SimBio); John Merrill (Michigan State University); Mark Urban-Lurain (Michigan State University); et al.	**69: STEM department chairs' perspectives: Current teaching evaluation metrics undermine change initiative viability** Ariel E Marcy (University of Nebraska-Lincoln)*; Blake Whitt (University of Virginia); Brian Couch (University of Nebraska-Lincoln); Luanna Prevost (University of South Florida); Marilyne Stains (University of Virginia); et al.
4:05 - 4:25 PM	**173: Introductory biology students' learning dispositions and proficiency with building conceptual models** Amanda J Sebesta (Saint Louis University)*; Elena Bray-Speth (Saint Louis University)	**33: Constructing Biology Education Research Scholar Identities: A Duoethnography** Rou-Jia Sung (Carleton College)*; Emily Holt (University of Northern Colorado); Stanley Lo (UCSD)	**236: Eliminating vaccine misconceptions to promote health literacy in adolescents through a short-duration health-focused science curriculum** Revati Masilamani (Tufts University)*; Finn Payne (Northeastern University); Ava Fascetti (Harvey Mudd College);	**212: Why students do not turn on their video cameras during online classes and an equitable and inclusive plan to encourage them to do so** Frank R. Castelli (Cornell University)*; Mark A. Sarvary (Cornell University)	**157: How can Academic Culture be more Inclusive toward Interdisciplinary Work?** Brie Tripp (San Francisco State University)*; Erin E Shortlidge (Portland State University)

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			Abdimajid Mohamed (Tufts University); Peter Rogers (Tufts University); Berri Jacque (Tufts University)		
4:25 - 4:45 PM	**152: Targeting instructional interventions to address student thinking about the central dogma revealed by automated analyses of student written responses** Jenifer Saldanha (Michigan State University - East Lansing, MI)*; Juli Uhl (Michigan State University); Kevin Haudek (Michigan State University)	**65: Exploring how Graduate Students Perceive their Role as an Instructor in the CURE Classroom** Emma C Goodwin (Portland State University)*; Jessica Cary (Portland State University); Erin E Shortlidge (Portland State University)		**149: What we've learned about online biology education: A three-year study of progressive intervention Jamie L Jensen (Brigham Young University)*; Mahealani Kaloi (Brigham Young University); Megan Niu (Brigham Young University); Porter Fife (Brigham Young University)**	**210: Professors' Professionalization Networks: a Systems-level Roadmap for Change** Dan Grunspan (University of Guelph)*; Anna Abraham (Arizona State University); Sara M Etebari (Arizona State University); Samantha Maas (ASU School of Life Sciences Biology Education Lab); Julie A Roberts (Arizona State University); et al.
4:00 - 5:00 PM	Poster Session 4				

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LONG TALK ABSTRACTS

Long Talk 1: Friday, July 16th, 2021

Why we need to consider religious identity and build religious cultural competence in biology education

Elizabeth Barnes, Assistant Professor, Middle Tennessee State University

Background: While ~75% of the American public is religiously affiliated only ~25% of biologists are affiliated. Meanwhile, religion is a prominent social force in history and currently plays a large role in shaping how science is received and acted on. For instance, religious affiliation is historically a negative predictor of evolution and climate change acceptance and most recently, religious affiliation has been associated with attitudes and behaviors that have led to increased COVID19 deaths. To maximize the benefit of science to society, biology educators have a responsibility to communicate and teach about these topics in effective ways for a range of student identities, even when they do not share identities with their students. However, despite this responsibility to more than half of undergraduate students who are religious, our past research shows that biology educators largely ignore, dismiss, or denigrate religion. In response, our present work aims to make biology environments more inclusive for religious students and to help religious students reconcile their religious identities with science for the betterment of society. Specifically, we strive to understand the source of conflict for religious students and test instructional practices for improving their attitudes.

In this talk, I will describe three separate studies on religious undergraduate biology students learning evolution and end with a fourth study on religious student perceptions, attitudes and behaviors related to COVID19. **Study 1:** I will describe how students' perceived conflict between their religious beliefs and evolution and not their religious affiliation is the main factor influencing students' attitudes towards evolution. **Study 2:** I will explore how perceived conflict between religion and evolution varies among Christian, Muslim, Jewish, Buddhist, and Hindu students. **Study 3:** I will present data that supports how to reduce students' perceived conflict between their religious beliefs and evolution by using Religious Cultural Competence in Evolution Education (ReCCEE). **Study 4:** I will discuss how the importance of student religious identity extends beyond evolution education to perceptions of, attitudes towards, and behaviors related to COVID19.

Research Design: Study 1: To determine if perceived conflict between religious beliefs and evolution is the main driver of low evolution acceptance, we gathered pre-instruction survey data from 2, 275 students in 28 biology courses about their evolution acceptance, religiosity, understanding of evolution, and their perceived conflict between their religious beliefs and evolution. **Study 2:** To determine how perceived conflict may differ across religious affiliations, we gathered pre-instruction data on students' perceived conflict and religious affiliation from 7,909 students in 52 biology courses. **Study 3:** To determine ways to increase student evolution acceptance and decrease perceived conflict, we used a quasi-experimental design to gather data from 3,542 students 68 biology classes pre and post-evolution instruction. Before instruction, we measured students' evolution acceptance and perceived conflict between religion and evolution. At the end of evolution instruction, students received the same survey with an additional measure of whether the instructor was using practices considered to be culturally competent for religious students. **Study 4:** To determine if religious identity is potentially important to consider for COVID19 education, we collected data from 495 students in 17 courses about their perceptions, attitudes, and behaviors related to COVID19 and COVID19 mitigation efforts (masks, social distancing, vaccines). We also asked students to describe how confident they were in their ability to communicate accurate scientific information about COVID19 and COVID19 mitigation efforts. All measures were previously published with validity evidence or were vetted through cognitive interviews, dimensionality analyses, and/or expert review.

Analyses and Interpretations. In all analyses, we controlled for a set of potentially confounding variables. **Study 1:** Using linear mixed models, we find that perceived conflict between religion and evolution is the strongest factor predicting evolution acceptance after controlling for demographic factors, understanding of evolution, and religiosity. This indicates that instructors can focus on reducing perceived conflict between religion and evolution to increase evolution acceptance rather than trying to change a students' religious identity. **Study 2:** Using regression analyses, we find that Muslim students and non-Catholic Christian students show the highest levels of perceived conflict and the lowest levels of evolution acceptance. This indicates it may be most useful to focus on reducing perceived conflict between the religious beliefs of these students when teaching evolution. **Study 3:** Using linear mixed models, we found that culturally competent practices were associated with better student outcomes among religious students. When religious students perceived that an instructor provided examples of religious scientist role models who accept evolution, gave students autonomy over their decision whether to accept evolution and avoided negativity about religion, acceptance of evolution increased and perceived conflict between religion and evolution decreased. **Study 4:** Using regression analyses we find that the importance of religious identity extends beyond evolution education to COVID19 education. Compared to non-affiliated students and controlling for political conservatism, religious students perceive the COVID19 pandemic as less severe, believe mask-wearing and social distancing are less effective, agree more with COVID19 conspiracy theories, have stronger concerns about COVID19 vaccines, and report lower intentions to get a COVID19 vaccine. However, religious students were just as confident in communicating to others accurately about COVID19 and COVID19 mitigation efforts as non-religious students. These results indicate religious students are a high need group for cultural competence when teaching about COVID19 and COVID19 mitigation efforts.

Contribution These studies highlight the importance of considering religious identity in undergraduate biology education, particularly when teaching about topics that are controversial in society. Historically, the collective approach of the biology community has been to dismiss, ignore, or denigrate religious identities. In evolution education research we have found that considering religious identity is important for improving attitudes towards evolution and we are now starting to measure and reduce students' perceived conflict between religion and evolution. However, the impact of religious identity in biology education goes beyond evolution education and we should build religious cultural competence in all applicable areas of biology education.

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Long Talk 2: Friday, July 23rd, 2021

Biology education and COVID-19: Faculty experiences, cheating, and student engagement during a pandemic

Lisa L Walsh*, Emma Wester, Sandra Arango-Caro, and Kristine L Callis-Duehl, Donald Danforth Plant Science Center

Research Question—The COVID-19 pandemic elicited emergency remote teaching (ERT) when classes rapidly switched from in-person to online. During ERT events, it is challenging to collect data, but a common theme across ERTs is the desire to learn from the experience so as to improve future education. As campuses shut down, we quickly rolled out quantitative and qualitative surveys to chronicle the experiences of biology instructors and undergraduates prior to starting the online portion of ERT and again at the end of the spring instruction during COVID-19. Our research provides insight on how to foster greater resilience moving forward.

Theoretical Frameworks—Instructors had to use unfamiliar technology and pedagogy while coping with the stress of a pandemic. To identify contrasting and shared experiences across instructors, we evaluated faculty experiences during the first COVID-19 ERT semester using a transactional distance (TD) theoretical framework. TD posits that online education is best when the psychological space is reduced between instructor and student by flexibility, communication, and reduced learner autonomy.

To evaluate why students felt cheating occurred more after transitioning online, we used a framework composed of 4 theories: game theory, in which students strategize around the instructor to cheat; moral development theory, in which integrity is shaped by professors and peers; neutralization theory, in which students rationalize cheating; and planned behavior theory, in which cheating is a combination of intent and opportunity.

To understand how ERT impacted students, we used the framework of student engagement, a multidimensional construct partitioned into 3 categories: behavioral, cognitive and emotional. Behavioral engagement refers to participation in academic activities; cognitive engagement is the ability to process new material; and emotional engagement includes personal views on courses and science.

Research Design—Properly developing an online course or converting one to an online format takes months of planning and cognitive energy. ERT literature is lacking in how training impacts faculty during emergencies. We surveyed 100 biology faculty across the country to better understand how training in online education affected their instructional experiences during the pandemic. Participants revealed if they had previously taught online and if and when they received training. Faculty described the difficulties and benefits they encountered, as well as a memorable moment from teaching during the COVID-19 pandemic. Their responses were read multiple times to identify emerging themes, independently coded by two researchers and reviewed for consensus. We used decision tree forests and Mann-Whitney tests to identify the

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most polarizing themes for experienced vs. inexperienced online teachers and instructors who did/not receive training.

Faculty felt that cheating increased after transitioning online and cited lack of discipline and increased pressure as potential explanations. While literature from traditional online classes also found students believe cheating occurs more online, it was unclear how a pandemic impacts such perceptions. Given the dynamic nature of assessments during ERT, we evaluated student perceptions of cheating in the context of a pandemic. In a survey, we asked 299 students from 31 institutions if they believed cheating occurred more frequently online or in-person, and if so, why and how. Likert scale responses were compared between modalities using non-parametric tests. Qualitative responses were coded according to which of the 4 cheating theories their responses referenced.

As college campuses closed in Spring 2020, students faced a myriad of personal and academic issues. We hypothesized that because of these disruptions, students' engagement in their courses would decline. 303 undergraduate students from across the US completed existing, validated Likert survey questions in March (pre) and June (post) 2020 to understand student behavioral, cognitive and emotional engagement. We used paired t-tests for students who completed both pre/post surveys to evaluate significant change during ERT.

Analysis & Interpretation—Untrained faculty mentioned an aspect of TD when describing an unexpected benefit of ERT more frequently ($p=0.022$) than trained faculty. All faculty mentioned equally often an aspect of TD as a difficulty. Experienced instructors were more likely to describe an act of kindness in their memory, but were also more likely to struggle with negative student behavior. Untrained faculty were the only respondents to struggle with student engagement and were twice as likely to describe a negative memory. Our results suggest training alleviated some aspects of ERT, and training should be provided to all instructors, including those with previous experience. The shared difficulties we identified should be especially prioritized in training.

More than 80% of students believed cheating occurred more frequently online than in-person ($p<0.001$). When explaining why, 87% of student responses mapped to planned behavior theory, especially the ease of cheating online. Students explained it was easier to cheat online because of no proctor, access to the internet, or access to notes. These results underline the importance of moving away from closed-book exams and ensuring students understand the purpose of assessments. Interestingly, 28% of responses mapped to game theory, with some students describing workarounds to trick proctoring software. Our results add to the growing evidence that institutions should avoid proctoring software.

We found that over time, students participated less in class discussions ($p=0.006$) but met with professors more ($p=0.036$). We saw no significant change in cognitive engagement. Alarmingly, we found a significant drop in emotional engagement ($p=0.007$), with students reporting a drastic decline in attitudes towards biology ($p<0.001$). We found the transition to online learning had negative impacts on undergraduate student engagement and may in fact dissuade students from pursuing biology. These results are consistent with other research emerging, in which students became less active online and were frustrated by the loss of hands-on learning in STEM due to COVID-19.

Contribution—Our research provides insight into how COVID-19 impacted biology education. Regardless of experience, faculty encountered difficulties that could be mitigated with proactive, holistic training that covers both pedagogical and crisis-specific skills. Untrained faculty uniquely struggled with engaging students, and our results highlight that this is especially critical for maintaining students' value of biology. Additionally, the pressure that students felt to cheat increased during ERT, but this can be mitigated by avoiding closed-book exams and developing assessments that double as learning experiences for all students.

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SHORT TALK ABSTRACTS

Friday, July 9th, 2021

Session A: Conceptual Understanding of Process of Science

Paper ID: 10

Natural Selection Does Not Come Naturally: Getting mired in pattern & process and proximate & ultimate causality.

Lucy Delaney (University of Illinois at Chicago)*****

RESEARCH PROBLEM
Biology offers explanation at multiple levels: first by establishing patterns and investigating their causal processes, and then by providing proximate and ultimate causes for observed patterns and processes. This dual causality -- the proximate functional 'how' and the ultimate evolutionary 'why' -- is of particular importance to biological sciences; the 'why' being the stuff that gives the 'how' consequence. Yet hundreds of studies demonstrate that students hold tenacious misconceptions regarding the evolutionary principles necessary for recognizing levels of biological explanation -- especially those related to the process of natural selection. While some work suggests that the focus in biology classrooms is more often on the proximate, few studies examine students' ability to distinguish the ultimate processes responsible for observed adaptations.

STUDY DESIGN
To explore how students construct their own explanations related to the process of natural selection -- and whether or not such explanations change following instruction -- I administered a pre-post assignment with five open-ended questions. The study spanned two semesters and included more than 600 students across four undergraduate biology courses, from introductory to advanced. My framework, adapted from Tinbergen's Four Questions, qualitatively categorized students' responses based on the level of explanation addressed (i.e., proximate or ultimate patterns and processes). I tallied the number of responses from each explanatory category both before and after instruction. I performed generalized linear models to assess possible correlations between the level of explanation invoked in each question and four other variables: the student's year of study, declared major, course affiliation, and number of previously earned credits in postsecondary biology courses. I also compared the observed distribution of students' levels of explanation between the pre- and post-assignments for each of the four variables.

ANALYSES AND INTERPRETATIONS
Irrespective of students' year of study, major, course affiliation, or number of previous credits in biology, more than 80 percent of explanations invoke ultimate patterns, proximate processes, or a combination of these two categories in a single answer, and shift often around explanatory categories both within and between assignments. Students are rarely able to distinguish

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ultimate processes, and their shifting answers suggest a lack of conceptual clarity regarding such concepts. There is also frequent use of familiar "schemas" or "cognitive construals" like anthropocentric and teleological reasoning. These findings suggest that without explicit and repeated reinforcement of explanatory categories across courses, students will likely continue to struggle with distinguishing between proximate and ultimate patterns and processes throughout their studies.

CONTRIBUTION
Dobzhansky famously said that nothing in biology makes sense except in the light of evolution. As such, forming a robust conceptual framework in biology requires distinguishing patterns from the processes that generate them -- and distinguishing the functional and evolutionary explanations for such patterns and processes. Without these higher-order cognitive skills, students face an enormous challenge in their conceptual learning of evolution and of biology generally. Here I review the implications of these findings for the teaching and learning of biological sciences, and briefly touch on methods of explicitly addressing such cognitive skills in the classroom.

Paper ID: 18

Item-feature context influences the content and architecture of student-constructed models

Joelyn de Lima*; Tammy Long (Michigan State University)

Scientific models are specialised external representations that explain or predict a concept, process, or phenomenon. They lend themselves to both authentic instruction and assessment. Student-constructed models are partial representations of their mental models and can give us insights into student thinking and reasoning that are not captured in multiple choice or even narrative responses. Such externalised representations are particularly valuable in gauging students' knowledge and understanding of complex biological phenomena. Additionally, features of model architecture can provide insights into aspects of students' cognitive structures (CSs), such as size and complexity.

Prior studies have used the content and the architecture of student-constructed models to make claims about students' cognitive structures and explored the effect of prior achievement on the way students construct models. Other studies have explored the effect of item-feature context on content by analysing their narrative responses. This study builds on all those previous strands of research and seeks to further our knowledge about the way students retrieve conceptual information from their CSs while engaging in modelling tasks.

RESEARCH QUESTION: In this study, we ask whether item-feature context (variables in a question prompt) impacts the content and network architecture of students' constructed models of evolution by natural selection.

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RESEARCH DESIGN: Students in two large (n=384) introductory biology courses were asked to construct models to explain the evolution of traits in two taxa – humans and cheetahs. Using a rubric developed through qualitative content analyses, we coded the model content for the presence/absence of evolutionary ideas. We used mixed-effects multiple logistic regressions and multiple ordinal logistic regressions to evaluate influence of context on model content.

We quantified model architecture using network metrics for each student model. We then used paired t-tests to evaluate whether the mean value of each network metric differed between models of Cheetahs and Humans. We also tested for association between prior academic performances and contextual effects.

ANALYSES AND INTERPRETATIONS: We found that taxon influenced the content of student-constructed models. Cheetah models were more likely to have key evolutionary concepts (p ranges from <0.001 to <0.1) and fewer naïve ideas ($p<0.05$) as compared to Human models. Taxon also influenced the architecture of the models - Cheetah models were larger ($p<0.01$) and more complex ($p<0.05$) than the Human models. Prior academic performance (measured by GPA) was a predictor of model content, architecture, and contextual susceptibility.

Our results indicate that contextual features of the prompt are eliciting differences in students' models. This could indicate that students are either using surface cues to access their cognitive structures and build their mental models, or that they have a piecemeal understanding of evolution which results in a non-robust cognitive structure. Decreased susceptibility to context with increasing GPA indicates a progression from novice to expert with respect to both modelling and evolutionary knowledge.

CONTRIBUTION: The fact that evolution, especially human evolution, is a notoriously difficult topic for students must be acknowledged and considered by instructors while designing their curricula/instruction. Multiple researchers have proposed instructional strategies that are designed to improve students' understanding of evolution, particularly human evolution.

To develop expertise in modelling, students have to understand not only how to construct a model, but what a model is, how to visualise it, and then how to represent it; in addition to understanding the nature and purpose of models and the modelling process itself. To facilitate this, students need practice in developing their own models in addition to working with provided models.

Paper ID: 111

Partial, temporary, induced: Student knowledge of terms that contribute to conceptual understanding of structure and function

Gretchen King (University of Georgia)*; Cheryl Sensibaugh (University of Georgia); Paula P. Lemons (University of Georgia)

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The interrelatedness of structure and function is a core concept that biology students are expected to master. In biochemistry, structure and function pertains to the underlying chemical causes of biomolecular structures and the resulting functions. Different chemical groups give rise to different types of electrostatic charges (i.e., full/partial, permanent/temporary, innate/induced). Electrostatic charges of the opposite sign attract each other, creating noncovalent interactions that hold macromolecules together in three-dimensional space and determine function. Students persistently struggle to learn and apply the concept of noncovalent interactions, perhaps because of a focus on categories of noncovalent interactions rather than the interactions' mechanisms.

We investigated student thinking about the electrostatic charges involved in noncovalent interactions using the resources framework. The resources framework focuses on the elemental nature of student knowledge and the way that different contexts (e.g., problems with different surface features) influence students' selection and use of these elements, referred to as resources. In this qualitative interview study, we asked students (N=45) to think aloud about the applicability of the terms partial, temporary, and induced to the electrostatic charges involved in three different types of noncovalent interactions. Using qualitative content analysis, we characterized student resources for each term and the use of these resources across the three types of interactions.

In general, we found that students expressed different resources for each term (partial, temporary, induced) in different contexts. For example, when Bill considered the term partial in the context of a hydrogen bond, he stated, "hydrogen bonds are all partial," noting correctly that the electrostatic charges in a hydrogen bond are, indeed, partial. Yet for van der Waals interactions, whose electrostatic charges are also partial, Bill explained that the electrostatic charges "depend on the distance between the molecules." In the context of an ion pair, Bill switched to a different term, permanent, stating that ion pairs have a "permanent positive and permanent negative charge." Bill was not able to make sense of the term partial for an ion pair, but he could think about the permanence of the electrostatic charge. Interestingly, all of Bill's statements were scientifically accurate, yet none of his statements actually explained what a partial charge is. We saw this variation across contexts for most students. Also, students' ability to recognize and leverage terms improved or worsened based on context. For example, students readily saw the relevance of the term partial in the context of hydrogen bonds, but not van der Waals. Students readily saw the relevance of the terms temporary and induced in the context of van der Waals, but did not see why these terms are inappropriate to describe hydrogen bonds or ion pairs. These data suggest that students possess the resources needed for mechanistic understanding of noncovalent interactions but need guidance and practice to select and use these resources appropriately across contexts.

An important goal of undergraduate science education is to help students move toward describing the underlying mechanisms of disciplinary core concepts. The first step is to characterize the resources students use during instruction. These insights can help instructors move students away from simplistic definitional associations toward mechanistic reasoning.

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Paper ID: 175

Biology undergraduates' beliefs about creative abilities and the role of creativity in science

Taylor A Farragut (University of Georgia)*; Robel Yohannes (University of Georgia); Halle Mastronardo (University of Georgia); Lisa B Limeri (University of Georgia); A. Kelly Lane (University of Minnesota Twin Cities)

Research Problem:
Students' decisions to persist in science educational pathways and careers are influenced by a suite of beliefs, attitudes, and perceptions. Theories from Industrial-Organizational psychology, in particular Gravitational Hypothesis and Person-Job fit, suggest that alignment of one's perception of themselves and a career is one factor influencing their persistence. Our group recently collected data indicating that biology undergraduates hold varying beliefs and perceptions about creative abilities and the role of creativity in science. However, there is little existing research on science students' beliefs about creativity. Person-job fit theory suggests that people will be most interested in careers that align with their abilities and interests. Based on this, we hypothesize that alignment between students' beliefs about their own creative abilities and perceptions of the role of creativity in science will influence their interest and persistence in science. Specifically, we predict that students who view themselves as highly creative but do not perceive science as a creative endeavor will be less interested in a career in science. Conversely, students who view themselves as having low creative ability but view creativity as an important part of science will also have low interest in science. Finally, we predict that alignment between students' views of their own creativity and the role of creativity in science will result in high interest in science.

Research Design:
We conducted a mixed-methods study to characterize biology undergraduates' beliefs about their own creative abilities and the role of creativity in science, and explore the relationship between these beliefs and sense of belonging and intent to persist in science. We surveyed introductory biology students (n=705) and are conducting in-depth semi-structured interviews with a subset of participants (ongoing, n=19 completed, n=25 anticipated). The survey included Likert-style and open response questions about students' beliefs about their own creativity abilities and the role of creativity in science.

Analyses and Interpretations:
We are conducting standard content analysis with the written responses and interview transcripts to characterize the range of students' beliefs about their creativity ability and the role of creativity in science. We identified three factors that influence students' perceptions of their creative ability: How much they enjoy creative activities, how often they engage in creative activities, and their creative ability. We are currently analyzing responses and developing themes of reasons why creativity is or is not important in science. We will analyze the Likert

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responses using Pearson correlations and multiple regressions to evaluate the relationship between students' beliefs about creativity and their sense of belonging and intent to persist in science.

Contribution:
This study will character the range of students' beliefs about their own creative ability and the role of creativity in science. We will explore whether these beliefs may shape students' sense of belonging and intent to persist in science. This work may result in implications and suggestions for how creativity could be framed in undergraduate science courses to encourage broader interest.

Session B: Groupwork and Citizen Science

Paper ID: 79

Citizen Science in Undergraduate Education: Current Practices and Knowledge Gaps

Heather D. Vance-Chalcraft (East Carolina University)*; Allen Hurlbert (University of North Carolina); Jennifer Styrsky (University of Lynchburg); Terry Gates (North Carolina State University); Gillian Bowser (Colorado State University); et al.

Research Question: Citizen science involves the public in the processes of science to investigate ongoing research questions. Although citizen science originated in informal environments, educators have recognized potential benefits of citizen science for class settings. Evidence suggests that citizen science in informal settings can enhance participants' sense of place, expose participants to scientific tools and practices, and increase project-specific disciplinary content knowledge. In this study, we asked how and why citizen science is being used in formal undergraduate courses, and whether the benefits to participants found in informal settings are enhanced, or reduced, when citizen science is used in a formal course. Courses can provide more scaffolding of the project than informal settings can, but participants may have lower motivation and autonomy. Thus, the benefits of participating in citizen science seen in informal settings may, or may not, translate to students in an undergraduate course.

Research Design: We reviewed the published literature and conducted a survey of college and university instructors to determine how and why citizen science is being used in higher education, as well as the impacts of participation in citizen science on student learning. Each paper fitting our search criteria was coded by two individuals with respect to the institution, course, and instructor attributes; three individuals read all the final papers to agree upon the emergent themes. In addition, we developed a survey to capture information on how citizen science was being used in courses that may not have been accessible through a literature search and distributed it through multiple professional listservs and professional contacts. Each respondent was able to provide information on up to three citizen science projects in up to three different courses. We coded the responses for institution, course, and instructor attributes and

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contacted some respondents, as necessary, to clarify their responses.

Analyses and Interpretations: We calculated the frequency of responses from the literature review and instructor survey. Only 14 papers fit our search criteria for the literature review, and few of those included data on educational outcomes. 79 instructors, from a variety of institutional types (36% R1, 11% R2, 2% R3, 22% Master’s, 19% Baccalaureate, and 10% Associate’s), provided usable survey responses. Interestingly, a quarter of the institutions represented in both the literature review and instructor survey are designated as minority-serving institutions. Citizen science was reported to be used in courses of all sizes (though most commonly in courses with 30 students or less) and formats (50% lab, 55% lecture, 5% seminar, 11% independent research, where lab and lecture could be selected together). Most instructors indicated their objectives for including citizen science in their course were to engage students (90%) and expose them to authentic research (77%) (respondents could choose more than one objective). Instructors perceived many benefits to students, but few papers or survey responses reported any formal assessment results.

Contribution: We find citizen science holds great promise for engaging students in authentic science practices, improving student learning outcomes, and broadening participation in science. More research is needed, however, to rigorously assess the ability of citizen science to positively impact student learning.

Paper ID: 89

Group work and student performance in biology: A meta-analysis.

Emily P Driessen (Auburn University)*; Sara Beth Ramsey (Auburn University); Sara Wood (Auburn University); Alan Wilson (Auburn University); Cissy Ballen (Auburn University)

Research Questions: The broad principle of active learning is based on the constructivist theory that learners need to construct their own understanding in order for it to be meaningful. Undergraduate biology instructors have increasingly embraced the use of active learning instructional practices over the past decade. Previous meta-analyses demonstrated that such practices increase performance, decrease failure rates, and disproportionately benefit underrepresented students in science. However, these meta-analyses combined all active learning practices together, evaluating their effect on student performance wholistically, rather than parsing out the effect of a single strategy. Here, we fill a gap in the literature by utilizing meta-analytic techniques to evaluate the effect of group work, an active learning practice commonly introduced in post-secondary biology classrooms, on student performance. Specifically, we investigated the following research questions: (1) What is the effect of group work on student academic performance in a post-secondary biology course?; and (2) How is this effect moderated by class size, group size, class year, or class time devoted to group work?

Research Design: We chose to focus on quantifying the effect of group work on student performance because (1) previous research showed that group work is one of the most

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frequently cited examples of active learning strategies implemented by post-secondary biology educators, and (2) it is frequently included as a strategy in active learning papers showing positive student outcomes. Given this, we reviewed nearly a century of literature on group work, including studies that collected student performance outcome data in at least one post-secondary biology course. We selected Hedges' g as our effect size in order to calculate the effect of group work on student performance outcomes. This statistic measures the effect size for the difference between means but includes a correction for small sample sizes. Student data were categorized by class size, group size, class year, and class time devoted to group work in preparation for moderator analyses.

Analyses/Interpretations: We examined articles pertaining to group work in post-secondary biological sciences classes over the last 96 years, resulting in 42 estimates taken from 12 studies from the published and unpublished literature. In total, the extracted data came from 11,799 students with an average of 281 students per estimate. The estimates indicate that, on average, student performance increased by 0.56 SDs when group work was utilized in class. To put the magnitude of this effect size in perspective, according to Hedges and Hedberg (2007), any educational tool with a positive effect larger than 0.20 SDs should be of educational policy interest. Moderator analyses demonstrate smaller group sizes and more time spent in groups enhance the effect of group work on student performance outcomes.

Contributions: Our results support calls to utilize group work, demonstrating a significant and large effect on student performance and, potentially, learning. Targeted research on successful implementation of group work and other strategies will improve our understanding of key ingredients that make active learning effective in higher education, allowing for more informed pedagogical decisions, especially when it is not feasible to implement every active learning strategy in one classroom.

Paper ID: 185

A challenge in teaching scientific communication: Academic experience does not improve undergraduates' ability to accurately assess their own or their peers' work

Mark A. Sarvary (Cornell University)*; Megan Biango-Daniels (Cornell University)

Communicating scientific discoveries is the last, but very important step of the scientific process, and it should be an integral part of undergraduate biology education. Communication assignments, especially technical writing, can be very time-consuming to provide feedback on. One way to reduce the burden on instructors is to engage students in a peer-review exercise, in which students assess classmates' writing anonymously as peer-reviewers. The integrity, reproducibility, and trust in scientific publications depend on the rigor and quality of peer-review, therefore exposing undergraduates to this process and helping them fine-tune their skills is an investment in the future. Here, we report on an exercise that challenges undergraduates to communicate through technical writing by replacing traditional laboratory reports with a semester-long, comprehensive writing exercise, mirroring the scientific peer-review process. We

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hypothesized a common assumption among instructors: students' assessments of their own and their peers' work becomes more accurate as they gain academic experience, and that novice students are overconfident in their own writing ability due to inexperience (Dunning-Kruger effect). We also hypothesized that these differences can be detected in high granularity, even between first and second-semester freshmen. In addition, we aimed to evaluate students' perceived value of the peer-review exercise, examining differences in opinions among students with different levels of their college experience. In a 9-semester-long study, we surveyed 2,606 students about their perception of peer-review in an introductory biology course and found that 91% of the students considered the exercise helpful, with 75% appreciating the feedback and 45% benefiting from seeing other students' written assignments. Out of 524 students, 88% took the peer-review seriously, despite that they knew they will receive additional feedback from an instructor. Pearson correlation coefficient tests were utilized to test for correlation between self-, peer-and instructor-assessed grades and Wilcoxon rank-sum tests were used to test for significant differences. The evaluation of 1354 students' peer-review showed that undergraduates overestimate the quality of their own work, as students' self-assessed grades were significantly higher than the grades they received from their peers. Both self-assessed and peer-assessed grades were higher than the instructor-assigned grades. The Dunning-Kruger effect, that novice students may be overconfident in their writing ability due to less academic experience, was not detected as the academic level of the students (under- or upperclassmen) did not predict how accurate they were in assessing their own or their peers' scientific writing. Instructors of diverse courses should not assume that freshmen overestimate the quality of their work because of their lack of college experience, or that returning students with greater academic experience are better judges of their own performance. Since all students had access to the grading rubric prior to submitting their work for peer-review, this study shows that students have a difficult time applying these rubrics, which may lead to the false perception that the instructor is an unfair grader. Interventions, such as using peer-review to teach technical writing, are appreciated by students and are powerful pedagogical tools, but they need to be evidence-based to become more effective.

Paper ID: 99

Understanding Longitudinal Change in Small-Group Dynamics through Social Network Analysis

Brock Couch (Middle Tennessee State University)*; Grant E Gardner (Middle Tennessee State University)

Introduction:
To promote discussion within classrooms, one pedagogical practice that is commonly utilized is collaborative small-group learning. Although these forms of structured small-group learning have demonstrated positive student outcomes, the effectiveness of the interactions within them relies on many complicated factors, such as group composition, individual student values and behaviors, and classroom community interactions. Because discussion is interactive in nature, social network theory may be applied to better understand the dynamic structure of students'

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small-group interactions. Social network theory focuses on the connections (ties) between individual actors (nodes) within a network, as well as the characteristics of actors themselves. A method utilized across a broad variety of disciplines to capture these network characteristics is social network analysis (SNA) that represents data through sociograms. Utilizing SNA, we can track the formation and longitudinal change of small group networks in classrooms, communicative interactions between actors, as well as compare network interactions to provide mechanistic explanations for positive student outcomes.

Research Questions:
This study will be guided by the following research questions: RQ1. How does the structure of small collaborative groups' social networks change over time during one semester of the course?, RQ2. How do students' degree of cooperation in conversations change in the groups' social networks over time during one semester of the course?, RQ3. Are changes in the structure of the groups' social networks associated with changes in their degree of cooperation?

Research Design:
In spring 2020, we tracked small collaborative group interactions in a large introductory biology course for majors, which had previously established small groups. Groups of 4 to 5 students interacted throughout the semester to answer "clicker" questions and complete small group exercises. We examined four randomly-selected small collaborative groups across multiple class periods. To track student interactions, we utilized the LessonNote software on iPads to record students' talk-turns for an entire class period (55 mins) during three different weeks of the course. To capture detailed qualitative data related to the content of discussion students, we collected audio and video recordings. Audio recordings were transcribed for analysis.

Analyses and Interpretations:
Data analysis was completed in R by creating weighted, directed sociograms of the small group interactions for each of the three class timepoints. Once the sociograms were created, comparisons of the networks' structure over time were made (RQ1) as well as relevant network variables calculated (density, centrality, homophily). Students' on- and off-task conversations were assessed utilizing Chiu's (2000) analytical framework to answer RQ2 and the degree of cooperation were correlated to pertinent network variables (RQ3). We found that the structure of talk-turns and conversations of the small groups changed across the sampling periods (See Figures 1-2).

Contribution:
Because techniques for capturing longitudinal small-group interactions are in their infancy, this research is applicable to helping further both our methodological and theoretical understanding of small-group interactions and will lead to innovative scholarship in the field of discipline-based education research.

Session C: Evolution Education

Paper ID: 196

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Evolution Acceptance and Understanding among Community College Students
Meredith Dorner (Irvine Valley College)*

RESEARCH QUESTION: Evolution education is contentious in the United States as the acceptance of evolution is controversial among the general public. Few studies focus on understanding what influences the acceptance of evolution among community college students. From a constructivist framework this study asks: to what extent does a relationship exist between the acceptance of biological evolution by community college students and their understanding of evolution and the nature of science (NOS)?

RESEARCH DESIGN: Students enrolled in life science classes at a midsize community college in Southern California (n=867) were surveyed anonymously as part of a larger study using portions of validated instruments regarding their attitudes towards evolution, understanding of evolution and the NOS, previous science experience, career goals, and demographic information. Sub-scores were calculated for the acceptance of evolution (MATE), the understanding of evolution (LSCI), and the understanding of the NOS (EALS-SF). Previous studies have found a range of acceptance and understanding among college students using various methods.

ANALYSES AND INTERPRETATIONS: Data were analyzed by calculating standard central tendency measures, Pearson Product Moment correlation coefficients, partial correlations, and a multiple regression analysis. The mean MATE score was 77.32 (out of 100), a high acceptance of evolution. The mean score on the LSCI items was 5.05 (out of 10), indicating the students had a poor understanding of evolution and students had a relatively better understanding of the NOS (mean score on EALS-SF was 15.93 out of 20. These students accepted evolution at a higher level than the general public but did not have a solid understanding of evolution.

The acceptance of evolution was significantly positively correlated with understanding evolution ($r = 0.536$) and understanding of the NOS ($r = 0.497$). Factors measured accounted for 39% of the variation in the MATE scores variance in the MATE scores (R2= 0.399, adjusted R2 = 0.390 [ANOVA significance < 0.001]). Understanding of evolution accounted for 43% and understanding of the NOS accounted for 36.4% of the variance. College biology and other science courses, career goals, course enrollment, and demographic variables did not significantly explain the variance in the MATE scores.

CONTRIBUTION: This study is important because evolution is widely accepted among scientists and it is the underlying framework of biology. Most students go through the K-12 public school system, which typically includes science standards about evolution, and should have an understanding of evolution upon entering community college. On average, students in this study correctly answered only half of the questions about evolution that were derived from 8th grade science standards. Either students are not learning the material in their K-12 education or they are not retaining it. Interestingly, despite this lack of understanding, students

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accepted evolution at a high rate.

Gaining greater insight into the acceptance and understanding of evolution among community college students may help science educators to refine educational strategies and promote a more scientifically literate population. Increasing acceptance of evolution may be more involved than increasing understanding of evolution and more exploration of the obstacles to accepting evolution might aid the development of useful strategies to improve the teaching of evolution.

Paper ID: 77

Introducing the Measure of Acceptance of the Theory of Evolution 2.0 (MATE 2.0)

Elizabeth Barnes (Middle Tennessee State University); Taya Misheva (Arizona State University)*; Sara Brownell (Arizona State University); Michael Rutledge (Middle Tennessee State University)

Research Question: The Measure of Acceptance of the Theory of Evolution (MATE) is the most used instrument for measuring evolution acceptance in studies. However, this 20-item instrument has not been updated since its creation over 20 years ago, and prior research indicates that limitations of the instrument could be causing confusion about how to increase evolution acceptance. Researchers have expressed concerns about whether the MATE measures more than acceptance of evolution, but no prior studies have tried to probe student misinterpretations of items on the MATE. The goals of this study were to identify current weaknesses of the MATE through student interviews, revise the MATE based on these identified weaknesses, and then conduct validity tests for the new instrument using a population of undergraduate biology students sampled from across the United States.

Research Design: To explore and improve the validity of the MATE, we conducted cognitive interviews with students with different religious affiliations, levels of evolution acceptance, and levels of knowledge about evolution to identify if items on the MATE were confusing to students, seemed to measure student knowledge of evolution instead of acceptance, or were affected by other extraneous constructs that were not acceptance of evolution. We first conducted 62 cognitive interviews on the original version of the MATE in order to identify any current weaknesses and identified problems with specific items. We then revised the MATE based on the interviews and conducted an additional 13 cognitive interviews using the revised "MATE 2.0" to determine whether the previously identified weaknesses had been sufficiently addressed. We finally administered the revised MATE 2.0 to 2,881 students in 15 college biology classes and ran Rasch and correlational analyses for evidence of construct and concurrent validity.

Analyses and Interpretations: We found that students' scores on the original MATE items were often incongruent with their stated acceptance of evolution. For instance, responses were influenced by student misconceptions about the nature of science, even when students expressed full acceptance of evolution. Understanding of evolution was another major confounding factor; students commonly acknowledged that they were unfamiliar with the

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evidence for evolution and did not know the age of the earth, which caused their scores on the MATE to be lower even though their acceptance was not necessarily lower. We also found that some questions measured student perceptions of scientists' acceptance of evolution, rather than students' acceptance. After revising the MATE, interviews with 13 students on the MATE 2.0 confirmed that students were no longer using extraneous constructs to answer survey items. Rasch analysis on the data from 15 college biology classes confirmed that MATE 2.0 scores fit a unidimensional model and correlation analyses showed that MATE 2.0 scores correlated with another measure of acceptance of evolution.

Contribution: In this study we developed and validated a revised MATE 2.0 that addresses validity issues that are present within the existing MATE survey. Biology education researchers and instructors alike can use the MATE 2.0 as a reliable measure of student evolution acceptance that does not conflate acceptance with extraneous constructs such as knowledge of evolution and knowledge about the nature of science.

Paper ID: 220

Reconciliation approaches are effective at increasing evolution acceptance, and here's why.

Danny Ferguson (Brigham Young University)*; Jamie L Jensen (Brigham Young University**)**

RESEARCH QUESTION: Evolution acceptance has been an issue for many students for decades now, especially religious students. Many students feel that evolution goes against their religious or worldviews, which may cause some discomfort. Educators have used methods to help increase evolution acceptance among students in their classrooms. Methods, such as a "deficit model" or teaching the facts, have not effectively increased evolution acceptance. In comparison, teaching students the nature of science and using a reconciliation of science and religion approach have been shown to be effective ways of increasing evolution acceptance among students. We have successfully used this reconciliation model in the classroom, in museums, and among educators in professional development workshops. However, our studies and other studies have been less clear about why a reconciliation model is effective. Thus, our research question is, why does a reconciliation model lead to gains in evolution acceptance? Using the principles outlined in Religious Cultural Competence for Evolution Education (ReCCEE) as a theoretical framework, we aimed to determine what components of the reconciliation model are most effective in changing student attitudes, including the following hypotheses: the influence of a role model, discussing potential compatibility, learning evolution, discussing cultural history, developing an understanding of the nature of science, reflecting on compatibility, and discussing with others.

RESEARCH DESIGN: To discover which components are most effective at changing viewpoints, we surveyed students in an introductory biology course at a religiously-affiliated private institution in the Western US. Students were surveyed directly following a reconciliation lesson and subsequent unit on evolution. Students were asked to evaluate each component

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listed above on how influential it was in changing their views on a 5-point Likert scale from no influence to very strongly influenced. We also administered the I-SEA instrument and a religiosity instrument to students before and after the unit to assess any changes in evolution acceptance or religiosity.

ANALYSES & INTERPRETATIONS: First, we found significant gains in evolution acceptance, including microevolution, macroevolution, and human evolution. In addition, we found no changes in religiosity, indicating that we had influenced students' acceptance of evolution without tearing down their faith. The survey results showed that the three most influential factors in changing their viewpoints were examining the compatibility of evolution with a religious belief, discussing the evidence of evolution in the classroom, and the influence of a role-model.

CONTRIBUTION: Our data aligns with research using culturally competent methods in evolution education. However, our data expands our understanding of why a reconciliation approach is effective and sheds light on the aspects of reconciliation that students find most helpful. These approaches therefore have the ability to significantly impact students' evolution acceptance and lead to a more scientifically literate generation.

Paper ID: 115

Crossing Cultural Borders: Community College Biology Students' Understanding and Acceptance of Evolution

Kathryn Green (University of Georgia)*; Cesar Delgado (North Carolina State University)

Research Question/Problem: The cultural border crossing (CBC) framework says students' thinking about science is influenced by two diverse cultures--their home culture and the culture of the science classroom. If a students' home culture centers around religious beliefs unsupportive of evolution acceptance, they may need to cross a "cultural border" when entering their science classroom. We investigated how an intervention designed to facilitate cultural border crossing during the evolution unit of an introductory biology class for non-majors affected their understanding and acceptance of evolution.

Research Design: We applied the CBC framework to a novel context by focusing on community college non-majors and the specific goal of increasing evolution understanding and acceptance. Our sample was 80 students from two classes. The control class received typical evolution instruction by the community college instructor while the intervention class received the same instruction plus the cultural border crossing intervention. We used well-accepted quantitative instruments to measure all students' understanding and acceptance of evolution pre- and post-unit. In addition, we conducted pre- and post-unit interviews with six intervention students to explore their thinking about evolution.

Analysis and Interpretation: After determining normal distribution of scores on both instruments, we used independent-samples t-test to determine the statistical significance of differences in

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acceptance and understanding of evolution between the control and intervention groups. We used Cohen's d to calculate the effect size of the intervention on both measures. The effect size showed a small to medium effect of the intervention on students' knowledge and understanding of evolution.

We coded interview data using codes created from the CBC framework as well as allowing for emergent codes. In addition to learning how the interviewees characterized evolution before and after the unit, two additional themes emerged. The first theme focuses on epistemic agency, or how students think about themselves as creators, curators, and evaluators of knowledge. Some students passively resorted to authority while others discussed the extent of religious or scientific knowledge. The second emergent theme relates to the often-seen illustration of "road to evolution" which begins with an ape-like creature and ends with man. When students were explicitly told this illustration is not intended to provide an accurate depiction of human evolution, they were astounded. Several students explained in their interviews that once they realized believing in "the road to evolution" illustration was not a requirement of evolution acceptance, they could more easily accept it.

Contributions: Results from this work demonstrate students can undergo smoother border crossings between their home culture and the culture of the biology classroom if instructors are aware of their role in cultural border crossing. The intervention will be shared and can be used in the future by biology instructors. In addition, our results show that explicitly addressing common illustrations of human evolution may ease tensions students face when learning about evolution. Finally, students' frequent use of teleological reasoning when discussing evolution shows that instructors should be aware of the frequency of teleological thinking by non-majors in introductory biology courses.

Session D: A Random Gathering of Great Stuff!

Paper ID: 17

A systematic review of change theory in STEM higher educational change efforts

Tessa C Andrews (University of Georgia)*; Daniel L Reinholz (San Diego State University); Isabel White (San Diego State University)

RESEARCH PROBLEM: A change theory is a framework of ideas, supported by evidence, that explains some aspect of how or why change occurs. Drawing on change theory allows educational reform projects to capitalize on and contribute to collective knowledge, but identifying appropriate change theory can be hard. Relevant theory comes from diverse fields in and out of STEM and change initiatives are often siloed by STEM discipline. Thus, we saw a need to bring together work across disciplines to investigate which change theories are used and how they inform change efforts. We conducted a systematic review of how change theory has been used in research on reform in undergraduate STEM education between 1995-2019.

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RESEARCH DESIGN: We used four distinct approaches to find potentially-relevant peer-reviewed articles, including starting with the papers reviewed by a seminal 2011 review, conducting comprehensive searches using search engines for more recent papers, reverse citations searches, and directly scouring DBER journals. This produced 409 articles that we analyzed for the following inclusion criteria: empirical, theoretical, or review papers in peer-reviewed journals; about undergraduate education; STEM-specific; and most critically, drew on change theory. This resulted in 97 articles that we analyzed further.

ANALYSES: We analyzed papers to determine whether and how change theory had informed the rationale and assumptions about how change occurs, the way that the context of change was conceptualized and examined, any interventions undertaken, and the indicators that researchers used to determine if change had occurred.

INTERPRETATIONS: This analysis revealed a notable lack of theoretical coherence in the relatively narrow domain of STEM higher educational change. The reviewed articles used 40 distinct change theories, more than half of which were used in just one or two articles. Eight change theories were used in three or more articles, with the vast majority using one of two change theories: Communities of Practice (n = 26 articles) and Diffusion of Innovations (n = 19 articles). Eleven articles created new theories. Though each change context is unique, this enormous diversity in theoretical grounding may be a barrier to generalization.

We also analyzed the way in which change theories informed efforts and found that most research drew upon theory in a superficial fashion. Work that does not substantively draw on theory often cannot contribute back to theory, limiting what can be transferred to new contexts. Lastly, the majority of articles focused on change at the level of individual faculty without considering the larger system in which faculty exist, yet altering systems may be key to achieving sustainable change. Our review identified a few rarely-used theories that could help projects consider the larger system.

CONTRIBUTION: This work can introduce researchers to change theories that may be relevant to their own work, and suggest considerations for researchers working to promote and study change in undergraduate biology education. Some additional implications of this work include the need for more opportunities for researchers to learn about change, which is a role that professional societies like SABER could play. We also noted a very modest focus on diversity, equity, and inclusion, suggesting the need for building bridges between equity and change scholarship.

Paper ID: 11

What's in a word? Exploring graduate student definitions of "success"

Maryrose Weatherton (University of Tennessee, Knoxville)*; Beth Schussler (University of Tennessee, Knoxville)

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Research Question: Differentials in student success have been reported for years, and countless initiatives have been enacted to increase the success of minoritized students in science. However, the state of minoritized student persistence suggests that these initiatives have not entirely succeeded. We argue that a central issue is that the definition of “success” is often unexamined and rarely includes student perspectives. Our previous research determined that the majority of research articles on student success did not define the term, nor did they gather student perspectives on the concept. This raises questions about what and whose definitions of success should be used when discussing success differentials. To begin to probe these questions, we used a phenomenological method to answer the question of how graduate students (GS) in life sciences perceive success.

Research Design: Our research was guided by interpretive phenomenological analysis, which posits that each individual’s reality is socially constructed and relative. Thus, one way to understand a concept is to probe individuals’ perceptions of the concept. We conducted semi-structured interviews with 11 GS in a life science department at an R1 institution. Our sample was majority white, first-generation, female, PhD students. Interviews probed student definitions of success, what factors shaped their definitions (e.g., cultural background, previous education), and how definitions changed over time. We chose a phenomenological method due to its philosophical intent to understand participants’ perspectives in light of their socio-cultural contexts, which honors the experiences of minoritized students.

Analyses and Interpretations: The interviews were transcribed. Transcriptions were analyzed using interpretive phenomenological analysis; the central tenants of which include iterative analysis, inductive coding, and a focus on a participants’ lived experiences. The codebook was iteratively updated and checked by a second researcher. Each participant’s interview was first coded individually, then coded across participant cases to create final themes by combining themes from each individual. We found seven definitions of success: 1) Academic 2) Career 3) Goal-based 4) Skill-based 5) Values-based 6) Resilience 7) Happiness. Each participant expressed two or more of these definitions. An additional three themes related to GS lived experiences in their programs: 1) Poor sense of belonging 2) Changing definitions 3) Antagonistic definitions. These results indicated that GS have multiple, nuanced definitions of success. Furthermore, participants perceived an institutional focus on academic success that often contrasted with their own definitions. While GS acknowledged the importance of academic success, they felt that definitions of success beyond academic success were not embraced in their program, which made them feel like outsiders.

Contribution: This study has implications for research in biology education and higher education, thus, it will be of general interest to SABER attendees. It adds new ideas about how success is defined by students, and how the conflict between student and institutional definitions may impact student well-being. Furthermore, this study helps address issues related to inequity, as it aims to counteract majority definitions of success by amplifying the voices of students and inviting new discussion about how success should be defined.

Paper ID: 122

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Motivation in reading primary scientific literature: how to assess student self-efficacy, competence, interest, and expectancy-value in reading disciplinary literature

Melissa R McCartney (Florida International University)*; Kyriaki Chtazikyriakidou (Florida International University)

A growing body of literature shows that Primary Scientific Literature (PSL) is a valuable and useful tool for STEM education. However, several barriers to including more PSL in classrooms exist, including the lack of validated assessment tools that specifically measure learning gains from student engagement with PSL. Most often, individual instructors design assessments to measure specific content students may have learned while reading PSL, resulting in new assessments being written for each piece of PSL used in class. While content assessment is important in its own right, these types of assessments do little to help us understand if students are learning how to engage in the scientific practice of reading PSL.

We believe that the underlying motivation students consider while learning to read PSL is equally important to assess. Motivation related to learning how to read PSL is less about students learning specific content and more about students engaging in the larger scientific practice of reading peer-reviewed research. Different frameworks for student motivation are not mutually exclusive and can be used together to describe student behavior in the classroom. For example, Expectancy-Value Theory shows that students will put more effort into activities that they simultaneously perceive to have value and at which they expect to succeed. In addition, self-efficacy, or one's self-confidence to perform a behavior, performance/competence, or one's confidence levels in relation to their learning environment, and interest in a subject are all components of motivation. We hypothesize that student motivation in reading PSL is described by these theories and may be critical for student learning through PSL.

We have developed and validated an assessment that can be used with a wide diversity of PSL implementations and with multiple levels of students, including students at the introductory level. We will present our 19 item Likert-style questionnaire "Motivation in Reading PSL" that can be used to measure student motivation in reading PSL through four subscales: 1) expectancy-value, 2) self-efficacy, 3) performance/competence, and 4) interest. Preliminary external validity of the questionnaire verified differences ($p<0.05$) in students' motivation between one control and two treatment groups after a one semester PSL-based intervention. These findings suggest that the "Motivation in Reading PSL" questionnaire can be used by instructors who implement PSL-based interventions and would like a more comprehensive understanding of how their students approach reading PSL. In addition, our data suggests that positively changing student motivation related to PSL is complex and likely influenced by many factors, examples of which will be presented and discussed.

Finally, our data show that implementation protocols for introducing students to PSL, especially novice, introductory students, for the first time really matter. This is important, as freshman biology students have full careers ahead of them where reading PSL will be necessary.

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Therefore, it is critical to try to make their first introduction to PSL successful, and to aim to increase their motivation for reading PSL as early as possible. Example implementations from our study will be presented and discussed.

Paper ID: 200

Anxiety- Eustress or Distress? Community college students report benefits of being called on in class, including paying attention, participation, increasing understanding and developing confidence

Gwen Shlichta (Edmonds Community College)*; Stacy M Alvares (Bellevue College); Jenny McFarland (Edmonds Community College); Elli J Theobald (University of Washington)

Research Question or Problem: As active learning has become more common in the classroom, education researchers question whether these practices generate new learning obstacles for students. Random call has been proposed as a way to equitably engage students but some studies have reported that random call results in increased student anxiety. However, these anxiety-induced behaviors may not always have a negative impact on student learning and may help promote student engagement. Our study examines community college biology students' perceptions of being called on in class, including random call, within the framework of negative stress versus eustress [Sheyler 1976]. As previous authors have suggested, eustress can be regarded as beneficial by contributing to learning and self-efficacy.

Research Design: Community college students taking in-seat biology courses were given a mixed methods survey at the end of the quarter. Data was collected in six different biology courses over six quarters. This survey contained Likert-scale questions and open-ended responses. We report on student responses to the open-ended questions: "In what ways did getting called on benefit your learning?" and "In what ways did getting called on interfere with your learning?" Qualitative data from these two questions were independently coded by three of the authors. The three coders compared and modified codes to create a code book. Once code descriptions and examples were agreed upon, the coders reached a consensus on the codes (reflecting student sentiments) for all student responses. Codes were binned to examine the relative frequency of student sentiments in response to being called on in class.

Analyses and Interpretations: Our results, based on 528 student responses with 455 unique responses, covered the same six biology courses taught by six instructors over six quarters. Our analysis of student responses resulted in the identification of nine codes that benefited students, including paying attention, participation, increasing understanding and developing confidence. Twenty three of the 455 participants answered that it did not support their learning. We also identified 8 codes on how it interfered with learning. Five of these codes addressed anxiety, but not all types of anxiety were viewed as negative, suggesting that being called on can lead to a form of eustress that facilitates learning. 168 of the 455 students also responded that being called on did not interfere with their learning.

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Contribution: Our qualitative data is consistent with the quantitative data from the same survey. Results show that while random call is associated with some level of anxiety, a large number of students report benefits from random call in the classroom. Context matters-small (20-40) classes with more student-faculty contact and consistent instructor-talk may result in students perceiving the benefits of being called on. Many of the themes identified in this study echo those articulated by instructors who use random call in large undergraduate classes. Our data suggests that calling on students, especially random call, increases equity and can be a productive challenge to students (eustress) that is beneficial to learning and self-efficacy.

Session E: Diversity, Equity, & Inclusion

Paper ID: 25

Coming Out to the Class: Students Benefit from Instructor Revealing LGBTQ+ Identity in a Large-enrollment Biology Course

Carly A Busch (Arizona State University)*; K Supriya (Arizona State University); Sara Brownell (Arizona State University); Katelyn M Cooper (Arizona State University)

RESEARCH QUESTION: Sharing personal information is a way for instructors to build relationships with their students. Revealing personal identities may be particularly impactful for students with concealable stigmatized identities (CSIs), defined as identities that can be kept hidden and that carry negative stereotypes. In this study we aimed to answer two research questions about an instructor revealing a particular CSI, LGBTQ+ identity, in a college biology classroom: (1) What is the impact on all students of an instructor revealing their LGBTQ+ identity during a course? (2) Do students think it is appropriate for an instructor to reveal their LGBTQ+ identity during a course? Previous studies have explored the personal consequences for instructors who revealed their LGBTQ+ identity in the classroom, but we know of no studies that have investigated the impact of an instructor revealing their LGBTQ+ identity on students. We used CSIs as a framework to interpret our results.

RESEARCH DESIGN: We conducted this study in an upper-level physiology course where the instructor revealed that she is part of the LGBTQ+ community in three seconds using a single PowerPoint slide at the beginning of the semester. At the end of the semester we surveyed 580 students in the course to answer our research questions. Students answered closed-ended questions about whether they remembered the instructor coming out, and if so, whether the instructor coming out had a negative, positive, or no impact on them, and an open-ended question asking them why. Students then answered Likert-scale questions to assess to what extent the instructor revealing her LGTBQ+ identity impacted their (1) willingness to approach the instructor, (2) feeling connected to the instructor, (3) confidence in their ability to pursue a science career, (4) sense of belonging in the course, and (5) sense of belonging in the scientific community. Students also answered questions about to what extent they perceived that an instructor revealing their LGBTQ+ identity in class was appropriate and why.

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ANALYSES AND INTERPRETATION: We used open-coding methods to analyze student responses and linear regression to examine to what extent student identities (gender, race/ethnicity, history of anxiety/depression, and LGBTQ+ status) predicted gains in each of the five outcomes. For the students who remembered their instructor coming out, most reported that it impacted them positively (66%), largely because it would normalize LGBTQ+ identities and benefit LGBTQ+ students. The majority of all students agreed that the instructor revealing her LGBTQ+ identity increased their willingness to approach her (71%), feeling connected to her (77%), confidence in pursuing a science career (53%), and sense of belonging in the class (64%) and scientific community (57%). Further, LGBTQ+ students reported a disproportionately positive impact across all outcomes. Women reported disproportionately higher confidence in pursuing a science career and sense of belonging in the class and scientific community. Students overwhelmingly (95%) perceived that it was appropriate for an instructor to reveal their LGBTQ+ identity in class.

CONTRIBUTION: This study is the first to demonstrate an impact of an instructor revealing their LGBTQ+ identity on biology undergraduates and supports that a brief intervention of less than three seconds could have far reaching effects on all students, not just those who share marginalized identities.

Paper ID:42

Experiences of trans, gender non-conforming, and genderqueer students in biology courses

Nicole A Rebolledo (Florida International University)*; Aramati Casper (Colorado State University); A. Kelly Lane (University of Minnesota Twin Cities); Sarah L Eddy (Florida International University)

Research Question or Problem: People who openly identify as trans, non-binary, or gender non-conforming (TNG) are increasing in frequency each generation, but knowledge of how to create inclusive educational environments for these students is understudied. This makes it challenging to identify the best methods to support TNG students. Biology classes may be particularly challenging for TNG students because they are confronted with topics around sex and gender that may not align with their experiences and “other” them. Studies on biology curriculum suggest that it can emphasize gender essentialism, the beliefs that gender and gender roles are natural, biologically driven categories. These beliefs directly contrast with the lived experiences of TNG students and this dissonance may help explain their lower persistence in biology relative to other STEM majors. In this study, we explore the experiences of TNG students with content related to sex and gender in biology courses and how this influences their sense of belonging in biology.

Research Design: We used qualitative content analysis to explore the experience of four TNG students in biology courses. With each student we conducted three semi-structured interviews focused on different aspects of their experiences in biology courses: narratives encountered

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about sex and gender, the student's appraisal of and short term affective impact of course climates, and how their own identities interact with biology spaces and impact factors related to retention (e.g. belonging and science identity). We used master narrative theory to guide our analyses to understand how messages in a cultural environment are internalized and impact an individual's beliefs about themselves.

Analyses and Interpretations: We identified three key themes: 1) oversimplification, 2) harm, and 3) resilience. 1) All students discussed how content was oversimplified: instructors only discussed sex as a binary, rarely mentioned gender, and left out examples that did not align with this simplistic view. 2) All students also discussed how these omissions caused harm related to their TNG identities. For some this silence made them feel invisible, unwelcome, and isolated. It impacted their ability to connect with their instructor, making it harder to request letters of recommendation or research experiences. Others described the silence as not giving credibility to sexes and genders beyond the binary, which was a lost opportunity to educate people going into medical fields and made it harder for them to navigate conversations about their own identities with their biology peers. 3) When students encountered the narrative of binary sexes in biology, they resisted this narrative by searching for inclusive biology resources online or in non-biology courses. For some this silence motivated them to change the system. Finally, some students reduced harm by compartmentalizing their personal identity: they expected sex to be taught as a binary in biology, so it did not harm them when this happened. The same students described experiences of both resilience and harm.

Contribution: This research suggests that TNG students do not think their identities are represented in biology curriculum and this has a negative effect on their sense of belonging. Further research on how we can teach biology in a more gender inclusive way may support the persistence of TNG students.

Paper ID: 40

Instructor conceptions of diversity in higher education

Nicole A Suarez (San Diego State University/University of California, San Diego)*; Song Wang (San Diego Statue University/ University of California San Diego); Stacey Brydges (University of California San Diego); Stanley M Lo (University of California San Diego)

RESEARCH PROBLEM: While the reasons for observed equity gaps in academic achievement are complex and multifaceted, a growing body of literature indicates that instructor-student interactions are crucial. Research has documented the pervasive problem of instructor biases that impact how they perceive and interact with certain students in the classroom. Thus, it is critical to examine how instructors conceptualize diversity. To investigate this, we used phenomenography as our theoretical framework. The goal of phenomenography is to describe the different ways individuals understand the same phenomenon, i.e. diversity. These ways of understanding are organized into an outcome space displaying specific features (aspects) that are attended to when describing a phenomenon and the differences within each aspect

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(variations) that give rise to the qualitatively different ways the phenomenon is conceptualized.

RESEARCH DESIGN: We individually interviewed 30 full- and part-time instructors from two- and four-year minority-serving institutions. Participants were primarily from science disciplines with some participants from humanities and social sciences. A semi-structured format was used with questions that were designed to explore instructors' conceptions and approaches to teaching, learning, and diversity. Examples of interview questions include: "When you hear the word diversity in relation to higher education, what comes to mind?" and "Does student diversity influence your teaching?"

ANALYSES AND INTERPRETATIONS: We used a constructivist-grounded theory approach to analyze the interview responses. Codes were developed to describe what each participant appeared to be attending to when discussing their experiences. Codes were then transformed into conceptual categories by drawing relationships between the aspects and variations that were emerging from the data. We also drew parallels between what was identified in participant responses and the existing literature, which served as a guide throughout the coding process. These were refined to ultimately give rise to three conceptions of diversity: essentialist, functionalist, and existentialist. These conceptions were distinguished based on the variations within five aspects: student identities, intelligence mindset, student engagement, instructor actions, and legitimized membership. In the essentialist conception, an instructor perceives student attributes (including intelligence) as fixed, uses instructional approaches based on equality, and views students as outsiders. In the functionalist conception, an instructor focuses on student features and knowledge that assist or hinder achievement in a discipline, finds ways to accommodate student deficits, and considers students as guests that need instructor guidance. In the existentialist conception, an instructor attends to the lived experiences and existing knowledge of students, leverages these experiences and knowledge as learning opportunities in the classroom, and views students as rightfully present in higher education.

CONTRIBUTION: The outcome space generated from this study serves as an individual tool for instructors to reflect on their own beliefs and actions and consider new ideas about diversity and how it impacts the classroom. Conclusions from this study also provide an evidence base to inform professional development and bring certain features of diversity into instructors' awareness to create more inclusive learning environments.

Paper ID: 207

A Community-Building Co-Mentoring (CoCo Cafe) Model Used to Promote Diversity, Equity, Inclusion, and Retention in STEM

Beverly L Smith-Keiling (University of Minnesota)*; Katrina Paleologos (University of Minnesota); Hari Gopalakrishnan (University of Minnesota); Mahesh Mathews (University of Minnesota); Ellie Vraa (University of Minnesota; et al.

Educational retention and degree completion are both educational and public health concerns associated with greater equity and life expectancy. Part of the challenge in addressing diversity,

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equity, and inclusion in education is to reach beyond the surface of the institutional academic system. Intentional steps must be taken to recognize and counter the underlying Dominant Western/European-American Socio-Historical 'White' Construct in the "system." While building a diverse multicultural "research team" working toward research aims as an orienting task, our method evolved to an ethnographic, observational, and exploratory intervention to identify and address barriers in STEM education that developed into a community-building co-mentoring (CoCo Cafe) model to promote inclusion. With consultant support from our community partner, the Cultural Wellness Center's Backyard Community Health Hub, which serves diverse local communities, we embraced a community-building approach: (identities, diverse cultural assets, consensus-based decision making, flexible, polychronic, and collectivist agendas). Working together within a multi-tiered co-mentoring team (diverse undergraduate/graduate students, postdocs and faculty learning from one another), participants focused on individual, interpersonal, and community determinants with a long-term goal of influencing institutional policy. Inherent to our program, the curriculum included impacts of "thought" on well-being through the realization of cultural wellness, inner wisdom, and innate health within the context of a Health Realization framework. Using an intervention program evaluation format, we analyzed four cohorts (n=36) (e.g., measured exposure to curriculum, dosage of curricular topics received through participation, and post-program outcome measures). Individual reflective self-study and post-program survey responses showed invitation mattered, increased belonging, resilience, and gained understanding in addressing barriers. Cultural wellness, flexibility, and a welcoming community while gaining research experience, and personal connections were highly valued. Results included the recognition of "thought" toward increased health realization. Even minimal dosage showed gains. Future programs planned to promote more equitable retention will continue to provide an adaptable structured curriculum while still promoting flexibility.

Friday, July 16th, 2021

Session A: DEI & Identity

Paper ID: 159

Examining the Sources of Teaching Self-efficacy for Science International Teaching Assistants: A Cross-Sectional Survey Study

Zhigang Jia (Midddle Tennessee State University)*; Grant E Gardner (Middle Tennessee State University)

Problem: The significant cultural differences between international teaching assistants (ITAs) and their students have created a profound intercultural communication problem, commonly referred to as the "ITA problem" in the literature. American undergraduate students often have prevalent negative perceptions of ITAs; ITAs experience multiple challenges in teaching, and they need training in language, culture, and pedagogy. Teaching self-efficacy can influence instructors' motivation, performance, and student outcomes. Therefore, gathering information on

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ITAs' self-efficacy and the factors that could impact their self-efficacy can inform teaching professional development (TPD) to better support ITAs in overcoming their challenges in teaching. This survey study adopted an analytical framework that examines STEM GTAs' source of teaching self-efficacy, including factors such as quality and hours of professional development, department teaching climate, and prior teaching experiences. The research questions are: 1) What is the level of teaching self-efficacy for this sample of science ITAs? 2) How do perceived English proficiency, department teaching environment, TPD hours, and quality of TPD associate with science ITAs' teaching self-efficacy?

Research design: The participants are international graduate students who teach science in the U.S. A total of n = 73 ITAs agreed to participate: 55.1% female, 42% male, 2.9% other/did not respond; 78.3 % Asian, 10.1% Africa, and 11.6% from other continents. The survey includes items that measure ITAs' teaching self-efficacy, department teaching environment, perceived English fluency, prior education and teaching experiences, and demographic information. The survey was disseminated to multiple U.S. universities using Qualtrics to collect responses through DBER conference listservs, ITA programs, science departments, and personal connections.

Analysis and Interpretation: Descriptive statistical analysis of the survey items that measure teaching self-efficacy revealed the level of science ITAs' teaching self-efficacy. Matrix correlation statistical analysis was run in R studio to determine the variables significantly correlated with science ITAs' teaching self-efficacy. The study results show that science ITAs have the same level of teaching self-efficacy ($M=4.15$, $SD=0.60$) as STEM GTAs in general. ITAs are perceived to be better supported with higher hours ($M= 40.9$; $Median=13.8$) and quality ($M=3.37$; $SD=1.00$) of PD and a more supportive department teaching climate. Moreover, perceived English proficiency, adaptation to American culture, department teaching climate, hours, and quality of PD are all significantly associated with ITAs' teaching self-efficacy. The quality of PD ($r(71) = .54$, $p < .01$), facilitating environment ($r(71) = .44$, $p < .01$), and peer teaching relationship ($r(71) = .45$, $p < .01$) have stronger correlations with ITA teaching self-efficacy than other variables. The results imply that the more relevant factors to ITAs' teaching practice, such as quality and hours of professional development, have stronger correlations with ITAs' teaching self-efficacy than for U.S. GTAs. Factors related to ITAs' support networks, such as peer and supervisor relationships, are also strongly correlated with teaching self-efficacy. The data also reveals strong correlations between hours and quality of PD and department teaching climate. Our interpretation is that the quality and availability of PD for ITAs within the department is essential to creating a supportive teaching climate. ITA PD within the department is a critical venue for ITAs to establish support networks for teaching.

Contribution: ITAs are an underrepresented group largely neglected in biology education literature. This study will raise more awareness in the SABER community of the factors that influence ITAs' teaching self-efficacy and provide implications to better support them in TPD and informal settings.

Paper ID: 116

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Understanding the Unique Experiences of South Asian International Students as They Transition into a PhD in the US: An Interpretative Phenomenological Analysis

Muhammad Zaka Asif (University of Georgia)*; Erin Dolan (University of Georgia); Chaitya Jain (University of Georgia)

Research Question: The purpose of this study is to understand the unique experiences of South Asian International (SAI) students as they transition into doctoral programs in the life sciences. International students comprise over 50% of the graduate student population in the life sciences in the US, over 70% of whom are Asian. Despite their large numbers, their experiences are a relatively understudied. The little research that has been done often treats Asian students as a monolith, discounting significant cultural and historical differences between regions in Asia that may affect students' motivations for pursuing graduate degrees, their experiences in graduate school, and their identities as scientists in training.

Research Design: To begin to understand the experiences of SAI students as they transition to PhD programs, we conducted an exploratory study in which we interviewed 10 SAI students and 12 US native students during the first six months of their doctoral programs. We used a semi-structured approach to inquire about their motivations for pursuing PhDs and experiences transitioning into doctoral programs. We performed content analysis of the interview data using open and axial coding with the aim of identifying factors that shaped students' doctoral transitions. We then selected factors that were distinctive to SAI students, rather than apparent for both SAI and native students. Finally, we interpreted SAI students' experiences related to the factors using interpretative phenomenological analysis (IPA), which is a qualitative research approach useful for making meaning of an individual's experiences from the perspective of the individual experiencing the events. Through IPA, we attempted to make sense of how individual SAI students made sense of their experiences.

Analyses and Interpretation: SAI students in our study described seven factors that they perceived as influencing their doctoral transitions: (1) Prior experience with US education system, including navigating credits system and being familiar with mentor-mentee interactions and US university culture; (2) Prior experience doing research, including having developed the technical and "soft skills" necessary to be successful in research; (3) Challenges with acculturation, including managing culture shock and navigating logistical issues of being in an unfamiliar place (e.g., figuring out transportation); (4) Utility of master's experiences, which helped students become familiar with graduate research and make decisions regarding their doctoral plans; (5) Attitudes towards and understanding of mental health issues, including how SAI students verbalize mental health problems and barriers to getting mental health support; (6) Financial affordances and constraints of pursuing a PhD, including the financial benefits of earning a PhD and the challenges of not having financial support from family, and (7) Barriers to communication, which ranged from issues with accents to difficulties communicating with students and scientists from around the world.

Contribution: This study yields insights into experiences of SAI graduate students, especially the

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specific issues faced by this group. The results of this work have the potential to be useful to graduate programs seeking to ease SAI students' transition to doctoral programs.

Paper ID: 131

Experiences of supports, barriers, and belonging in Community College Faculty participating in Biology Education Research

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RESEARCH QUESTION
Despite the fact that Community Colleges (CCs) welcome the majority of underserved students into Undergraduate Biology, previous research has found only ~3% of Biology Education Research (BER) articles focus on CC communities. In an effort to encourage more CC BER representation, an NSF-funded network called CC Bio INSITES (Community College Biology Instructor Network to Support Inquiry into Teaching and Education Scholarship) was developed. This network aims to provide support for CC instructors to engage with BER and to connect participants with the BER community, increasing their sense of belonging. Specifically, the network uses a model of support articulated by CC faculty for CC faculty that includes social, intellectual, and resource supports. Our aim was to investigate the efficacy of this network. We asked: 1) What barriers have CC faculty experienced in participating in BER? 2) In what ways has CC Bio INSITES reduced barriers and provided support for network members to engage in BER? To our knowledge, this is the first study that specifically investigates how the three supports described above facilitate CC instructors' engagement in BER.

RESEARCH DESIGN
We conducted 14 interviews and 3 focus groups (FGs) with 17 CC Bio INSITES participants. We used a phenomenological approach in which we aimed to better understand the lived experiences of participants within the CC Bio INSITES network. Network participants represented 15 different community colleges and have been part of CC Bio INSITES for ~3 years.

ANALYSIS AND INTERPRETATION
We used open coding followed by qualitative thematic analysis to analyze our data. Past barriers identified by participants included: lack of time to pursue the research, lack of knowledge to conduct BER, lack of incentives or funds, and lack of structures in place to conduct BER. Participants indicated how the INSITES network has helped them to overcome the two major barriers related to knowledge of how to conduct BER and access to structures to conduct BER through receiving intellectual and resource support. Specifically, INSITES provided these supports by connecting CC researchers to collaborators and experts in statistical analysis, helping them to write an IRB, and providing access to journals. These supports gave CC faculty confidence in their ability to participate in BER, which is often not what they were trained in. Time continued to

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remain a significant barrier to conducting CC BER for many participants.

Interview participants remarked on how supports built on one another, with social support allowing more comfortability in asking for intellectual or resource support from other network members. Social support especially contributed to a sense of belonging within the INSITES community but did not always extend to a sense of belonging within the broader BER community. Overall, the INSITES network appears to increase representation of CC faculty among BER researchers, but work remains to fully include CC faculty in the broader BER community.

CONTRIBUTION
With CC students representing several underserved groups in the classroom, reducing the barriers and providing effective support for CC faculty to participate in BER is critical to accurately represent all biology classrooms in our education research. By fostering a greater sense of belonging for CC Faculty through the support from the network, we can encourage greater participation and research in Biology Education.

Paper ID: 168

How does student ethnicity influence student science identity in undergraduate biology classes?

Rebeka AF Greenall (Brigham Young University)*; Jose Gasper de Alba (Brigham Young University); Elizabeth G Bailey (Brigham Young University)

RESEARCH QUESTION:
The underrepresentation in STEM of certain ethnic groups persists due to a culture of exclusion that is inherent to Western science. Social Influence Theory suggests that students' retention in science is influenced by three major things: 1) science identity, 2) self-efficacy, and 3) alignment with science values. When viewed from this framework, the pattern of persons excluded because of ethnicity or race (PEERs) dropping out of STEM at significantly greater rates than non-PEERs indicates that these students do not integrate into the scientific community at the same rate as nonminority students.
We evaluated the intersection between students' ethnic identities and their science identity, self-efficacy, and alignment with science values. We also looked at intersections with belonging and attitudes toward the environment. As Native Hawaiians and Pacific Islanders (NHPI) are among the most underrepresented groups in STEM, our study paid particular attention to how these students felt their cultural and ethnic identities aligned with their science identities.

RESEARCH DESIGN:
Two surveys were distributed in 23 biology classes at five different institutions in three states, with 730 respondents. These surveys contained validated instruments that assess ethnic identity, science identity, self-efficacy, alignment with science values, belongingness, and attitudes toward the environment. Students were asked to score how much their ethnic identity conflicted with their science identity, then to explain their answer. The first survey was given at

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the beginning of the semester, and the second was given at the end of the semester. This allowed us to see how going through a biology course influenced students' responses.

ANALYSES AND INTERPRETATIONS:
First, we compared survey responses quantitatively by ethnicity. White students had lower NEP scores than non-White students, and non-Whites had a higher intent to pursue science than white students. Additionally, White students had greater self-efficacy than non-White students before the course and may have made higher gains throughout the semester than non-white students. NHPI students saw their ethnicity as more strengthening to their science identity than non-NHPI students both before and after the course.
Next, we analyzed open response items qualitatively using inductive thematic analysis. Since about one third of NHPI students reported that their ethnicity strengthened their science identity and very few reported conflict, we were interested in understanding how students viewed this intersection. Many cited they felt their traditional knowledge was a different form of modern science and that they felt their closeness to nature supported their science identity.

CONTRIBUTION:
If we want to address the exclusion of certain groups in STEM, we need to collect data that tells us where this exclusion originates. If we can understand where students feel their identities conflict with their science identity, we can develop interventions to mitigate this conflict where possible. Understanding if ethnic or other identities conflict with science is an important step in creating a more diverse and inclusive field. Additionally, this data will help us understand what other ways of knowing are inherent to students that are perhaps being left unacknowledged in their science classes.

Paper ID: 198

Ph.Depression: Examining how graduate research and teaching affect depression in life sciences Ph.D. students

Logan Gin (Arizona State University); Nicholas Wiesenthal (University of Central Florida); Isabella Ferreira (University of Central Florida); Katelyn M Cooper (Arizona State University)*

RESEARCH QUESTION:
In 2018, researchers declared a "graduate student mental health crisis" when graduate students were found to be more than six times as likely to experience depression compared to the general population. National calls to improve graduate student mental health followed. However, few studies have examined how graduate school specifically affects student depression. In this exploratory qualitative interview study, we set out to answer two research questions: (1) How do aspects of graduate research and teaching affect depression in Ph.D. students? and (2) How does depression affect Ph.D. students' experiences teaching and researching? We drew from the three most prominent models of depression to interpret our findings: cognitive, behavioral, and psychodynamic.

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RESEARCH DESIGN:
Owing to the exploratory nature of our research questions, we designed a qualitative interview study. We interviewed 50 graduate students enrolled in life sciences Ph.D. programs from 28 U.S. institutions. We chose to constrain our study to the life sciences to limit the variability that might emerge among Ph.D. student experiences in different science disciplines. We developed an interview script to answer our research questions and conducted think-aloud interviews with four graduate students with depression to establish cognitive validity. All questions were open-ended, allowing graduate students to describe how depression affected their research and teaching and how research and teaching affected their depression.

ANALYSES AND INTERPRETATIONS:
Three researchers used inductive coding to create a codebook describing aspects of research and teaching that positively or negatively affected student depression and ways that depression affected their research and teaching. Two authors used the codebook to code 10% of all interviews and their Cohen's k interrater score was at an acceptable level; one researcher coded the remaining interviews. The most commonly mentioned aspects of research that negatively affected student depression included failures, obstacles, or setbacks during research (48% of students) and unstructured research experiences (38% of students). The most commonly mentioned aspects of research that positively affected students' depression were completing small or concrete research tasks (26% of students) and working with others (22% of students). With regard to teaching, aspects that negatively affected students' depression included time taken from research (47% of students) and negative reinforcement from undergraduates (28% of students), whereas teaching positively affected students' depression when they received positive reinforcement from undergraduates (58% of students) and because it was a structured task (33% of students). Students reported that depression had an exclusively negative effect on their research, hindering their motivation (64% of students) and self-confidence (58% of students), but helped them be more compassionate teachers (20% of students). We used cognitive, behavioral, and psychodynamic models of depression to further examine why each of these aspects contributes positively or negatively to depression.

CONTRIBUTION:
This is the first study to identify aspects of both research and teaching that affect depression in graduate students. This work pinpoints specific aspects of graduate school that Ph.D. programs can target to improve mental health among life sciences graduate students.

Session B: Remote Assessment & Student Beliefs

Paper ID: 194

R-COPUS: Transitioning to Remote COPUS

Tea Pusey (University of California, Merced)*; Andrea Presas (University of California, Merced); Petra Kranzfelder ("University of California, Merced"); Adriana Signorini (University of California Merced)

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Recently, Denaro et al. (2021) noted a national focus on implementing evidence-based teaching practices to improve the quality of science, technology, engineering, and mathematics (STEM) education. The Classroom Observation Protocol for Undergraduate STEM (COPUS) provides descriptive feedback to instructors by capturing student and instructor behaviors during in-person instruction. At the University of California, Merced (UC Merced), the undergraduate interns from the Students Assessing Teaching and Learning (SATAL) program partner with faculty to provide support in formative assessment, such as collecting COPUS data. SATAL undergraduates work with faculty who are focused on pedagogical and curricular exploration with the desire to have their students' experiences and perspectives inform classroom practices to create more inclusive classrooms (Signorini & Pohan 2019).

As the global pandemic forced instructors to transition to remote teaching and learning, UC Merced's SATAL program promptly identified the need to adjust their COPUS training and code descriptions to better document student and instructor behaviors in the remote learning environment. Therefore, this study focuses on the development and validation of a classroom observation protocol, remote COPUS (R-COPUS), to measure remote instructor and student behaviors in college STEM classrooms.

The SATAL program created R-COPUS to ensure consistency and consensus between online observations. To develop R-COPUS, SATAL interns collected COPUS data from 40 STEM courses during the transition and continuation of emergency remote learning. Following each observation, interns met for up to thirty minutes to discuss their observation notes and codes in detail. Additionally, the entire SATAL team also discussed code development in weekly group meetings to reach a consensus on remote teaching and learning behaviors. To collect expert feedback on R-COPUS, we consulted a group of STEM educators and discipline-based education researchers at a research-intensive university unrelated to the institution in this study (n = 11).

There were changes to the code descriptions of 6 instructor behaviors and 6 student behaviors. The most significant change to instructor code descriptions was to moving and guiding. Instead of physically moving around the classroom and guiding students, instructors virtually moved throughout breakout rooms and guided students in active learning activities. Instructors also engaged in moving and guiding behaviors by using the messaging function or verbally guiding students while they were working on an activity. The most significant change to student code descriptions was to answering questions. The addition of messaging function in the remote environment allowed students to answer their instructors' questions in multiple ways as well as their peers.

R-COPUS will allow for other individuals or programs to implement COPUS in the remote learning environment. As the pandemic continues to bring uncertainty to the future of education, it is important to have formative assessment tools designed for online learning to support assessing and improving teaching practices in college STEM classrooms. Future studies can consider other variables that also influence the remote environment. By looking at other

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variables alongside R-COPUS, such as instructor discourse, we can gain a better understanding of how instructors engage their students in the remote environment.

Paper ID: 134

Barriers to Online Formative Assessments in Introductory Biology Courses

Allison M Upchurch (University of Nebraska-Lincoln)*; Dana Kirkwood-Watts (University of Nebraska-Lincoln); Gabrielle Johnson (Southeast Community College); Sarah Spier (Southeast Community College); Brian Couch (University of Nebraska-Lincoln

Research Question: Formative assessments (FAs) are a way for instructors to gauge student understanding and provide feedback on learning progress. Instructors often use online platforms to deliver their FAs to students outside of class. Online assessments have become even more essential in the past year, as the COVID-19 pandemic has required a shift toward online course delivery. Previous studies have shed some light on general barriers to online learning, but there has been little work on how these barriers relate to specific learning activities, like FAs, over which instructors have control. Our project is focused on investigating the barriers that students in undergraduate biology courses face while engaging with online FAs. Building on a framework for factors influencing student access, we examined the extent to which students experience difficulties when engaging with online FAs due to technology, social interactions, instructor organization, personal engagement, and learning environment.

Research Design: Our study gathered data from over 750 undergraduate biology students at both a 2-year community college and a 4-year university in the fall of 2020. Students from introductory level biology courses were invited to complete a survey regarding the various factors they face when completing online formative assessments. The survey was adapted from a 2005 study by Muilenburg to better fit our research goal and the current academic and online environments. Our survey consisted of five categories with 8-10 items per category. Students rated their level of agreement to these items on a 7-point Likert scale. We also collected demographic data from participants. The survey was tightened based on the initial data and re-administered during the spring 2021 semester to a broader range of students.

Analyses and Interpretations: We analyzed the data via confirmatory factor analysis. The 5-factor analysis of the fall data yields a CFI of 0.846 and Cronbach's Alpha scores between 0.85 and 0.93, which provided an initial indication that student responses align with the five survey categories and represent discernable factors. All items within each category had factor loadings above 0.5, also suggesting that the items are indicative of the categories. The lowest loading items were dropped, resulting in an instrument with a better fit (CFI= 0.906). This 36-question survey was used in the spring administration. Overall, we found that a small number of students have issues with entire categories, but most students have issues with more specific aspects of a category: 19% of students reported specific issues within the technology category, 28% within instructor organization, 47% within social, 43% within personal engagement, and 62% within personal engagement.

Contribution: This research provides another angle into how students engage with online FAs. Through the survey, we will identify the difficulties students experience when interacting with online FAs. Once we have this information, we can explore relationships between this data and other factors, such as demographics like gender, ethnicity, class rank, and course performance. Ultimately, our findings can be used to design and implement institutional supports, such as

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faculty workshops, that will help alleviate the barriers identified in the survey and increase student engagement.

Paper ID: 91

Untangling mindset, universality, and brilliance beliefs in science and math undergraduates

Lisa B Limeri (University of Georgia)*; Nathan Carter (University of Georgia); Franchesca Lyra (University of Texas Austin); Joel Martin (University of Georgia); Halle Mastronardo (University of Georgia); et al

Research Problem: Students' beliefs about the nature of their abilities, collectively called "lay theories," affect their motivations, behaviors, and academic success. Researchers have identified three types of lay theories. Mindset theory refers to beliefs about the extent to which intelligence is improvable or innate. Universality theory refers to beliefs about who (i.e., everyone, or only some people) has the potential for excellence. Brilliance theory refers to beliefs about whether success in a field requires innate brilliance that cannot be taught.

Recent research on each of these beliefs demonstrates that they influence students' educational experiences and academic outcomes. However, there remain open questions about whether they represent distinct latent constructs or are susceptible to the "jangle fallacy" (i.e., different names given to the same underlying construct). Progress uncovering the structure of these beliefs has been hindered by the lack of valid and reliable measures of undergraduate students' lay theory beliefs. We are developing a survey to measure these beliefs in accordance with the Standards for Educational and Psychological Testing. We present data from the factor structure of the measure to shed light the relationships between lay theories.

Research Design: We drafted and iteratively revised items related to mindset, universality, and brilliance beliefs based on feedback from undergraduates (semi-structured interviews [n=45] and cognitive interviews [n=29]) and experts (researchers actively studying lay theories [n=11]). We carried out cognitive interviews to evaluate whether students engaged in the desired thought processes when responding to items. We collected expert feedback through a sorting task to evaluate the extent to which items represented the different constructs. We then revised the item set, resulting in 50 draft items: 21 mindset, 23 universality, and 6 brilliance. We collected responses to these items from 1,192 undergraduates in introductory science and math courses from 68 different institutions.

Analyses and Interpretations: We are in the process of evaluating the underlying factor structure of the draft measure using both exploratory and confirmatory factor analyses (EFA and CFA, respectively). We are randomly dividing the data into three subsets. One the first subset, we are carrying out EFA to gain preliminary insight into the underlying structure of the measure. On the second subset, we are evaluating the fit of multiple CFA models to determine whether separate or combined factors better fit the data. We are selecting the best fitting CFA model and

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performing a final CFA on the last subset to safeguard against overfitting. The resulting factor structure will serve as validity evidence for the measure in addition to revealing the extent of conceptual overlap among Mindset, Universality, and Brilliance beliefs.

Contribution: This work will provide theoretical insight on the relationships among three lay theories gaining increasing attention in undergraduate contexts: mindset, universality, and brilliance beliefs. Additionally, the work will produce a new measure with strong evidence of validity and reliability useful for answering research questions about undergraduates' lay theories and for developing and testing interventions to improve student outcomes. This measure could also be used by instructors to learn about their students' beliefs and tailor their instruction accordingly.

Paper ID: 26

Do Students Follow Through on Their Study Plans?

Elise Walck-Shannon (Washington University in St. Louis)*; Shaina Rowell (Washington University in St. Louis); Grace Yuan (Washington University in St. Louis); Ashton Barber (Washington University in St. Louis); Regina Frey (University of Utah)

RESEARCH QUESTION:
Students often struggle to regulate their own learning during independent study sessions. Self-regulated learners are able to monitor the difference between their progress and their goals, come up with a plan to change their behaviors based on any difference that they encounter, and stay motivated to follow through on those plans. In this study, we ask whether an online intervention can help students plan and follow through on changes to their self-reported study habits and/or exam grades.

RESEARCH DESIGN:
This study followed the design of an exam wrapper, which included three assignments where students: (1) reflected on their study and health habits after exam 1, (2) created either a study or health plan two weeks before exam 2, and (3) reflected on their study and health habits after exam 2. While all students completed the same reflection assignments, half of the students were randomly assigned to the experimental group that planned their study habits, while the other half were assigned to the control group that planned their general health habits. In the both groups, we incorporated a memory technique called mental contrasting with implementation intentions. This technique prompts students to visualize the contrasting outcomes if they do or do not follow on their plan, to predict an obstacle that they may encounter, and to decide how they would overcome it. The open-ended questions of the exam planning exercise allowed us to determine whether students were incorporating effective study strategies into their plans and the corresponding reflection exercises allowed us to examine the extent to which students followed through on their plans.

ANALYSES AND INTERPRETATIONS:

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There was no significant difference in exam 2 scores (t(481)=-0.9912, p=0.322) between students who generated plans about their study strategies (M=77.2, SE=0.924) relative to those who generated plans about their general health habits (M=78.5, SE=0.937). Given this result, we asked which strategies students actually chose to incorporate in their plans. Two independent coders qualitatively categorized students' plans by which study habit(s) they wanted to change leading up to exam 2. In the experimental group (n=266), we found that the three most common study habits that students wanted to change were: (1) starting to study earlier (36.5%), (2) being less distracted during study sessions (24.1%), and (3) re-reading less (19.6%). In the control group (n=264), we found that the three most common health habits that students wanted to change were: (1) sleeping more (51.1%), (2) limiting screen use before bed (36.0%), and (3) improving sleep quality (26.1%). Next, we asked whether students actually reported any differences in the habit that they planned to change using their exam 1 and exam 2 reflections. Preliminarily, when controlling for exam 1 habits we found that students who planned to be distracted less (t=0.81, p=0.42), study earlier (t=0.90, p=0.37), or re-read less (t=0.95. p=0.34) did not actually report doing so in their exam 2 reflections. Similarly, students in the control group who planned to make changes to their sleep habits did not actually sleep more (t=1.92, p=0.06).

CONTRIBUTION:
While exam wrappers are a popular metacognitive technique utilized by college instructors, our data suggest that their efficacy in actually helping students change their behavior and performance in the classroom need to be studied more carefully.

Paper ID: 208

Value for Learning Communication Skills in Undergraduate Biology Students

Christina M Cline (Northern Illinois University)*; Alecia Santuzzi (Northern Illinois University); Karen Samonds (Northern Illinois University); Nicole LaDue (Northern Illinois University); Heather E Bergan-Roller (Northern Illinois University)

Educational Problem: Undergraduate biology students should develop proficient interpersonal skills like communication. The need for developing communication skills has been explicitly identified in national reports for undergraduate students in STEM and healthcare related programs, which includes anatomy. To help students develop effective communication skills throughout their education, instructors need to consider the value students give to learning these skills. According to expectancy-value theory (EVT), students' motivation for learning and persistence with completing a task is tied to how they value the task. Previous work looking at student value for learning communication skills focused on mainly verbal communication in a graduate and medical school context.

RESEARCH QUESTION: For this project, we developed an instrument, grounded in EVT, to investigate the following research question: how do undergraduate students value learning communication skills?

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Research Design: We developed the Student Attitudes Toward Communication Skills Survey (SATCSS) which consists of 36 items including 12 items for each mode of communication (verbal, written, and non-verbal) and 9 items for each of the task values proposed by EVT (importance, interest, relevance, and cost). Students ($n = 233$) in an A&P course at a public, R4 university completed SATCSS over two semesters (Fall 2019-Spring 2020). We analyzed SATCSS for reliability using Cronbach's alpha and validity using Principal Components Analysis. Further, we compared student responses among the task values using a general linear model with post hoc Tukey tests for multiple comparisons.

Analyses and Interpretations: We found SATCSS to show evidence of reliability when measuring total value ($\alpha = .946$) and the four task values individually ($\alpha \geq .819$). There was a significant difference among the four task values ($F(2.4,232) = 343.383$, $p < .001$, $\eta2 = .308$) such that students thought that learning communication skills was important and relevant, but were less interested in it and found it to be costly (i.e., poor use of their time). This grouping was consistent with our validity findings in that importance and relevance items loaded as one component and interest and cost items loaded as a second component. Students with high total value scores valued communication skills across all four task values. As total value scores decreased, it was first due to students finding learning communication skills to be time prohibitive and then a lack of interest in learning communication skills. Our results suggest that instructors should incorporate communication skills training in biology courses that increases interest and considers cost concerns to help students value and learn communication skills.

Contribution: SATCSS allows for a broader context for use, compared to previous instruments, and helps to inform instructors how to motivate their biology students to learn critical communication skills. Results could be used by instructors to guide their instruction more precisely in communication skills training. Modifying existing activities and assessments by including opportunities to practice communication skills (e.g., explaining the anatomy of a region to a fictitious patient) could help minimize the time constraint that students feel. Throughout a course, these activities can be adjusted to include different modes of communication and different audiences.

Session C: Instructor Practices

Paper ID: 95

Exploring the Relationship between Instructor Epistemological Beliefs and Classroom Discourse Practices in Undergraduate Biology Classrooms

Ashley Laskowski (University of Minnesota); Abdi Warfa (University of Minnesota)*

In science education, research on teacher beliefs has been linked to how teachers behave in the classroom. Broadly defined as the personal beliefs one holds about a person, a group of people, a behavior or event, beliefs guide one's instructional decisions, classroom management

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and can provide insights about overall classroom practices. In this exploratory qualitative study, we investigated the relationship between instructor beliefs and classroom discourse practices. Using a modified version of Roehrig and Luft's (2007) Teacher Beliefs Index (TBI), we conducted semi-structured interviews with 14 faculty teaching large introductory biology courses across two US research-intensive institutions. Qualitative analysis of the interview data revealed three types of instructors: 1) those who focused on information sharing and structure, passive instructional strategies (e.g., lecturing), maintaining student focus, and providing teacher-centric experiences; 2) those who focused on student/teacher relationships or student understanding; and 3) those who focused on mediating student knowledge or interactions, generation of reasoning, student collaboration, feedback and knowledge development. Building on recent findings by Andrews et al (2019) on teacher knowledge development, we called the first type "instructive teachers," the second type "translational instructors" and the final type "generative instructors." These categories allowed to examine how classroom discourse practices, as measured by the Classroom Discourse Observation Protocol (CDOP), were influenced by instructors' beliefs about teaching and learning. For example, we find that generative instructors were most likely to enact dialogic-interactive discourse, as measured by CDOP, whereas instructive teachers mostly employed authoritative, non-interactive discourse practices. In our presentation, we will describe the implication of our findings for faculty professional development, the enactment of active learning in undergraduate science classrooms, and the importance of measuring classroom talk as a lens to understand student-teacher interactions in engaged STEM learning environments.

Paper ID: 141

Investigating Undergraduate Student Memories and Perceptions of Instructor Talk in Biology Classrooms

Dax Ovid (San Francisco State University)*; Mallory Marie Rice (San Francisco State University); Karen Tabayoyong (San Francisco State University); Joshua C. Vargas Luna (San Francisco State University); Parinaz Lajevardi (VA Palo Alto Health Care System); et al.

RESEARCH QUESTIONS: How do students remember and perceive instructor language? Instructor Talk is the non-content language used by instructors in classrooms. The systematic analysis of previously recorded Instructor Talk instances, present in every course analyzed to date, produced two frameworks: Positively-phrased and Negatively-phrased. Theoretical frameworks and previous research related to instructor immediacy, stereotype threat, and student resistance all suggest that instructors' non-content language is a key and understudied variable in undergraduate science courses. However, to date, there has been little interrogation of student perceptions of instructors' non-content language. To explore this, we investigated 1) To what extent do students remember non-content instructor language? 2) Which categories of Instructor Talk are most prevalent when coding student memories? 3) To what extent do students align with researchers in their perceptions of Instructor Talk as promoting a positive or negative learning environment?

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RESEARCH DESIGN: To determine if biology majors remember and how they perceive Instructor Talk, we invited 90 upper-division students to participate in a multi-part assessment. Students were asked to provide memories of instructor language perceived as promoting either a positive or a negative learning environment, which we coded using the Instructor Talk frameworks. Further, we presented students with a stimulus set of 20 Instructor Talk quotes randomly selected from a prior study, 10 of which were categorized by researchers as Positively-phrased and the other 10 as Negatively-phrased Instructor Talk. Students were asked to evaluate the 20 quotes as promoting a positive or negative learning environment.

ANALYSES AND INTERPRETATIONS: The majority of students remembered non-content instructor language that we could categorize using the Instructor Talk frameworks. Interestingly, the majority of student memories of Instructor Talk perceived as promoting a positive learning environment were coded in the Positively-phrased category “Building the Instructor Student Relationship.” Most student memories of Instructor Talk perceived as promoting a negative learning environment were categorized in the parallel Negatively-phrased category, “Dismantling the Instructor-Student Relationship.” When asked to evaluate 20 Instructor Talk quotes, students overall aligned with how researchers previously categorized Instructor Talk by assigning Positively-phrased quotes as promoting a positive learning environment and Negatively-phrased quotes as promoting a negative learning environment (Wilcoxon; $p < 0.0001$).

CONTRIBUTION: Indeed, students do remember details about what instructors are saying in class that have nothing to do with content. Further, these findings address skepticism about whether students would agree with researchers assertions about Positively-phrased versus Negatively-phrased Instructor Talk. Importantly, student memories of Instructor Talk – both positive and negative – were centered on the instructor-student relationship, suggesting future consideration of instructor immediacy when interpreting evidence about classroom learning environments. These findings about students' perceptions of Instructor Talk may be key in understanding instructors' variable success with active learning pedagogies, as well as point towards underappreciated mechanisms of promoting students’ sense of belonging and inclusion in science.

Paper ID: 142

First Day & First Impressions: What do students take with them besides the syllabus?

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Research Question or Problem. The first day of class is a salient experience for students in helping them learn about the classroom environment and influencing their expectations and attitudes towards their STEM course. Instructors typically set their expectations for the classroom environment on the first day of class using non-content related messages. However, how influential the instructor messages are on student attitudes is not fully understood. To

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explore the impact of instructor non-content messaging on students, we asked the following research question: What features of the first day are the most salient for students' attitudes towards the course?
Because students are learning about the classroom through interactions with their instructors and peers; we explored the experience of students using the lens of Social Cognitive Theory.

Research Design. We surveyed students in eleven introductory STEM courses at two Ph.D.-granting institutions during the first week of class in Spring 2020, before pandemic closures. In the survey students were asked, "What things did your instructor do on the first day that influenced your attitude towards this course?" We received 870 student responses, which we analyzed using an open inductive coding approach. We developed a codebook using language derived from the participants which identified student attitudes and the factors that influenced them. After several rounds of iterative coding, we reached a Cohen kappa of 0.848 and 99.75 percent agreement while following guidelines to maintain the trustworthiness of our qualitative data.

Analyses and Interpretations. The qualitative analysis revealed that students typically expressed positive sentiments about their courses following the first day (70% of attitudinal statements). In regards to what factors influenced student attitudes, we identified two broad thematic groups: that of Instructor Qualities (79% of student responses) and that of Course Attributes (62% of student responses). The Instructor Qualities thematic group captured student responses where the instructor was the main subject of their response and consisted of sub-themes around an instructor's traits (e.g. comments about the instructor being approachable, 29%) or their beliefs (e.g. that the instructor believed all student could do well in the course, 23%). The Course Attributes thematic group captured student responses where the focus was on features of the course, such as the overview and expectations for the course (e.g. going over the grading scale or syllabus, 21%) or the applicability of the course to the real world (e.g. use of statistics in the field of law, 8%). Preliminary analyses indicate: 1) students, regardless of gender, tend to comment more on female instructor traits when compared to male instructors, and 2) female students tend to comment more on instructor traits, regardless of instructor gender, as compared with male students.

Contribution. This study adds to an understanding of how non-content instructor messages on the first day of class influence student attitudes Our results suggest that even on the first day of class, instructors can directly influence students' perceptions and attitudes within a course. These findings have implications for helping instructors create strategies to develop an effective and welcoming environment on the first day of STEM classes.

Paper ID: 36

What do faculty want non-majors to know? Characterizing content, skills, and stated learning expectations from non-major biology course syllabi

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Research Question or Problem:
The goal of science education is to develop a scientifically literate citizenry. This is especially important, as 8 out of every 10 college students are not STEM majors. Yet science education research and policy primarily focus on STEM majors. As a result, faculty of these non-science major courses may not rely on Vision and Change - a document that identifies concepts and competencies for science majors. We explored the content and skills faculty prioritize and their stated expectations for student learning in non-major biology courses. Specifically, we asked two questions: RQ1. What are the course-level learning objectives students will achieve after completing the non-major science course? and RQ2. What content and skills do non-major biology faculty prioritize in their courses?

Research Design:
We characterized the content and skills faculty prioritize and their stated expectations for student learning by analyzing syllabi and course schedules (n=28), as well as demographic data from a survey distributed by Howard Hughes Medical Institute (HHMI) BioInteractive. Of the submitted syllabi, 94% (n=26) were from courses taught in 2019 or 2020. Our sample included faculty from a range of institution types, including: two-year, 35% (n=11), four-year, 32% (n=10), MS granting, 11% (n=4) and PhD granting, 21% (n=6). To address RQ1, course-level learning objectives (CLOs) were extracted from syllabi and coded for Bloom's cognitive level and Vision & Change core competencies. To address RQ2, we coded course schedules for core concepts in biology (i.e. Cells, Molecules of Life, Ecology, Evolution, Genetics) that were identified via a review of commonly used textbooks and Vision & Change Core Competencies as articulated in BioSkills. 12.5% of content areas observed fell outside of the core concepts of biology present in 34% of courses. For these instances, we adapted our coding plan to include these content areas (i.e. Socioscientific Issues, Health & Nutrition, Biotechnology). We estimated the percentage of time a course spent on a particular content area from their course schedule.

Analyses and Interpretations:
Findings from the analysis of CLOs (n=176) reveal that non-science major faculty most often (52%) focus on low-level thinking skills (i.e. Remember and Understand) upon completion of the course. Additionally, only 39% (n=69) of CLOs included a science process skill, which students could use in everyday life to make science-informed decisions. Findings from the analysis of content reveal that faculty tend to prioritize the core concepts of biology, where collectively, these units accounted for 85% of the instructional days. This suggests that most non-major biology courses are primarily content-based instead of issues-based courses. For example, a non-majors biology course centered around human disease is considered an issues-based course.

Contribution:
Our results indicate faculty continue to focus on low level cognitive skills and science content in non-major biology courses. We argue that instructors of non-science major courses should

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incorporate science competency skills and create opportunities for students to engage with science they will encounter as a citizen.

Paper ID: 79

Undergraduate genetics assessments: What are we assessing and how?

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Research question/problem: The field of genetics has experienced rapid growth over the last two decades. New technologies have aided in research that has expanded our knowledge about the complex nature of genetics – with genes and environments both playing important roles. As our knowledge of genetics continues to expand, so do our students', with increased access to genetic information, data, and resources leading to increased student interest in complex genetics concepts. With this study, we aim to determine if current undergraduate genetics assessments match these changes in the field of genetics and students' interests. Specifically, we address the following questions: (1) In the validated assessments developed to investigate students' learning in genetics, what proportion of questions address the effect of the following on inherited phenotypes: single gene, multiple genes, genes and the environment (G+E), gene-by-environment interactions (GxE)? (2) Are there particular categories that are underrepresented in these assessments? (3) How can these categories be better represented?

Research design: To investigate our research questions, we employed qualitative content analyses to categorize assessment questions published in genetics concepts assessments and CourseSource genetics lessons. We explored whether these questions probe multifactorial genetics concepts (categories include single gene, multiple genes, G+E, GxE, and other) and how they assess student knowledge (categories include question type, presence/absence of data in the question, and type of organism being asked about).

Analyses and interpretations: Our analyses reveal that the majority of genetics questions about the inheritance of at least one allele do not ask students about the role of the environment on phenotypic outcomes. Notably, 45.6% of the genetics concept assessment questions ask about single genes and 26.3% ask about multiple genes. Of the remaining questions, the focus is on G+E, there were no questions on GxE. Similarly, for CourseSource lessons 45.6% of the questions that ask about the inheritance of at least one allele address single gene concepts and 26.3% about multiple genes. Only 28% of questions address G+E, while none address GxE. We are currently looking at the intersection of these outcomes and question features such as the inclusion of data in the question and organism type.

Contribution: Results from this study suggest that available undergraduate genetics curricula focus on the effect of genes only. Therefore, while our knowledge of genetics has greatly expanded and our students' interests have evolved, our genetics curricula continue to focus on simple models surrounding genes, rather than including more multifactorial concepts and

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meeting our students where their interests lie. We suggest the introduction of more multifactorial genetics concepts into the undergraduate genetics curriculum, including the development of assessment questions that incorporate the effect of the environment. Ultimately, incorporating multifactorial concepts into undergraduate genetics curriculum is especially important as it will help students develop a more accurate understanding of genetics and, in turn, reduce deterministic thinking.

Session D: Active Learning

Paper ID: 43

Taking Active Learning to the Next Level: Student-Thinking-Centered Instruction

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RESEARCH QUESTION: There have been calls to improve college teaching in STEM courses to increase learning and retention. At the K-12 level, there is evidence that student-thinking-centered instruction can lead to increased conceptual understanding and success for students. Both teacher noticing and responsiveness are theoretical lenses focused on the productive knowledge students bring to class and how teachers attend to and support student thinking. Some active-learning instruction may center student thinking, but little is known about how instructors leverage student thinking in their instruction at the college level.

Guided by theory and research from K-12 education, we investigated this research question: In what ways do college STEM faculty who use active learning leverage student thinking in their teaching?

RESEARCH DESIGN: We collected data from college instructors who taught courses of various sizes in biology, physics, chemistry, and math, and regularly used active learning. To investigate how they leveraged student thinking, we interviewed participants before a lesson, filmed the lesson, and conducted a stimulated recall interview using video clips from the filmed lesson. The selected clips highlighted moments when the instructor had access to student thinking and the interviews asked participants about how student thinking informed their planning and real-time decision-making.

ANALYSES AND INTERPRETATIONS: We used thematic analysis of interviews to characterize instructor thinking and behaviors related to student thinking. We systematically analyzed filmed lessons to document instructor access to student thinking. From both of these analyses, we identified a group of active-learning instructors who exhibited high levels of leveraging student thinking (high-leveragers), and active-learning instructors who exhibited low levels of leveraging student thinking (low-leveragers).

High-leveragers behave as if student thinking is central to their instruction. We see this in how they access student thinking, work to interpret it, and respond in-the-moment and after class. They also draw on much more extensive knowledge of student thinking (i.e., pedagogical content knowledge). High-leveragers spent about twice as much class time getting access to detailed information about student thinking compared to low-leveragers. High-leveragers then altered instructional plans from lesson to lesson based on what they learned about student thinking, often designing or selecting problems for the next class period that targeted specific content that was proving difficult for students. High-leveragers used knowledge of student thinking to anticipate student difficulties, quickly diagnose and interpret student thinking, and identify how and when to respond. In contrast, low-leveragers often accessed lower-resolution information about student thinking, never discussed adjusting the content or problems for the following class period, and rarely worked to interpret student thinking during class.

CONTRIBUTION: This research provides a deep look at how faculty teaching both large and small STEM courses can leverage student thinking, and highlights the fact that not all active learning is centered around student thinking. These results can prompt self-reflection for new and experienced instructors and generate hypotheses about instructional behavior and teacher knowledge that warrant further exploration.

Paper ID: 215

Systematically Evaluating Evidence-based Teaching Practices in Undergraduate Anatomy and Physiology Education

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RESEARCH QUESTION: Undergraduate Anatomy and Physiology (A&P) courses are historically challenging courses that tend to have high drop-fail-withdraw rates and difficult course-level content. Evidence-based teaching offers a framework with which to iteratively investigate and improve teaching practices to support student learning outcomes. As A&P courses are ubiquitous prerequisites for nursing and allied health programs, identifying and evaluating peer-reviewed, published evidence in this specific context is warranted. We sought to answer the following research questions, using systematic literature review methodologies: (1) What pedagogical and curricular components of learning environments have been investigated in the context of undergraduate A&P courses? and (2) What evidence exists in the research literature informing best pedagogical and curricular practices for undergraduate A&P courses?

RESEARCH DESIGN: Systematic literature reviews are often used in medical literature to synthesize and evaluate evidence from available research meeting specific eligibility criteria. Unlike narrative literature reviews, systematic literature reviews use rigorous methodologies aimed at mitigating sources of researcher bias, and instead evaluate the full corpus of related literature. We engaged in a systematic review to evaluate all peer-reviewed and indexed research investigating undergraduate A&P pedagogy or curricula published through December 2018. We composed a protocol based on Cochrane systematic literature review principles that

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identified a priori database search procedures, eligibility screening procedures, and quality appraisal methods. After an initial search using the pre-determined search terms in eight databases, hits were pared down by removing duplicates, title and abstract screening, and a final full-text screening phase to determine which of the initial 8,601 resources from the search results met our inclusion criteria.

ANALYSES: We scored the papers that met our inclusion criteria for markers of generalizability, such as using predictive statistics in the findings, collecting data from multiple student cohorts, and/or having multiple institutions represented. We organized the included articles thematically. We have found that research conducted in undergraduate A&P tends to focus on student satisfaction or affect, and not on learning outcomes. While publishing learning activities for A&P classes is common, there is a lack of data about the efficacy of such activities outside of instructor anecdotes. However, collecting student data around such activities could serve as a starting point of investigation to develop future evidence-based teaching practices.

CONTRIBUTION: This project systematically identifies potential educational tools that could address the pedagogical challenges identified in A&P contexts and evaluates available research informing teaching practices in A&P courses. In addition to offering a research perspective on generalizability criteria for research underlying evidence-based teaching in biology education broadly, this project will also be of interest to educators looking for resources to support students and improve outcomes in A&P courses.

Paper ID: 127

Influence of social supports from learning assistants and faculty on student engagement in active learning in-person STEM classes

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Research Question or Problem: Using active learning in large classes is challenging, but enlisting the help of Learning Assistants (LAs) to facilitate student discussions and activities offers a potential solution. LAs stimulate student engagement and improve performance, but the mechanism by which LAs do this is unclear. Social supports offers a promising framework to help elucidate the type of assistance LAs provide to students .LAs may provide social supports to their students by: giving feedback [Appraisal]; caring for them [Emotional]; establishing class norms and values [Informational]; and clarifying concepts [Instrumental]. The provisioning of these four supports is critical for motivating and reinforcing students to actively engage in class activities. In this study, we compare the social supports provided by LAs to instructors and identify the extent to which these supports drive student engagement during active learning.

Research Design: To identify the provisioning of social supports from LAs and instructors, the Perception of Social Supports for Active Learning Instrument (PSSALI) was deployed in the last quarter of the semester of 4 in-person introductory chemistry classrooms (n = 827). Students'

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self-reported engagement was measured using three constructs from the Formative Assessment and Buy-In Utilization Survey (FABUS) (Brazeal & Couch ,2016), including: value of class activities [Buy-In]; desire to learn for a good grade [Surface Engagement]; and desire to learn for conceptual understanding [Deep Engagement].Using structural equation modeling we explored which of the social supports and from which source (LA or instructor) influenced deep engagement in active learning directly and indirectly through buy-in. We also used a similar model to explore surface engagement.

Analyses and Interpretations: We employed confirmatory factor analysis to validate our existing survey structure and structural equation modeling to assess the relative contribution of instructor- and LA-provided supports on student buy-in and engagement. Initial validation analyses confirmed a three-factor solution for the PSSALI, where students perceived strong social supports from their LAs ($\chi 2 = 35.8$; CFI = 0.98, RMSEA = 0.05, SRMR = 0.032). CFA evidence suggests an identical structure ($\chi 2 = 272$, CFI = 0.97, RMSEA = 0.046, SRMR = 0.03), holds for instructor-provided social supports. Our proposed SEM model ($\chi 2 = 2435$, CFI = 0.92, RMSEA = 0.059, SRMR = 0.04), suggests instructor-provided Informational Support ($\beta = .39$, $p < .01$) directly increased students' deep engagement. In addition, LA-provided appraisal support ($\beta = .33$, $p = .049$) and instructor-provided informational support ($\beta = .37$, $p < 0.01$) both influenced buy-in which in turn increased deep engagement. Our model explained 42% of the variation in deep engagement overall. We found no evidence that LA- or Instructor-provided social supports impacted surface engagement, either directly or indirectly. These findings suggest that the provisioning of certain supports will encourage students to buy-in to active learning, and consequently engage in more deep engagement and less surface engagement.

Contribution: This work helps us understand how LAs' influence student achievement in STEM classrooms. By providing appraisal support during active learning LAs help students engage more deeply in the activities. These findings can be used to refine training for LAs and other peer-mentors in the classroom.

Paper ID: 151

Search strategies: Answering biology questions using the internet

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Research Problem: Internet use has increased in academia over the last 30 years since its introduction to the public and more so since the start of the pandemic. Based on a previous survey and interviews performed by our lab, we know that students use the internet to help them answer out-of-class formative assessments (FA), especially if the answer to the question is not readily found in the textbook. However, little research on how students utilize the internet as a resource has been done, particularly in a biology formative assessment setting. As such, this research sought to understand how students use the internet to answer biology FAs. Using a

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search strategies framework, we analyzed each search the student performed and characterized the steps students took to answer these assessments using the internet.

Research Design: The study gathered data from multiple sources for a mixed-methods design. We used Zoom recordings of searches performed, a think-aloud protocol as they performed their searches, and demographic information. The Zoom session using the think-aloud protocol allowed for a semi-structured interview to tease out the thought processes students use when looking up information. Using these forms of data and the Information Searching Strategies for Problem Solving framework, we determined the types of searches the students did, analyzed how many searches, what kind of searches they performed, and how the searches helped the student answer the question. We sought to determine if these steps changed based on the type of question the student tried to answer (e.g., questions in which a search readily produces the answer vs. questions that require assembling concepts to produce an answer).

Analysis and Interpretations: Thirty interviews were conducted by two researchers over Zoom. The recordings of the interviews and the searches were coded and categorized using the Search Strategies for Problem Solving frameworks (behavioral, procedural, or metacognitive). Among the patterns we found were that the students exhibited high self-efficacy in performing online searches but had different strategies for both how the search was formulated and in how they evaluated the search results page. To determine if there were patterns across the searches the students performed and if these patterns related to the answer the students submitted, we analyzed the search query data for the number of searches per question, the type of websites visited, and the time spent per question. This information allowed us to develop a model to connect the type of question presented, the search strategy used, and the answer the student developed.

Contributions: This research shows that though students have individual strategies to search for biology answers using the internet, many aspects of the searches are similar in nature. This research established precedent for the potential benefit of learning how to effectively navigate the internet. Using this knowledge, faculty could develop more engaging questions to help students utilize the internet as a resource in answering formative assessments, as well as instruct the students on how best to perform searches to get the results they need. Characterizing how students use the internet to complete the assignments may be a crucial step in developing FAs that will enhance the students' understanding of and engagement with the material, especially as institutions are becoming more dependent on asynchronous course formats.

Paper ID: 178

How undergraduates engage with tradeoffs when solving complex issues using a structured decision-making tool

P. Citlally Jimenez (University of Nebraska - Lincoln)*; Jenny M Dauer (University of Nebraska-Lincoln)

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Context: A part of Vision and Change, decision-making about complex issues is an important aspect for developing students' science literacy skills. Decision-making involves applying scientific evidence and recognizing tradeoffs among differing perspectives for societal wellbeing. A vital but difficult practice, recognizing tradeoffs allows decision-makers to recognize the associated costs of fulfilling multiple valued outcomes under different policies. Engaging in tradeoffs analyses is a skill that can be developed in science courses, aimed at helping students reflect on multiple perspectives and priorities to make science-informed and value-based decisions about complex issues. The science education field has not clearly defined tradeoffs practices in terms of student learning goals, though some researchers document how students struggle with some aspects like considering multiple stakeholders when evaluating solutions. We sought to describe undergraduates' tradeoffs practices within an interdisciplinary and introductory science literacy course that implemented a structured decision-making (SDM) tool. Our exploratory study helps define learning goals for sophisticated tradeoffs practices and gives insight into the efficacy of the course in terms of student achievement. Though we explored several tradeoffs practices (internal consistency and compensatory strategies), we focus on the following for this short talk:

RQ1) Do students discuss multiple perspectives (e.g., stakeholders) and tradeoffs after doing structured decision-making?

Design: Our mixed methods study focused on describing students' tradeoffs practices as they worked through an SDM tool in a science literacy course in fall 2018. The SDM tool encouraged undergraduates to critically analyze alternative solutions to a socioscientific issue using various sources of scientific information to determine the consequences of alternatives, and purposely engage in a tradeoffs analysis to make an informed decision. Through multiple-iterative constant coding of a subset of student responses (n = 40), we developed frameworks that describe how well students 1: mentioned tradeoffs and 2: affected stakeholders of their final choices.

Analyses & Interpretation: We found 48% of students provided only advantages when asked "why is your final choice is best?" while 82% of students referenced tradeoffs amongst multiple valued objectives when explicitly asked "what are the tradeoffs of your final choice?". Similarly, 85% of students mentioned multiple affected stakeholders of their final choice. Asking explicit reflection prompts helped students recognize multiple tradeoffs and stakeholders involved in a complex issue.

Contribution: We defined student tradeoffs practices as: considering multiple perspectives, demonstrating internal consistency, and using compensatory strategies. These practices represent a holistic understanding of specific goals students can achieve and educators can assess. Additionally, our work lays a theoretical foundation for researching how students address tradeoffs in their reasoning. Our frameworks may aid educators in identifying how students consider tradeoffs when decision-making about complex issues and recognizing challenges to refine educational programming aimed at enhancing students' decision-making skills to support science literacy.

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Session E: Instrument Development

Paper ID: 20

The Plant Awareness Disparity Index: An Assessment to Measure Plant Awareness Disparity in Undergraduate Students

Kathryn M Parsley (University of Memphis)*; Bernie Daigle (University of Memphis); Jaime L Sabel (University of Memphis)

Plant awareness disparity (PAD, formerly known as plant blindness) is the tendency not to notice plants within one's environment leading to naïve and anthropocentric points of view such as plants are not important to humans, are boring, or do not do anything (Parsley, 2020; Wandersee & Schussler, 1999). This phenomenon is composed of four components: attitude (not liking plants), attention (not noticing plants), knowledge (not understanding the importance of plants) and relative interest (finding animals more interesting than plants) (Parsley, 2020). Previously, instruments have only been used to assess attitudes or attention toward plants. These instruments are insufficient to measure PAD as they only focus on one aspect of the phenomenon. The development of the PAD-I is significant in that it allows researchers to measure PAD and determine whether their interventions to mitigate PAD work or not.

To address the lack of an instrument that includes all four components of PAD, we have developed the Plant Awareness Disparity Index (PAD-I) which is designed to evaluate students' level of PAD based on PAD's four components. To that end, we developed the following research questions:

1. To what extent does the PAD-I demonstrate structural validity?
2. To what extent does the PAD-I demonstrate face validity?
3. To what extent does the PAD-I demonstrate concept validity?

To develop the Plant Awareness Disparity Index (PAD-I) we considered each of the four components of PAD separately and created items that would address each component. We used the Plant Attitudes Questionnaire (PAQ) as a reference for how plant-related attitude items could be written but decided to create our own items that would address attitudes towards plants (Fančovičová, & Prokop, 2010). We created items that aligned with the other three components based upon conversations with Dr. Elisabeth Schussler and previous findings from the literature. The first version of the PAD-I which included eight items about attitude, eight items about knowledge, six items about relative interest, and six items about attention, for a total of 28 items, and included a Likert-style scale answering scale.
We completed two rounds of exploratory factor analysis (EFA) to determine structural validity of the instrument. Both rounds utilized the same methodology, and changes to the instrument after the first round reflected the results from the first round of EFA. Our

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target population was undergraduate students taking a biology class. We analyzed the data using a maximum likelihood factor extraction with direct oblimin rotation within the psych package in R (Revelle, 2019). We also collected interview data to establish face and concept validity, and these results will be presented in the talk.

At the end of the two rounds of EFA, results indicated that a six-factor model would be a good fit for our data, so we moved forward with a model that included six factors and had the best goodness-of-fit scores. Every item in this model loaded with a score of 0.3 or above. Our final model of the PAD-I includes six factors: Caring for or Investment in Plants, Necessity of Plants/Importance of Plants, Attention toward Plants, Positive Affect toward Plants, Plants Better than Animals, and Animals Better than Plants. The development of this tool will allow instructors to measure PAD in their students, and it will allow researchers to study PAD in a (previously unavailable) quantitative light.

Paper ID: 114

Exhaustive Coding of Assessment Items with Bloom's Taxonomy: A Novel Teaching and Learning Practice using a Conventional Tool

Tori Larsen (University of California San Diego)*; Bianca Endo (University of California San Diego); Tiffany Hinchey (University of California San Diego); Ivan Chim (University of California San Diego); Stanley M Lo (University of California San Diego)

RESEARCH PROBLEM: Bloom's taxonomy is widely used across educational contexts to describe aspects of student learning that contribute to fulfilling learning objectives. In 2001, the taxonomy was revised to suggest that learning occurs at the intersection of two dimensions: knowledge and cognitive process. The knowledge dimension consists of four types of knowledge: Factual, Conceptual, Procedural, and Metacognitive. This knowledge is used to perform a cognitive process: Remember, Understand, Apply, Analyze, Evaluate, or Create. Bloom's taxonomy is based on the underlying assumption that it is hierarchically structured in both dimensions: from simple to complex and from concrete to abstract. Thus, using Bloom's taxonomy to classify assessment items traditionally involves selecting a singular, dominant code from each dimension. Yet assessment items likely require more than one cognitive process and knowledge type for a student to complete them. To test this, we created an exhaustive coding process to break assessment items down into their constituent steps, then categorize them using Bloom's taxonomy. We hypothesized that patterns in the Bloom's codes for a given assessment item would be structured such that items requiring "higher-order" categories would also require "lower-order" categories.

RESEARCH DESIGN: Coders classified 128 assessment items using a biology-specific articulation of Bloom's revised taxonomy. Each coder mapped a series of steps reflecting their thought process to solve each test item in a concept map or table format. Every step was then classified with a single type of knowledge and cognitive process. Some items were coded multiple ways (different steps and order of steps) based on different approaches to solving the problem. Assessment items were taken from multiple sources including biology portions from

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standardized tests (MCAT and AP) as well as upper and lower division biology course assessments from a private, medium-size research university with very high research activities in the Midwestern United States. Items in this sample reflect variation in formatting (e.g. multiple choice and free response), discipline, and difficulty.

ANALYSES AND INTERPRETATIONS: Exhaustive coding of the sample revealed a strong association between the processes Remember, Understand, and Analyze. Similarly, in the knowledge dimension, Factual knowledge is concurrently consulted when students draw from Conceptual knowledge. However, about a third of the questions that asked students to Apply only entail that they Remember information and not Understand it. A similar proportion of questions that drew from Procedural knowledge was associated with Factual knowledge and not Conceptual knowledge. These findings do not necessarily support a linear structure from simple to complex and from concrete to abstract as originally hypothesized.

CONTRIBUTION: In addition to the insights this novel procedure provides regarding the structure of the revised Bloom's taxonomy, we believe this approach can also be used as a novel teaching and learning tool. By having students and instructors alike break down an assessment item into its constituent steps and assign those steps to Bloom's categories, one could evaluate alignment between instructor and student understanding. Instructors could use this as a tool to provide feedback on assessment items, or students could perform exhaustive coding to study and identify sites of misconceptions.

Paper ID: 155

A Conclusion Assessment Rubric (CAR) for assessing a key experimentation competency

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Biology students are often asked to generate logical scientific conclusions based on evidence they have collected in course-based undergraduate research experiences (CURES), in faculty labs, or have gathered in literature reviews. Student-generated conclusion statements offer a rich opportunity to assess higher order reasoning skills aligned with the Vision & Change core competency of applying the process of science, but few tools exist to assess students' ability to generate logical, evidence-based conclusions. Our literature review of tools found that 50% of studies described assessment tools that directly measured experimentation performance, but only 1/3 of studies examined conclusion-making skills. To fill this gap, we created a Conclusion Assessment Rubric (CAR), building on the experimentation competency framework developed by biology educators in the ACE-Bio network, literature on scientific argumentation, as well as our own combined 45+ years of experience assessing CURE student research papers. Knowledge building in which students use argumentation to generate a collective explanation through negotiating evidence has been referred to as constructing and defending scientific explanations, and is formed through three underlying goals: sensemaking, articulating,

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and persuading. The CAR integrates key aspects of knowledge building to comprehensively evaluate student ability to construct scientific conclusions. To collect evidence of content and substantive validity, we invited post-secondary biology educators to review the CAR and provide feedback on completeness and clarity of the key components and associated performance levels, as well as feasibility of applying the CAR in their own courses. Additionally, we conducted a cross-sectional, field study to determine whether the CAR could differentiate student performance at different levels in their academic progression. We collected evidence of construct validity by comparing CAR rubric ratings on student independent research papers summarizing their CURE projects to scores that students earned through evaluation using existing course rubrics. Interrater reliability as measured by one-way random intraclass correlation coefficients (ICC) of the CAR key components ranged from 0.55 to 0.71 (k=3). The cumulative total CAR score had an ICC of 0.69 (k=3). Raters (n=4) represented a spectrum of educator experience, ranging from undergraduate and graduate teaching assistants to PhD instructors with >15 years of CURE teaching experience. We found a significant positive association between scores derived from vetted course writing rubrics and the total CAR scores given by our raters (n=16, t=2.91, p=0.012), which provides evidence that the CAR is measuring the intended construct of conclusion making. Finally, papers written in a capstone CURE lab earned significantly higher CAR scores (12.9 ± 2.7) compared to papers written in the first lab of an integrative 3-semester curriculum (9.6 ± 2.5) (t(15)=2.53, p=0.023) indicating that the CAR is able to differentiate learner performance in generating conclusions based on learner experience as they progress through their post-secondary biology curricula. The CAR is a uniquely flexible tool that can be used to achieve diverse assessment goals, from fairly and consistently documenting student achievement of a key V&C Process of Science core competency within a CURE course to tracking undergraduates' progression through their STEM program.

Paper ID: 162

Congruence testing to validate narrow-band concept inventories in genetics

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Research Problem: The concepts of transmission, storage, and exchange of genetic information are recognized by the Next Generation Science Standards [1], the American Association for the Advancement of Science [2], and the Genetics Society of America [3,4] as a disciplinary core idea within biological sciences education. Within the last two decades, biology educators have published multiple CIs for various biological concepts [2-5]. For example, the Genetics Concept Assessment (GCA) was developed and used to highlight students' alternative conceptions about transmission, population, and molecular genetics [5]. While the GCA proves to be useful to educators, it captures an understanding across multiple and varied genetic concepts, which provides educators with a broad understanding of students' alternative conceptions. Narrow-band assessments, such as the Lac Operon Concept Inventory [6], are more specific and designed to better assess changes in student understanding of a single concept [7].

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Research Design: Looking at the topic of mutations, we established common learning objectives (LOs) based on GSA's framework and faculty interviews, wrote open ended questions based on these LOs, gathered student data, and established a codebook to identify trends in student misconceptions and convert questions to a multiple-choice format. We then used this multiple-choice version in a variety of courses at different schools, gathering student response data from hundreds of students.

Analyses and Interpretations: In addition to the standard psychometric measures of reliability and validity (point biserial (mean = 0.30), KR-20 (0.686), and item discrimination (mean 0.59)), we report here a novel final step used to validate these concept inventories. As a confirmatory step, we asked the students to explain their reasoning after they answered each question. We then used the codebook established earlier to code student responses in the context of explaining their responses to multiple choice questions to determine if their reasoning was congruent with the option they picked. Comparing the proportion of congruent responses to a random binomial distribution based on the number of misconceptions identified codebook for each question, we found that both the incorrect responses and correct responses were congruent with the reasoning given ($p < 0.001$) after answering each multiple-choice question in the MuCI.

Contribution: The MuCI provides instructors data needed to tailor their curriculum and teaching practices by measuring students' pre and post instruction knowledge on genetics concepts. These assessments also provide researchers with an improve concept inventory design process. This novel final step in concept inventory development provides direct evidence that the distractors accurately capture student misconceptions.

References
1. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press; 2013. English.
2. Brewer CA, Smith D, editors. Vision and Change in Undergraduate Biology Education2009; Washington DC: Carol A. Brewer and Diane Smith.
3. Smith MK, Wood WB. Teaching genetics: Past, present, and future. Genetics. 2016;204(1):5-10.
4. McElhinny TL, Dougherty MJ, Bowling BV, et al. The Status of Genetics Curriculum in Higher Education in the United States: Goals and Assessment [journal article]. Science & Education. 2014;23(2):445-464.
5. Smith MK, Knight JK. Using the Genetics Concept Assessment to document persistent conceptual difficulties in undergraduate genetics courses. Genetics. 2012;191(1):21-32.
6. Stefanski KM, Gardner GE, Seipelt-Thiemann RL. Development of a Lac Operon Concept Inventory (LOCI). CBE-Life Sciences Education. 2016;15(2):ar24.
7. Ones DS, Viswesvaran C. Bandwidth–fidelity dilemma in personality measurement for personnel selection. Journal of Organizational Behavior. 1996;17(6):609-626.

Paper ID: 73

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Does your department evaluate your teaching well? Research-based guides to support STEM departments develop robust and equitable teaching evaluation practices

Sandhya Krishnan (University of Georgia)*; Tessa C Andrews (University of Georgia); Jessica Gehrtz (University of Texas at San Antonio); Paula P. Lemons (University of Georgia); Erin Dolan (University of Georgia); et al.

RESEARCH PROBLEM: National work to improve undergraduate STEM education has often focused on developing resources and training for evidence-based teaching. Yet the system in which faculty work and how evidence-based teaching is recognized and rewarded (or not) may be key to achieving and sustaining instructional change. Currently many STEM departments fall short of enacting robust and equitable teaching evaluation practices that would allow them to reward evidence-based teaching. Using an approach similar to instrument development, we created and refined a set of guides to support departments in changing teaching evaluation practices.

RESEARCH DESIGN: Drawing on prior work, the guides help departments draw on three voices to inform teaching evaluation: students, trained peers, and the instructor. We developed recommendations for departmental practices, called Target Practices, based on prior research, key principles of evaluation, and practices from nationwide efforts to improve teaching evaluation. We refined the Target Practices and developed accompanying resources based on evidence of validity from multiple sources. We used detailed data about existing teaching evaluation practices and expert feedback to refine content validity. We also examined response process validity using data from think-aloud interviews and meetings with department leaders who were interacting with the guides. Researchers can use the Target Practices to assess departmental change, so we also examined inter-rater reliability.

ANALYSES & INTERPRETATIONS: Our evidence-based development and validation work resulted in a 13-page set of guides, including 4 pages per voice (students, peer, self) and an overview. The core of the guides are the Target Practices, which are organized by three aspects of evaluation. Robust and equitable teaching evaluation is: (i) structured to minimize bias, including formalized processes, training and support for enactment, and collective decision-making; (ii) reliable, including multiple sources of meaningful and trustworthy evidence; and (iii) longitudinal, in order to document change over time and provide feedback to instructors. Additionally, the guide for each voice includes a page that describes common starting places for departments, a self-assessment to determine where the department stands for each target practice, and a quick start reference that provides early entry points to target practices and bundles target practices that may be efficiently accomplished together. The need for these additional resources emerged from data about how departmental leaders responded to the Target Practices. At our own institution, most STEM departments enacted few (or none) of the Target Practices originally. We use the guides in a long-term change project, and they help departmental leaders recognize the various practices needed to make teaching evaluation robust and equitable, and provide resources to work toward those practices. This is also a reliable research tool for documenting change in departmental teaching evaluation practices.

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CONTRIBUTION: These teaching evaluation guides were carefully designed to serve as a practical and long-term resource for STEM departments with a range of current practices. They are a valuable first step toward guiding departments to carefully consider how their teaching evaluation practices support effective teaching, or not. They can be useful to faculty, administrators, and change researchers.

Friday, July 23rd, 2021

Session A: Conceptual Understanding

Paper ID: 16

ATP as an activator: developing a consistent approach to the mechanism by which ATP drives unfavorable reactions across chemistry and biology

Keenan Noyes (Michigan State University)*; Clare Carlson (Michigan State University); Melanie Cooper (Michigan State University)

RESEARCH PROBLEM: The concept of energy is foundational to both the physical and life sciences, but it is also confusing. This creates challenges for instructors, especially for teaching ideas related to energy in a congruent way across the disciplines. Central to this issue is the role of ATP in reaction coupling. A typical biology approach might involve the idea that hydrolyzing ATP to ADP and inorganic phosphate causes a release of energy, which can then be used to drive an unfavorable reaction. While productive in biology, discussing ATP in this way can lead students to believe that it is the breaking of the "energy-rich phosphate bonds" that releases the energy, which directly contradicts how bonds and interactions are discussed in chemistry. We propose an alternate, causal mechanistic approach to this phenomenon that highlights the properties and behaviors of the underlying entities relevant to the process of reaction coupling. That is, the transfer of a phosphate group from ATP to another molecule, creating a more reactive common intermediate that then goes on to produce the original thermodynamically unfavorable product. To this end, we have developed an activity to both help students think about this mechanism and to probe how this approach impacts their understanding of ATP and reaction coupling.

RESEARCH DESIGN. In our homework activity, we asked students about the production of glutamine from glutamic acid and ammonia, a thermodynamically unfavorable reaction that occurs via the activation of glutamic acid by ATP. Specifically, we designed questions to investigate students' understanding of key ideas related to the phosphorylation mechanism, including the Gibbs free energy changes, reactivity, and stability of the components of the system. We administered this activity to students in undergraduate general (N = 283) and organic chemistry courses (N = 925).

ANALYSES AND INTERPRETATIONS: We adopted an open coding approach to analyze a randomly selected subset of those responses (N = 40) to identify emergent themes and patterns in the students' explanations. Our analysis revealed both challenges and successes in focusing on this mechanism. The bulk of the students (78%) recognized that phosphorylating the reactant would increase its reactivity. However, many (63%) struggled to incorporate phosphorylation into their explanation of how ATP drives unfavorable reactions. We believe that this reflects just how ingrained the idea of ATP hydrolysis is in student thinking and how a single activity is

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unlikely to allow a reconstruction of the role of ATP. Despite these barriers, some students (15%) recognized the activating role of ATP, providing examples that show how focusing on this mechanism can support an understanding of ATP that is consistent and productive across disciplines.

CONTRIBUTION: For over 50 years, studies have documented how difficult it is for students to understand the role of ATP and the energy associated with forming and breaking chemical bonds. However, by focusing on the mechanism by which ATP activates other molecules through phosphorylation, it may be possible to provide students with a way to explain such phenomena. Our results may inform how chemistry and biology instructors approach the role of ATP in biological systems. This is an important step towards our ultimate goal of helping students develop a robust understanding of energy that is congruent across the disciplines.

Paper ID: 106

Assembly required: How students and instructors define and connect biological processes

Sharleen Flowers (Purdue University)*; Kal H. Holder (Purdue University); Stephanie M Gardner (Purdue University); Gabrielle Rump (Purdue University); Stephanie M. Gardner (Purdue University)

Research Problem: The ability to integrate concepts and processes across levels of organization and build mechanistic explanations for a variety of different biological phenomena is an important practice within biology. To augment our knowledge base for helping students develop their competence with this practice, we used the theory of Knowledge Integration (KI) as a theoretical and analytical framework and disciplinary knowledge as a conceptual framework to address two research questions: How do undergraduate biology students and biology instructors define and relate three foundational modules in biology (i.e., gene regulation, cell-cell communication, and phenotypic expression)? How do undergraduate biology students and biology instructors bring in biological contexts to explain their answers?

Qualitative Research Design: We interviewed undergraduate biology majors (9) and instructors (6) at a large Midwestern university with very high research activity. We used a semi-structured, think-aloud interview protocol framed by KI with questions designed to elicit knowledge associated with each module ('how' they work and 'why' they occur) and then determine the ways in which the modules were connected to other biological ideas and contexts.

Analyses and Interpretations: Through iterative inductive and deductive coding of audio transcripts, we described how participants defined the three modules and explained the relationships between them. We also characterized biological contexts used to frame answers. We found 4/9 students associated gene regulation with nonnormative ideas such as keeping genes "good". Similarly, most students (5/9) suggested that gene regulation occurs to stay "healthy". The majority of students (5/9) described phenotypic expression being regulated by incomplete or unrelated ideas such as gene heredity and cell division. For the phenotype 'why' question, students mainly cited ideas about genetics not working or not knowing the function of genes (7/9). All instructors used mostly normative ideas when answering the 'how' and 'why' questions for all three modules, showing little overlap with students. In describing module connections, students overwhelmingly specified cell-cell communication affecting gene regulation (8/9) and gene regulation affecting phenotype (7/9). Most connections were unidirectional and few other connections were made. In contrast, instructors described more

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types of relationships and used more bidirectional connections (5/6). Participants used examples and elaborated contexts to situate their answers. Both students and instructors averaged using ~3 examples when answering questions. Students used 1-6 specific contexts during the interview, but instructors used 4-16 specific contexts. The most common examples and contexts were cancer, immunology, and neurobiology.

Contribution: Students have diverse ideas that do not always match those of instructors for module definitions. Differences in count and types of connections between modules suggest a more nuanced understanding that instructors have about these concepts. Further, the instructors' abundant and spontaneous use of contexts corroborates the idea that experts reason within disciplinary contexts. These results emphasize the need to support students' understanding of fundamental concepts and processes and suggest that providing them with opportunities to do so situated within biological contexts rather than in isolation could assist their learning.

Paper ID: 176

The Conceptual Analysis of Disciplinary Evidence (CADE) Framework as a Guide for Evidentiary Reasoning during a Hardy-Weinberg Equilibrium (HWE) Laboratory Investigation

Chaonan Liu (Purdue University)*; Dayna Dreger (National Institute of Health); Shiyao Liu (Purdue University); Ala Samarapungavan (Purdue University); Stephanie M Gardner (Purdue University); et al.

Recent emphasis on learning biology through scientific investigations has focused biology education more on helping students to understand and use scientific evidence. However, studies show that students still have problems in appreciating the importance of scientific evidence, identifying the relevant evidence, and properly interpreting examples and tables of data as evidence. Here we report on a study of instructional practices to guide instructors who engage their students in thinking and reasoning with and about scientific evidence during science learning. The Conceptual Analysis of Disciplinary Evidence (CADE) framework unpacks scientific evidence and evidentiary reasoning, so we used CADE to inform modification of instructional lab activities for an introductory-level biology course Hardy Weinberg Equilibrium (HWE) investigation, which was required for all first-year students who are biology majors at an American research-intensive institution in the Midwest. Our research question is how the implementation of CADE influenced lab discussions of a HWE investigation. The HWE is a fundamental model for population genetics, and the investigation was aimed to help students use basic concepts in genetics and statistical thinking to understand evolution. Traditionally the HWE had been taught by focusing on calculations using the HWE equation with given numbers. Our novel HWE lab investigation uses Petfinder.com as a data source to investigate the allele frequencies in dog populations. When the instructor used scaffolding questions designed according to CADE to guide the students in (a) generating a research question for hypothesis testing, (b) collecting data with the Petfinder.com and (c) using the data as evidence to test their hypotheses, the students were prompted to think and reason with and about scientific evidence during the investigation from both perspectives of disciplinary knowledge in biology and epistemic considerations. Changes in an instructor's lab discussions over three semesters were analyzed with rigorous qualitative research methods to illustrate how the implementation of CADE influenced the lab discussions. Findings reveal features of evidentiary reasoning that had previously been missing from the HWE lab, such as detailed disciplinary knowledge about the genetic mechanisms underpinning their investigation as a key component of evidentiary

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reasoning. The changes with CADE provide a practical demonstration of how to direct students toward evidentiary reasoning during an HWE investigation. With CADE, the lab instructor used more scaffolding questions, directed students to consider multiple aspects of evidentiary reasoning, and encouraged students' epistemic considerations about the nature, scope and quality of scientific evidence. Findings also suggest that CADE is worth testing as a practical pedagogical tool in other instructional lab contexts to guide instructors in developing and implementing questions to guide students' evidentiary reasoning during scientific investigations. Although our study was conducted in the context of a HWE investigation, proposed questions in epistemological part of CADE are very general and are intended to be applicable in many different contexts and science disciplines. A practical handout will be provided to the audience to help biology instructors design scaffolding questions for their own lab courses.

Paper ID: 184

Exploring Undergraduate Chemistry and Biology Students' Understanding of Enzymes

Emma Grace N Micer (University of Memphis)*; Jaime L Sabel (University of Memphis); Nathan DeYonker (University of Memphis)

Undergraduate students in introductory biology and chemistry courses learn about both the structure and function of enzymes. However, their understanding tends to be superficial, and students tend to lack the ability to think about the functionality of enzymes in a visually representative way. Through the application an NSF CAREER grant-funded website the Residue Interaction Network-based Residue Selector, RINRUS, we created an assignment to enhance student understanding of enzyme structure and substrate interactions to address our goal of increasing long-term retention and understanding of enzymes for students in introductory courses. In this study, we asked the following questions:

1. What do students currently understand about enzyme structure and function?
2. How much of the material taught in class regarding enzymes do students retain?
3. How can the RINRUS assignment support student understanding of enzymes?

We began by creating the RINRUS assignment. In this assignment, students find enzymes in the Protein Data Bank, read the associated literature for information about enzyme-substrate interactions, and insert the strand information for the complex into the RINRUS website, allowing students to view this complex in many forms. By allowing students the opportunity to visualize and manipulate enzyme-substrate complexes, we expect that students will better understand the interactions between the complexes. Following this, we performed a pilot study in a class of chemistry graduate students to determine accessibility. Following the assignment, we conducted interviews to understand their experiences during the assignment and the changes that should be made before presenting the assignment to undergraduate students. To explore student understanding of enzymes, we began performing surveys and interviews in students enrolled in General Biology I and General Chemistry I and II to determine their knowledge and understanding of enzymes. Students were asked to explain what an enzyme is and how it works, including any other information they knew about enzymes and their interactions. All data was qualitatively analyzed to find commonalities between student understanding and misconceptions regarding enzymes.

From the graduate study, we determined that the assignment is accessible to undergraduate students, however students may face difficulty in reading the literature and more complex enzyme understanding. When analyzing undergraduate student responses, it became clear that, while students were broadly aware of enzyme functions, most students had difficulty

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explaining enzyme structure and specific interactions with substrates. We are currently conducting a pilot of the RINRUS assignment with undergraduate biology students to analyze the effectiveness of the assignment before inserting it into the General Biology I laboratory curriculum. By inserting the RINRUS activity into the course curriculum, we hope that student retention of enzyme-substrate knowledge will better set the students up for success in later courses where they will again encounter enzymes. Results from this study will help to develop student understanding about enzymes and provide ideas and strategies for instructors to support their students in understanding the structure and function of enzymes.

Paper ID: 201

Improving Introductory Biology Students' Population Modeling Mastery Through Visualizing Population Growth Models

Samantha R Wasson (Brigham Young Univeristy)*; Channing Hudson (Brigham Young University); Dallan Carlson (Brigham Young University); Elizabeth G Bailey (Brigham Young University)

RESEARCH QUESTION: In biology, we predict how populations will change over time by using population growth models. These mathematical equations are useful tools for exploring complex systems though simplified relationships. They're used to forecast disease spread in the current COVID-19 pandemic as well as explore the causes and consequences of global climate change. Introductory college-level biology students consistently struggle when math and biology concepts intersect in the classroom, which leads to suboptimal understanding of how mathematical population models are designed and used.

A possible cause for collegiate student difficulty with population modeling is math anxiety: a documented phenomenon marked by feelings of helplessness, panic, and pain at the thought of doing math. It is often an anticipatory response to the expectation of performing mathematical calculation. Math anxiety requires self-soothing on the part of the student, creating an extraneous mental load. According to cognitive load theory, if mental resources are devoted to regulating math anxiety, then less cognitive power is available for the intrinsic load of understanding and applying abstract concepts of population growth modeling.

We sought to reduce the math anxiety students experience while learning about population modeling through using visual diagrams before exposing them to traditional equations and variable symbols. If students are taught to draw population growth diagrams before learning traditional population growth equations, will their math anxiety levels decrease and their modeling mastery increase?

RESEARCH DESIGN: Over 200 students from a non-major biology course completed a pre-test to assess scientific reasoning skills, trait math anxiety, and demographic information. The students were randomly sorted into two online learning module groups. Half of the students were given four lessons using traditional, equation-based pedagogy for modeling exponential growth, logistic growth, and predator-prey interactions. The other half were given two lessons for population modeling using a diagram-based system to first visually model population growth without math equations, as well as two lesson to introduce them to traditional population growth equations after diagram scaffolding. The students were regularly surveyed for state anxiety levels and cognitive load demands, and given a practice and formal test at the end of the unit.

ANALYSES AND INTERPRETATIONS: T-tests and repeated measures ANOVAs suggest that

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while the students from the two treatment groups performed equally on the population modeling unit assessment, teaching visual pedagogy before traditional equations reduced student state anxiety when completing certain tasks. In additional, analysis shows that teaching visual modeling before traditional equations reduced the intrinsic cognitive load for students in two of the four population modeling lessons. Student trait math anxiety was predictive of reported cognitive load, but there was no interaction between the effects of trait math anxiety and treatment group on the unit assessment and cognitive load.

CONTRIBUTION: Increasing student comfort with the basic concepts of population growth modeling will help them become citizens that appreciate and can think critically about scientific predictions based on mathematical models.

Session B: Research - CUREs

Paper ID: 64

How different Course-based Undergraduate Research Experience models impact student perceptions of the scientific research culture

Jessica Dewey (University of Minnesota)*; Alaina Evers (University of Minnesota); Anita Schuchardt (University of Minnesota)

BACKGROUND: Undergraduate students interact with the culture of scientific research when they participate in direct mentorship experiences and laboratory courses such as Course-based Undergraduate Research Experiences (CUREs) (Aikenhead, 1996; Auchincloss et al., 2014). Much work has been done to explore how CUREs impact the interest, motivation, and retention of undergraduate students in science (Dolan, 2016). However, little work has been done exploring students’ experiences and perceptions of the culture of scientific research in the CUREs context, and no work has explored how different CURE models that represent different subfields of science impact these experiences and perceptions. These different models of CUREs may present different cultural barriers and entry points to students trying to join scientific research, potentially contributing to the underrepresentation of certain groups in different science fields.

RESEARCH QUESTION: How do students’ experiences and perceptions of the culture of scientific research following participation in a CURE differ as a function of project type (i.e., bench-based versus computer-based research projects)?

RESEARCH DESIGN: The context for the study was a second semester introductory laboratory course designed as a CURE at a large Midwestern University. Students in this course are given the opportunity to choose one of four different project areas in which they conduct a research project in groups of 4-6. Three of the project areas are bench-based, and one is computer-based. Informal interviews were conducted with students during their required, end-of-semester poster sessions (N=192; 158 bench-based and 34 computer-based). Students presented their research projects and were asked three broad questions about what they liked, found

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challenging, and took away from their experiences in this course. These interviews were audio recorded and transcribed.

ANALYSES AND INTERPRETATIONS: Student responses were coded by two independent coders using the Culture of Scientific Research (CSR) Framework (Authors, under review). The CSR Framework is comprised of 31 cultural aspects categorized as either Practices, Norms/Expectations, or Values/Beliefs. The two coders overlapped on 36% of the interviews (IRR = 0.94). Coded responses (N = 529) were qualitatively compared across project areas and interview questions. Students in the bench-based project areas commonly talked about hands-on practices (e.g., 'Running Investigations'), while students in the computer-based project area focused on computational practices (e.g., 'Data Analysis'). The practice of 'Teamwork' was challenging for students in all project areas, but the types of challenges associated with 'Teamwork' in student responses differed between the bench-based and computational project areas. Computational students talked about the Norms/Expectations of 'Freedom & Independence' and 'Persistence & Resilience' as mostly challenging, while bench-based students found these aspects to be enjoyable or important takeaways.

CONTRIBUTION: The results of this study suggest that different CURE models can differentially impact students' experiences and perceptions of the scientific research culture. This is an important area of educational research because if students experience different cultural barriers and entry points in different CURE models, they may also experience these barriers and entry points when trying to join different fields of scientific research.

Paper ID: 112

An Effective CURE in Introductory Biology at a Regional Comprehensive University

Anne Casper (Eastern Michigan University)*

Research Question or Problem: Course-based undergraduate research experiences (CUREs) could make science more inclusive, because they give greater numbers of students the opportunity to carry out authentic research. CUREs have been reported to increase students' sense of research project ownership and persistence in science. However, most of these positive effects are from studies of CUREs implemented at research-intensive institutions, and many of the CUREs were limited to high-achieving or upper-level students. It is unclear whether CUREs can be effectively implemented in introductory-level courses at regional institutions and community colleges, and whether CUREs have positive effects when they reach a greater diversity of students. We have evaluated the effect of a CURE implemented in first semester introductory biology at a regional comprehensive university with a diverse student population. We investigated students' perception of the key aspects of CURE and students' sense of research project ownership. We also investigated whether replacing the traditional lab with the CURE came with a "cost" of lower exam grades in the associated lecture course, and we evaluated student persistence into later biology courses.

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Research Design: We implemented our CURE in partnership with a national research consortium, Tiny Earth, which has the goal of student-sourcing the discovery of new antibiotics from soil microbes. Our introductory biology lab sections are taught by Master's students, many of whom are focused on ecology research, therefore we enhanced both pedagogical and microbiology training for our Master's students who teach this CURE. We collected data from four semesters over two years. Student survey data was collected post-course, using the Laboratory Course Assessment Survey (LCAS) and the Project Ownership Survey (POS). Exam grade from the associated lecture course were collected from faculty instructors, and enrollment in later biology courses was collected from institutional records.

Analyses and Interpretations: We used multiple regression to analyze survey responses, controlling for student preparation, gender, race/ethnicity, and enrollment type. Similar multiple regression was used to analyze lecture course exam scores and enrollment in later biology courses. In comparison to our traditional lab, in our CURE lab students perceived higher levels of all three key aspects -- collaboration, iteration, and discovery/relevance. Students' sense of research project ownership was also higher in the CURE lab, and project ownership was significantly positively mediated by all three key aspects of CUREs. Relative to our traditional lab, our CURE lab does not adversely affect lecture success of our student population, and it increases the odds of enrollment in later biology courses, particularly continued enrollment by first generation in college students.

Contribution: We report a successful CURE lab in Introductory Biology I at a regional comprehensive university that has a diverse student population in both ethnicity and academic preparedness. There are many aspects by which we define our success, including: (1) we were able to bring our students into a research project with broad relevance to the greater scientific community by joining a national network, Tiny Earth; (2) we were able to empower Master's students who had little training in microbiology or pedagogy to effectively teach this CURE; (3) our students perceived the defining features common to CURES -- collaboration, iteration, and discovery/relevance; (4) students in our CURE did not experience adverse effects on their grades in the associated lecture course; (5) students in our CURE, particularly first generation students, were more likely to enroll in additional biology courses. Our research clearly indicates that we have the opportunity to make STEM education more equitable by widely implementing CURE courses at regional public universities and community colleges, in courses taken by first-year students.

Paper ID: 206

Challenges and opportunities for students with disabilities in life science undergraduate research experiences

Logan E Gin (Arizona State University)*; Danielle Pais (Arizona State University); Katelyn M Cooper (Arizona State University); Sara E Brownell (Arizona State University)

Research question or problem: Individuals with disabilities are notably underrepresented in

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postsecondary science education. As such, it is critical that we examine the experiences of students with disabilities in high-impact practices, such as undergraduate research experiences (UREs). In this study, we aimed to understand: (1) the unique challenges that students with disabilities experience in UREs, (2) how students with disabilities navigate challenges in UREs, (3) the benefits that students with disabilities experience in UREs, and (4) the ways in which students with disabilities uniquely contribute to the scientific community. We used the medical and social models of disability to characterize the challenges and opportunities for students with disabilities.

Research design: We conducted an interview study of 20 undergraduate researchers with disabilities in the life sciences from 12 institutions due to the exploratory nature of our research questions. Interview questions asked students about (1) challenges in UREs, (2) ways in which students navigated challenges, (3) benefits of UREs, (4) and any unique contributions that students perceive they make to the scientific community. We conducted think-aloud interviews with two researchers with disabilities to establish cognitive validity. We reached data saturation within the first 15 interviews.

Analysis and interpretation: Two researchers used inductive coding to develop a codebook describing common themes that emerged from the interviews. We leveraged the qualitative nature of this study to identify themes that were commonly experienced by students with disabilities broadly and to not make claims about how students in specific disability groups were affected. Both researchers coded a random subset of 25% of the interviews and had an acceptable interrater reliability score ($\kappa = 0.89$). One researcher coded the remaining interviews. We identified (1) that students with disabilities experienced unique challenges in UREs including difficulties carrying out specific tasks and having to self-advocate to receive assistance. Students often described their challenges using the medical model, suggesting that their challenges were due to their disability instead of using the social model, suggesting that challenges were due to structural aspects of UREs that exclude individuals with disabilities. (2) Students navigated challenges by working with research mentors to create informal accommodations, such as modifications to the research space and adjusting schedules around students' needs. (3) Students with disabilities reported benefits from participating in UREs, such as building their confidence in doing science given their disability. (4) Finally, students with disabilities reported bringing unique perspectives to the scientific community, such as having a greater sense of compassion for others and drawing upon their lived experiences to inform their approach to research.

Contribution: This study is the first to illuminate the unique challenges and opportunities that students with disabilities experience when participating in undergraduate research. Research mentors can use the results of this study to structure more inclusive research experiences for students with disabilities.

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Who do Students Talk to About their Course Research? An Investigation of CURE Students' Ego Networks

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Research Questions. Course-based undergraduate research experiences (CUREs) have been empirically shown to promote growth in cognitive and affective student outcomes as well as, ultimately, aid in the retention of students in science, technology, engineering, and mathematics (STEM) fields. While these findings are imperative, the underlying processes that aid in the social integration and acculturation of students to science remain unstudied in CURE contexts. Tinto's (1975) Model of Institutional Departure posits that a student's social integration within their discipline is as important to their retention as is their academic achievement. We draw upon Tinto's work to investigate the following research questions: 1) Who do students discuss their course research with throughout the semester, and what is the nature of those discussions?; 2) How do students' social networks change over time?; and 3) What factors do students believe impact their ability to form networks?

Research Design. We conducted a mixed methods study to describe student socialization within four biology CUREs at an R1, Hispanic-serving institution in the Fall 2018 semester. To collect social network data from students, we administered a name generator survey every three weeks over a 15-week period. This survey asked participants to list all people – within and outside the course – with whom they had discussed their course research and to provide additional contextual information regarding those interactions. We analyzed student network data using an egocentric approach and descriptive statistics to determine the density of student networks as well as the frequency and quality of interactions between respondents and alters of various roles (e.g., parent; classmate). We included two free-response questions on the final survey to probe students on the factors they believed supported or hindered their ability to interact with others. Inductive coding was used to identify emergent themes in this dataset.

Analyses and Interpretations. Analysis of student ego networks revealed that students discuss their research in discrete interactions (n = 1509) throughout the semester with classmates (51.9%), professors (4.3%), course instructors (14.2%), and friends and family (26.7%). The nature of these discussions ranged from advice on their research project and requests for resources to general discussion of their projects. Moreover, we found that students' connections outside the course decreased over time from 34% to 18% of total interactions; connections with classmates and the instructor increased over time. Most interactions (70%) occurred face-to-face. Participants cited the lack of opportunities for intergroup collaboration (68.0%) and limited confidence in initiating conversations with others (37.5%) as inhibitory to network formation, whereas instructor mentions of collaborators (46.7%) and small class sizes (25%) were viewed as beneficial.

Contribution. Networking is a crucial skill for both scientists and non-scientists; however,

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research on CUREs has historically centered on student cognitive and affective outcomes rather than social behavior. Our results indicate that students foster connections with those who are affiliated with the CURE and those outside of the CURE, albeit to varying degrees, over time. Ultimately, these findings can aid researchers and practitioners in structuring opportunities for collaboration and networking in CUREs to promote social integration.

Paper ID: 57

Advancing CURE Graduate Teaching Assistants' Professional Development Through an Online Learning Community Intervention

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Research Question: Course-based undergraduate research experiences (CUREs) have increasingly been incorporated into biology curricula as a means to engage students in relevant scientific opportunities. Prior studies indicate that CUREs are effective at promoting undergraduates' science reasoning and process skills development, affect, and persistence. Comparatively, few studies have examined instructor outcomes in the context of CUREs. This is especially true for graduate teaching assistants (GTAs), who are frequently tasked with teaching CUREs, yet who often receive little professional development (PD) to improve teaching skills that are vital to this type of instruction. We therefore investigated the following research question: What impact does participation in the CURE Professional Learning Community (PLC) initiative have on GTAs' affect toward and perceptions of teaching CUREs? Our work was guided by Cohen & Ball's (1999) instructional capacity framework, which posits that instructor capacity is imperative to providing quality education and true instructional reform.

Research Design: A mixed-methods approach was used to evaluate CURE GTA (N = 7; 88% of all eligible participants) outcomes in the context of a virtual professional development intervention. The implementation and design of this initiative was informed by the work of Heim and Holt (2019) and McDonald et al. (2019) and involved GTAs facilitating biology and biochemistry CUREs at an R1, Hispanic-Serving Institution in the Fall 2020 semester. Intervention activities included synchronous interactive discussions, reflective journaling, and asynchronous practical exercises (e.g., creating a teaching philosophy statement and mentoring video introduction). To determine program effectiveness, we invited participants to complete a retrospective, post-intervention survey (adapted from McDonald et al. (2019)) and engage in a brief (~45 min.) focus group interview. Descriptive statistics were tabulated for all survey responses, and thematic analysis was employed to analyze all interview data.

Analyses and Interpretations: As compared to before their participation in the CURE PLC, GTAs reported being moderately more confident or a great deal more confident in their ability to promote students' development of experimentation skills (n = 6), foster effective collaboration between students (n = 7), and mentor students in their courses (n = 7). More holistically, they likewise expressed a moderate-to-great deal of confidence in their ability to develop research-

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oriented and instructional goals for their CUREs (n = 7 respondents for each task). Participants viewed the intervention activities very favorably, especially biweekly opportunities to engage with peers in real-time discussion. During the focus group interview, one participant noted, for instance, that what he “liked the most was being able to have that peer-to-peer feedback… my other peers… don’t teach a research-driven course, so we couldn’t really collaborate or share ideas so much. With the [CURE PLC], it was nice to kind of share ideas… like ‘well, this worked for my research course, and how about yours?’” These findings suggest that the CURE PLC was an effective means to provide professional development to the GTAs in the context described.

Contribution: Collectively, the results of this study can inform best practices for developing, implementing, and evaluating CURE GTA PD in the STEM fields, including in a virtual format.

Session C: DEI – Inclusive Teaching

Paper ID: 94

Student and instructor perceptions of inclusive and exclusive teaching practices in undergraduate biology classrooms

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Research Question or Problem: Given the national priorities and research literature on instructor immediacy to retain students from diverse backgrounds in science, it is imperative to understand how different teaching practices are perceived across student demographics as either inclusive or exclusive. Science instructors have been encouraged to integrate a variety of teaching practices in undergraduate classrooms to foster student belonging and promote inclusive learning environments for a diverse student population. However, few studies have investigated student perceptions of teaching practices they feel result in feeling included, or evaluated alignment between student and instructor perceptions of inclusive teaching practices. To that end, we investigated which teaching practices biology students perceived – and instructors asserted – as inclusive or exclusive in biology classrooms.

Research Design: To address this research need, we conducted a department-wide programmatic assessment at a large, urban university with a diverse student body in the semester of Spring 2018. This assessment asked students to share up to three teaching practices their biology instructor used that made them feel included (inclusionary practices) and then asked students to share up to three teaching practices their instructor used that made them feel excluded (exclusionary practices). At the end of the assessment, students had the option to share self-identified demographics. Similarly, instructors were asked to report up to three teaching practices they used to promote student inclusion and three teaching practices they used that might cause student exclusion. We used qualitative coding to develop two rubrics (one for inclusionary practices and one for exclusionary practices) and coded student responses

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within their respective rubrics (IRR = ~85% for both rubrics). Instructor responses are still being analyzed.

Analyses and Interpretations: Approximately 3,425 biology students were invited to participate in the assessment, and 34% of biology students (n = 1173/3425) participated and shared 719 inclusionary and 253 exclusionary practices. The majority of biology students felt included when their instructors promoted a relationship with students (e.g., welcomed and responded to questions), encouraged peer relationships (e.g., think-pair-shares and group work), and made evidence-based teaching practices (e.g., in-class exercises). In contrast, biology students felt excluded if instructors undermined their relationship with students (e.g., responded judgmentally to students' questions, discouraged peer relationships (e.g., no group discussions), or did not integrate evidence-based teaching practices (e.g., does not include student equitably in-class).

Contribution: Understanding students' perceptions of teaching practices that make a biology classroom inclusive or exclusive across student demographics is essential to inform effective pedagogical changes that can foster inclusive learning environments.

Paper ID: 107

Training Faculty-Teaching Assistant Dyads in Anti-Racist Science Teaching

Hillary Barron (University of Minnesota)*; Grace Devine Boutouli (University of Minnesota); Theresa Hallman (University of Minnesota); Sehoya Cotner (University of Minnesota)

Research Problem and Question. With ongoing COVID-19-related disruptions, much of our equity work in science education has taken on new meaning. Specifically, teaching in a time of crisis has exposed inequities in a way that is undeniable and should bring more faculty "to the table" during discussions of Diversity, Equity, and Inclusion (DEI). More importantly, the past year has elevated the visibility of structural racism that students of color endure in institutions of higher learning. Specific to pedagogy, the ability for educators to engage in inclusive and culturally responsive practices is hindered by limited meaningful interaction with students. It is imperative that educators receive quality training in culturally responsive and anti-racist science teaching practices that can be translated to online and remote spaces. By developing and implementing targeted professional development around ideas of culturally responsive and anti-racist science teaching strategies, we sought to answer the following question: how do faculty and teaching assistants (TAs) engage with ideas of racism and anti-racism in science education?

Research Design. Culturally responsive science teaching (CRST) draws on the frameworks of culturally relevant pedagogy and culturally responsive teaching to create science learning experiences for students that are culturally competent and foster agency, while validating students' rich and varied backgrounds. Centralizing social-justice science issues in CRST work focuses training on anti-racist science teaching efforts. Educators who engage in CRST and anti-racist science teaching are not only aware of their students' needs in the classroom, but

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also make pertinent and timely adaptations to their instruction when needed. We drew on these frameworks to create a semester-long professional development program wherein faculty and teaching assistants paired up in dyads to explore teaching strategies as well as their own understanding of and development in ideas of anti-racism in science. We collected training artifacts, faculty and TA reflections, and focus group and interview data to better understand the ways in which the dyads engaged with the material.

Analyses/Interpretations. Using first- and second-cycle qualitative analyses, we triangulated across the multiple data sources described above. In the first cycle, we applied initial and open coding to understand main ideas across datasets. In second cycle analysis, we used thematic analysis to create categories from first-cycle codes. We engaged in consensus coding to assure inter-coder reliability. The following major categories emerged from the data, faculty and TAs: 1) hold widely-varied ideas of how science is cultural, 2) develop in their beliefs about racism in science over time, and 3) expand their approach to CRST and anti-racist teaching.

Contribution. While studies in culturally responsive and anti-racist science teaching are and emerging field of research in undergraduate science education, these findings add to the literature on the importance of educator development in relation to inclusive and equitable teaching. This is particularly salient as we continue to grow in our understanding and development of mechanisms to disrupt systemic racism in undergraduate science teaching and learning.

Paper ID: 123

Meta-analysis of gender performance gaps in undergraduate natural science courses

Sara E Odom (Auburn University)*; Halle Boso (Auburn University); Scott Bowling (Auburn University); Sara E Brownell (Arizona State University); Sehoya Cotner (University of Minnesota); et al.

Research Question: Extensive research on the experiences of women in science, technology, engineering, and mathematics (STEM) fields has revealed several common patterns of inequalities that reduce the retention of women in STEM (Eddy & Brownell, 2016). Barriers still exist that discourage women from pursuing scientific and technical fields, including bias (Carli et al., 2016; Miller et al., 2018), gender disparities in participation (Ballen et al., 2019; Eddy et al., 2014), and numerous affective factors (Eddy & Brownell, 2016; Hill et al., 2010). Drawing from feminist theory (Allegrini, 2015), we focus on academic performance as one factor that might influence women’s classroom and disciplinary experiences. Reports on whether gender gaps in academic performance persist in biology classrooms is mixed, suggesting that the issue is complex and there are likely many factors at play. In this study, we ask the following research questions:

1. Is there a performance gap between men and women in undergraduate life science classes?
2. What classroom factors narrow historic gender gaps by promoting women’s performance?

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Research Design: To investigate broad patterns of performance by gender, we conducted a meta-analysis reviewing performance gaps using data from 18 published studies, representing 89 different courses, and grades from 80 individual courses collected through the Equity and Diversity in Undergraduate STEM Research Coordination Network. We identified studies via a database search following the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA, 2015). We used Hedge's g (standardized mean difference) to calculate the effect size, and compared the overall differences using linear mixed models across a variety of classroom factors, such as class size, assessment type (exams, course grade, or concept inventory), and pedagogical approach (characterized as "lecture" or "active learning" classes based on curriculum descriptions; Driessen et al., 2020, Freeman et al., 2014).

Analysis and Interpretation: The analysis revealed no significant difference in academic performance overall on the basis of gender (Hedge's g=-0.2268, p-value=0.4119), but a high degree of heterogeneity within the dataset (I2=92.9%), indicating the likely correlation of classroom factors with gender gaps. Investigation of such factors identified class size, assessment type, and pedagogy as factors correlated with gender gaps, with women's relative performance improving with smaller class sizes, by focusing on course grades rather than exam grades, and utilizing active learning strategies.

Contribution: This study adds to the growing literature showing that classroom factors impact student learning and performance in major ways (Casper et al., 2019; Cotner & Ballen, 2017; Tanner 2013). By using informed, data-driven solutions, instructors and administrations can create more inclusive classrooms.

Paper ID: 169

Science faculty's conceptions of equity and their relationship to teaching practices

Tatiane Russo-Tait (UT Austin)*

RESEARCH PROBLEM: Extant studies show that faculty's beliefs can inform their teaching. For example, faculty beliefs about diversity have been linked to instructional choices, such that those who shared appreciation for the benefits of diversity reported using student-centered teaching. While important, this body of work was survey-based, and the operationalization of diversity limited the range of views it captured. Further, there is a need for research that moves beyond diversity and explores faculty's conceptions of equity, which is the focus of current reform efforts. Equity in education has been described by scholars in various ways, which provide different affordances and constraints for policy, research, and teaching decisions. Regarding the latter, there is a dearth of research on how postsecondary science faculty's conceptions of equity may inform their instructional choices. This study aims to address these gaps by exploring faculty's conceptions of equity and whether and how these understandings are related to their reported instructional practices.

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RESEARCH DESIGN: Using a comparative case study design, equity conceptions and teaching choices were explored among faculty in a College of Natural Sciences at a R1, predominantly White, public university in the U.S. Semi-structured, in-depth interviews were conducted with 45 faculty members from either the life sciences (n=26) or the quantitative sciences (n=19), recruited via snowball sampling. The sample was representative of a R1, PWI—participants were majority White (76%), men (62%), tenured/tenure-track (70%), and continuing generation (89%).

ANALYSIS AND INTERPRETATIONS: Reflexive thematic analysis was conducted. Inductive coding was used to develop initial semantic and latent codes. Memos were written to capture early thoughts, compare ideas, identify connections, and further develop codes. Underlying patterns in the codes were identified and initial themes developed. These themes were compared within and between interviews to check for frequencies and relationships. For trustworthiness and validity, data was triangulated with teaching or DEI statements, or other documents provided by faculty. Further, extensive peer checks were conducted throughout the analysis. Findings show that faculty conceptualized equity as "equality" (54%), "inclusion" (33%), or "justice" (13%), and these conceptions were associated with teacher-centered or student-centered instruction, and different points of view on how to support students in their classrooms. Faculty with “equality” conceptions of equity tended to report teaching mostly via lecture and focused on treating all students the same; while those with an “inclusion” conception tended to report active learning and/or inclusive teaching practices and be aware that students needed different supports. Faculty with a “justice” conception went beyond active learning and inclusive practices to practice an emerging critical pedagogy.

CONTRIBUTION: Conceptions of equity have important implications for how science faculty see their roles in advancing equity in their classrooms via their teaching and interactions with students. These findings can inform future research, as well as professional development initiatives to support faculty in developing the understandings needed to advance equity-related reform efforts in postsecondary science education.

Paper ID: 181

Future Implications of Participatory Action Research on Black Science Majors

Christin Walls (University of Georgia)*; Darris Means (University of Georgia); Julie Dangremond Stanton (University of Georgia

Research Question or Problem
Participatory action research, commonly known as PAR, is a method that directly engages members of a minoritized population being studied in conducting the research itself. For example, our research team investigates the strengths and assets of academically successful Black science majors through a collaboration between faculty and undergraduate researchers who are also Black science majors. In PAR, undergraduate researchers are “co-researchers”, who are responsible for leading all aspects of the work, including study design, data collection,

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data analysis, and dissemination of results. The ultimate goal of PAR is to enable social change through action. Some known benefits of the PAR approach are shared leadership between the researched group and the researchers, and a context for deeper connections within the research itself. PAR also gives co-researchers the opportunity to use their unique insights and critical expertise to uncover knowledge that may not be understood or recognized by other researchers. Despite the known benefits, PAR has not been widely used to study undergraduate students and PAR has rarely been used in the sciences. As part of a larger study that uses PAR to study the strengths and assets of Black science majors, we are interested in understanding the co-researchers' PAR experience. This study aims to answer the question, "How does participation in PAR impact co-researchers?"

Research Design
We used a case study design to answer our research question. We collected qualitative data using a semi-structured interview protocol designed to explore past co-researchers' experiences with PAR. A current undergraduate co-researcher interviewed four past co-researchers one year after they graduated from college to investigate the impact of their participation in a PAR project.

Analyses and Interpretations
Through content and thematic analysis of interview transcripts, our research team identified several benefits from past co-researchers' PAR experience. We found that PAR allowed co-researchers to make deep connections with study participants, research team members, and the data. PAR projects were personally meaningful to the co-researchers. As a result, co-researchers were able to gain a deeper understanding of themselves while also developing a deep understanding of study participants. PAR allowed co-researchers to use their insider knowledge of the research topic to improve all aspects of the project. For example, co-researchers were able to create a protocol with language that was more inviting to study participants than typical research interview protocols. Being able to enhance all facets of the research helped co-researchers gain a sense of ownership and authority over their project. Co-researchers also found that PAR allowed them to develop strong communication and time management skills because of the increased responsibilities they carried as leaders of the project. Past co-researchers reported using these skills on a regular basis in professional school or in their science career.

Contribution
This study will be beneficial for SABER members as they become increasingly committed to work that promotes equity and inclusion. PAR is a powerful approach that empowers co-researchers to use their critical expertise to enact social change. This study contributes to our understanding of the long-term benefits of PAR for co-researchers.

Session D: Pandemic Instruction

Paper ID: 59

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Motivations and concerns influencing faculty choices about online instructional practices during the COVID-19 pandemic

Catherine Ishikawa (California State University, Sacramento)*; Eric Pennino (California State University, Sacramento); Navneet Singh (California State University, Sacramento); Sayonita Ghosh Hajra (California State University, Sacramento); Kelly McDonald (California State University, Sacramento)

Research Question or Problem: The COVID-19 pandemic forced many STEM instructors to quickly move courses online, all while facing disruptions to their lives and the lives of their students. We studied faculty and student experiences during this unique time, including whether faculty chose to incorporate inclusive practices in their Fall 2020 online classes, the motivations for their instructional choices, and perceived effectiveness of practices they chose. Dewsbury and Brame's online evidence-based teaching guide provided a framework for identifying inclusive practices, and we used Fuller's simplified Stages of Concern as a lens for categorizing reasons for choices. This talk focuses on motivations for instructional choices and perceived effectiveness.

Research Design: Participants were faculty at a four-year university, chosen using a cascade approach where we recruited from a group of faculty interested in STEM education, who then recruited colleagues, resulting in 18 faculty from Biology, Math, Physics, Environmental Studies, Chemistry, and Engineering. Our university provided an interesting case study, as administrators decided early to be fully online in Fall 2020, providing faculty with opportunities for training and time to plan online courses. We surveyed faculty three times during the semester, asking open-ended questions to learn what they were changing (from Spring 2020), what motivated the changes, what practices worked well, and why they liked the practices. We also asked what they were anxious about in relation to teaching the course and what concerns they had about student learning.

Analyses and Interpretations: Two students and one faculty iteratively coded surveys, initially using both open-coding and the Stages of Concern Framework as a priori categories: self/task concerns (e.g., instructors' lack of time, tasks becoming more difficult online) and impact concerns (effects on students). Open-coding produced subcodes for the impact category , and surveys were re-coded with three coders coming to consensus. For questions about why they used or liked specific instructional practices, most faculty reported a combination of self/task and impact codes. Student impacts mentioned most often related to connection (e.g., building community), engagement, and ease-of-use for students (e.g., building in flexibility, creating clear routines). Direct references to student thinking and learning were less common, except on the end-of-semester survey. The most common concern about student learning related to engagement, followed by student well-being (e.g., mental health, life events). Some interesting tensions were revealed—building in flexibility and reducing anxiety for students sometimes increased faculty workload or led faculty to worry that students took their course less seriously. While equity was rarely mentioned as an explicit reason for using practices, building connections and understanding students' challenges may represent indirect motives for

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incorporating equitable practices.

Contribution: While it is a case study of instructors at one institution, the results add to the faculty adoption literature. Personal concerns about time and difficulty of practices are well-documented barriers to adoption of evidence-based practices. But the desires to create connections, see students engaging, and help them succeed under adversity represent affordances that may be useful leveraging tools for facilitating future change.

Paper ID: 191

Participation and Performance by Gender in Live Zoom Classrooms

Sierra C Nichols (Brigham Young University)*; Elizabeth G Bailey (Brigham Young University); Yongyong Xia (Brigham Young University); Mikaylie Parco (Brigham Young University)

RESEARCH QUESTION: Our research lab previously found that women were less likely to participate than men in life science classrooms, especially when women were in the minority. Women also earned lower final grades than their male peers when in the minority and/or when taught by a male professor. The COVID-19 pandemic presented a unique opportunity to look further into gender difference in an online, live setting where class gender distributions are not as obvious as they may be in person. We used Zoom recordings and chat box data from live synchronous classes in the life sciences to answer the following research questions. First, are men and women equally likely to participate in and earn high grades in an online class? Second, does the proportion of female students or the gender of the instructor impact female participation and performance in an online setting? Third, how do participation trends change over the course of a class period and over the course of a semester?

RESEARCH DESIGN: We conducted an observational, quantitative study of five 400-level life science classes and one 100-level life science class taught during the Fall 2020 semester. We obtained consent from professors and students to receive the Zoom recordings and chatbox data from three class sessions at the beginning of the semester, three in the middle, and three near the end. Researchers watched each video, recording all student participation events and instructor practices that facilitated student participation. Finally, we obtained final course grades (de-identified except for student gender) for the observed classes from the university registrar's office.

ANALYSES AND INTERPRETATIONS: We analyzed synchronous Zoom classes or instances of participation. Researchers recorded each time a student typed in the chatbox or unmuted and participated verbally, noting whether such participation was student-initiated or instructor-initiated. Each of these participation events will be reported on over the course of a class and the semester. We quantified and compared participation rates for male versus female students and how these rates changed over time. Preliminary analysis suggests that participation rates do not differ for men and women in an online setting like they do in person and that students may participate less near the end of class (perhaps suffering Zoom fatigue). We will also report

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on performance data as we plan to compare final course grades of male and female students using an ANCOVA, with ACT score as a covariate.

CONTRIBUTION: Much remains unknown regarding a post-COVID 19 world in terms of education. As we strive to achieve greater equity in life science education and promote better outcomes for women in STEM, we need to understand the impact different education formats have on female students. We already know that female students benefit from female instructors and classrooms with greater female attendance. This study will build on that understanding and allow educators to make informed decisions in the future regarding online vs in-class education.

Paper ID: 164

Perceived supports and barriers during COVID-19 emergency remote teaching

Cristine Donham (University of California Merced)*; Erik Menke (University of California, Merced); Hillary Barron (University of Minnesota); Maya Changaran Kumarath (University of California, Merced); Jourjina Alkhouri (University of California Merced); et al.

Background: Due to the current COVID-19 pandemic, universities have moved to emergency remote teaching (ERT). This move can enable flexibility in scientific teaching and learning. However, ERT is not without consequences as it can disproportionately affect students with lower socioeconomic backgrounds. For example, students may have inadequate technological supports, such as internet and computers. Students may also have poor learning environments at home and may need to find added employment to support their families. Additionally, it has been shown that female instructors are more disproportionately impacted in terms of mental health issues and increased domestic labor.

Questions: This research aimed to investigate students' and instructors' perceptions of their transition to ERT. Specifically, we wanted to know:
1. What helped and hindered faculty in making the transition to remote teaching?
2. What supports and barriers did students identify as having impacts on their transition to remote learning?

Design: We interviewed thirty-one instructors from biology, chemistry, math, physics, and engineering two months after switching to ERT. These semi-structured interviews were carried out over Zoom. Additionally, sixty-seven students filled out a Qualtrics survey before conducting focus groups two months after ERT. We asked both instructors and students about their perceived supports and barriers to teaching and learning during their transition to ERT.

Using grounded theory techniques, we applied two-cycle, qualitative analyses to assess the instructor transcripts. In first-cycle analysis, we used open coding to develop initial ideas from the data. We then used second cycle coding to generate categories with definitions and criteria agreed upon during discussion-based consensus building. Finally, these categories and descriptions were used to code student survey data, and all student data were coded by

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reaching a consensus between researchers.

Analyses/Interpretations:
Preliminary findings suggest that instructors identified roughly twice as many barriers as supports in their teaching during the transition to ERT. Instructors identified casual and formal conversations with colleagues as valuable supports. Emerging categories for barriers consisted of academic integrity concerns as well as technological difficulties. Similarly, students identified more barriers than supports in their learning during the transition to ERT. More specifically, students described pre-existing course structure, classroom technology, and community as best supporting their learning. Barriers that challenged student learning included classroom environment, student availability, and student emotion and comfort.

Contribution: Together, this research will help us understand supports and barriers to teaching and learning during the transition to ERT. This understanding can help us better plan and prepare for future emergencies, particularly at HSIs, where improved communication and increased access to resources for both students and instructors are key.

Paper ID: 172

Access to Learning Resources in Introductory Biology Courses, Their Effectiveness, and the Consequences of the Pandemic

Shima Salehi (Stanford University)*; Cissy Ballen (Auburn University)

Research Questions: Previous works document how introductory STEM courses fail to provide equitable learning environments for students from different demographic backgrounds (Seymour & Hunter 2019). Under-served demographic minorities (UDM) are at a disadvantage in introductory STEM courses and underperform primarily due to lower incoming academic preparation (Salehi et al., 2019, 2020). Using critical pedagogy theory as a lens (Freire, 2018), and with the objective to change institutional structures to ultimately improve teaching, we investigated the following research questions related to student resource use: (RQ1) How do students use faculty and teaching assistants (hereafter instructors) as learning resources, and does this vary across students based on their first generation status and socioeconomic status?; (RQ2) How do changes to remote teaching due to the pandemic affect learning resource use for all students, particularly first generation and low-income students? (RQ3) What do students perceive as the most useful way to interact with instructors as resources?

Research Design: We collected data from large introductory biology course from a public institution in the southeastern U.S. in fall 2019 (before the pandemic, N=471), spring 2020 (beginning of the pandemic, N=648), and fall 2020 (continuation of the pandemic N = 1188). We asked students about how they used faculty and teaching assistants as learning resources, and which resources were the most effective ones for their learning. (RQ1) We conducted Fisher's exact test to compare the frequency of different resource use across first generation and socioeconomic status. (RQ2) We conducted ordinal regression analysis to examine how the

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pandemic has affected resource use across different offerings, first generation, and socioeconomic status. (RQ3) We used descriptive statistics to analyze which resources students perceived the most effective ways to interact with instructors as resources, and used Fisher's exact test to check whether there is a variation in effectiveness of a given resource across first generation and socioeconomic status.

Analyses/Interpretations: (RQ1) Our analyses show that the most frequently used resource across all demographic groups and all three offerings was talking with faculty members outside the class sessions and emailing teaching assistants. (RQ2) The pandemic and the transition to online teaching reduced the frequency of using all resources for all students. Not surprisingly, we observed the most pronounced decrease in students reporting talking with TA's and faculty members during the lecture, because students were not in in-person lectures, and online lectures as they are do not provide the similar interaction opportunities. (RQ3) This finding is particularly concerning because before the pandemic, talking with TA's during the lecture sessions was the most frequently cited effective resource for students.

Contributions: Our analyes revealed the most frequently used and effective resources according to students. Given that performance challenges in introductory STEM courses are frequently cited as the primary reason students leave STEM (Seymour & Hunter 2019), and UDM students are disproportionately impacted by performance challenges in introductory STEM courses (Rauschenberger & Sweeder, 2010; Creech, & Sweeder, 2012; Eddy & Brownell, 2016), our results contribute to the literature by highlighting the common and more importantly effective learning resources that can contribute to an equitable learning environment in introductory STEM courses, and the effects of the pandemic on student access to them. Future work will identify strategies to make these available to all students when they are needed most, such as in times of crisis.

Paper ID: 103

Authentic assessment for all – Including remote learning!

Justine Hobbins (University of Guelph)*; Kerry Ritchie (University of Guelph); Emilie N Houston (University of Guelph); Bronte Kerrigan (University of Guelph)

RESEARCH QUESTION: In the shift from face-to-face (F2F) to emergency remote teaching (ERT) due to COVID-19, instructors were forced to reconsider assessment design. Best practices such as the creation of non-googleable test questions (contextual, problem-based), the provision of clear expectations (criteria), and frequent, low stakes assessments (multiple points of feedback) were widely shared. Notably, these recommendations align with the core dimensions of authentic assessment (AA): realism, cognitive challenge (CC) and evaluative judgement (EJ) – criteria and feedback. Despite this, ERT is often perceived to be lesser quality than F2F. However, we proposed that there may be a shift towards increased authenticity of assessments in a newly created ERT curriculum, relative to a traditional F2F curriculum. Therefore, this study documented how assessments change (number, type, authenticity) in ERT

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compared to a traditional F2F setting in a 4-year health science curriculum. Emerging themes from informal faculty discussion around assessment design will also be presented.

RESEARCH DESIGN: We recently constructed an AA inventory of all assessments in our large F2F health science curriculum using institutionally standardized course syllabi. The current study replicated these methods in the ERT setting. Specifically, ERT assessments were individually scored against an AA rubric and classified as low(1), moderate(2) or high(3) on each AA dimension. A quantitative authenticity score was calculated for each assessment and course, accounting for a course's overall grading scheme. Follow-up, 1:1 semi-structured interviews with instructors were conducted to further inquire about assessment practices. F2F and ERT assessment inventories were compared on key AA dimensions across the complete curriculum
.
ANALYSES AND INTERPRETATIONS: Compared to F2F, the ERT setting offered a higher number of total assessments (507 vs. 448). The average number of assessments per course also increased (9 vs. 7), though there was a large range in the number of assessments per course (2-27) in both settings. The proportion of tests to assignments shifted, with a slightly higher reliance on assignments in the ERT setting (43%) compared to F2F (37%). In both environments, authenticity of assignments (1.98 ± 0.50 F2F, 1.98 ± 0.47 ERT) was greater compared to tests (1.51 ± 0.35 F2F, 1.41 ± 0.34 ERT).

The authenticity score of the overall curriculum remained the same (1.80 ± 0.05 F2F vs. 1.81 ± 0.05 ERT, ns), suggesting that it is possible to maintain the authenticity of assessments in the remote environment. Although overall AA score did not change in the shift to ERT, there was a trend towards a decrease in authenticity in year 1 (Δ -0.07) and year 2 (Δ -0.29), and a trend towards an increase in authenticity in year 3 (Δ 0.04) and year 4 (Δ 0.13). In both F2F and ERT, EJ – feedback scored the least authentic relative to other dimensions, suggesting that providing meaningful feedback is the dimension of AA instructors struggle to achieve.

CONTRIBUTION: This research explores the changes implemented in assessment design according to core characteristics of AA in the shift from F2F to ERT. We show it is possible to offer AA in both F2F and ERT environments, although there are areas to improve. Practical strategies to increase authenticity on each dimension will be discussed using exemplars from a variety of courses. Emerging trends in instructors' rationale for implementing changes to assessment practices will be shared.

Session E: Diversity, Equity, and Inclusion

Paper ID: 72

It's not the title, it's the teaching: Comparing the effects of different types of instructors on equity gaps and students' sense of community

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Austin Zuckerman (University of California, San Diego)*; Rebecca A Hardesty (University of California, San Diego); Trinh Phung (The Preuss School); Kameryn Denaro (University of California Irvine); Stanley M Lo (University of California San Diego); et al.

Research Question: Institutions of higher learning have different faculty types to provide education to an increasing number of students. These include tenure-track Teaching Professors or Professors of Teaching (also known as lecturers with security of employment, or LSOEs), who are hired with greater teaching responsibilities than research-focused faculty while also conducting discipline-based education research and service. At the same time, meta-analyses have demonstrated that active-learning practices can increase learning gains for students and decrease equity gaps for minoritized populations. We leveraged the Four Frames of systemic change in STEM (structure, symbols, power, and people), with an emphasis on the “people” and “structures” dimensions, as a theoretical framework to investigate how Teaching Professors differ from research-focused professors and non-tenure-track lecturers in their teaching practices and effects on student sense of community and equity gaps. We hypothesized that Teaching Professors would use active-learning practices to a greater extent and improve student outcomes relative to instructors with other titles.

Research Design: We studied a four-course introductory biology series (n=27 courses) at a large public R1 university that is taught by three types of instructors: tenure-track Teaching Professors, tenure-track research professors, and non-tenure-track lecturers. Teaching practices were analyzed with Decibel Analysis for Research in Teaching (DART). Students’ sense of community was measured using the Classroom and School Community Inventory (CSCI). We then used linear mixed effects (LME) modeling to examine if instructor type predicted CSCI scores and equity gaps (as measured by course grades). We also generated separate LME models to test whether DART scores predicted student outcomes independently of instructor type.

Analyses and Interpretations: Contrary to our hypothesis, instructor type and DART measurements did not correlate, and instructor type was not a significant predictor of any student outcomes. However, consistent with previous literature, courses with higher amounts of active learning as measured by DART had decreased equity gaps in grades for first-generation ($\beta = 0.0215$, $p<0.001$) and under-represented minority ($\beta = 0.017$, $p<0.05$) students. Courses with higher active learning also increased students’ sense of social support ($\beta = 0.016$, $p<0.05$) but decreased their sense of learning support ($\beta = -0.014$, $p<0.01$), which may reflect an element of student resistance to active learning. Within the study context, these results suggest that teaching practices, as measured by DART, are stronger predictors of student outcomes than instructor title.

Contribution: This is only the second study to compare teaching practices and student outcomes in a dual tenure-track model, adding to conversations of how to improve STEM teaching. The results indicate that regardless of title and role, it is important for all types of instructors to implement active learning practices to improve student outcomes in STEM. Situated in the frames of systemic change, these results indicate that in this context, the roles and expectations

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established by institutional structures are not as important as the individual agency of the people in those structures. The reasons and mechanisms behind this observation remain an open question for future research.

Paper ID: 86

Isolation, Resilience, and Faith: Experiences of Black Christian Students in Biology Graduate Programs

Angela Google (Middle Tennessee State University)*; Chloe Bowen (Middle Tennessee State University); Lisa Hanson (Middle Tennessee State University); Elizabeth Barnes (Middle Tennessee State University)

Research Question or Problem: In efforts to increase participation of students of color in biology graduate programs, emerging areas of biology education research focus on illuminating and improving student experiences. Past research shows Black students are vastly underrepresented among those awarded Biology PhDs. Between 2015 and 2017, only 5% of biomedical degrees, 10% of nursing science degrees, and 1% of evolutionary biology PhDs were awarded to Black students. Further, Christianity has been identified as stigmatized in biology graduate programs and Black students are the only racial/ethnic group that remain majority Christian in biology graduate school. Given that graduate school is important for socialization into a discipline and that Black students are likely to experience stigmatization of both their racial and religious identity, we explored the experiences of students with these two identities. We sought to gain a deeper understanding of why Black students are more likely to leave or not pursue advanced degrees in biology and also to identify unique strengths and positive experiences of Black Christian graduate students that help facilitate their persistence and success.

Research Design: Biology graduate students from a sample of 63 R1 public and private institutions across the U.S. took a survey in which they identified both their race/ethnicity and their religion. We sent recruitment emails to students who identified as both Black and Christian on the survey. We created interview questions based on prior literature from social psychology on the experiences of individuals with stigmatized identities. We then conducted semi-structured interviews with 12 participants. We asked participants about their perceived conflict between their science identities and religious identities, if they were ever reminded of their racial and/or Christian identity in the science community, and about experiences where they have felt valued or not valued by someone in the science community because of their religion or race.

Analyses and Interpretations: We used both deductive and inductive content analysis to find themes in the interviews. Deductively, we identified student experiences that aligned with pre-existing themes found in literature on stigmatized identities such as Perceptions of cultural stigma, Anticipated stigma, Experienced stigma, and Impression management strategies. To find themes that were not part of our deductive coding scheme, the team inductively coded interviews to agreements. We found that students' experiences varied significantly based on

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Geographical and Institutional differences. This theme included differences in experiences based on the location of the institution (North or South), and HBCU vs PWI experiences. Also, several students described using impression management strategies, by limiting their religious conversation or “code-switching” within the biology community in fear of stigmatized responses. We also found religion-as-a-support in navigating negative experiences among participants. We will end this talk with recommendations provided by participants of what the biology community can do to make students with multiple stigmatized identities feel more valued and respected.

Contribution: This study is the first to explore the experiences of Black Christian graduate students in biology programs and indicates that both religious and racial identity can impact student experiences in the biology community.

Paper ID: 30

First-Year Students from Marginalized Groups Report Decreases in Task Value, Self-Efficacy, and Metacognition in an Introductory Biology Course

Holly J Swanson (University of Rhode Island)*; Bryan M Dewsbury (University of Rhode Island)

RESEARCH QUESTION:
Student affect and psychosocial behaviors critically impact academic success. Self-regulated learning (SRL) is a reiterative process where students reflect and adapt their learning approaches to achieve their academic goals based on the effectiveness of previously used strategies. Student affect and psychosocial behaviors can be integrated into SRL through Bandura’s social cognitive theory (SCT) which describes the interrelatedness of personal factors, environmental factors, and behaviors. In the absence of appropriate pedagogies and interventions, students may choose to engage in maladaptive behaviors as these factors change over a semester, especially first-year students transitioning to higher education. This study explored how measures of SRL changed over a semester for first-year students in a large-enrollment introductory biology (Bio101) course and how changes differed for marginalized identities.

RESEARCH DESIGN:
This descriptive study was conducted across three sections of Bio101 at a predominantly White institution. Responses to the Motivated Strategies for Learning Questionnaire (MSLQ) were collected at the beginning and end of the semester for subscales of the motivation and cognitive and metacognitive strategy scales. The MSLQ is based on Bandura’s SCT and has been validated and widely used across disciplines and contexts. Personal factors from SCT included the motivation survey scale responses and demographic data. Measures of behaviors included survey responses for the cognitive and metacognitive strategies scale and the different sections provided an environmental factor.

ANALYSES AND INTERPRETATIONS:
Cronbach alpha scores found the subscales reliable (ranging from 0.741 to 0.943).

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Factorial multivariate analyses of variance (MANOVAs) were used to compare changes in scores for the motivation subscales and the cognitive and metacognitive strategy subscales. Factors used were first-generation (FG) status, ethnicity, early course performance, course section, and all possible interactions. Follow-up ANOVAs and Type III sum of squares were used to further determine significant subscales and student groupings. Significant decreases in task value and self-efficacy were detected for FG students ($\eta 2 = 0.205$, 95%CI [0.099, 0.311]). When students find personal value in a course, the effort and time exerted are viewed positively, meanwhile, if there's no value, then it's a detrimental cost. If the cost is perceived as too high, they may disengage or choose to use maladaptive behaviors. Decreases in self-efficacy ($\eta 2 = 0.336$, 95%CI [0.223, 0.449]) and metacognitive strategy use ($\eta 2 = 0.334$, 95%CI [0.208,0.460]) were also observed for students of color who performed poorly on the first exam. For those students, a decrease in self-efficacy could have led to the decreased use of metacognitive strategies. Over the course of the semester, our study found that marginalized groups lose interest in the course, lose confidence in their abilities, and choose maladaptive behaviors.

CONTRIBUTION:
Academic gaps continue to persist in introductory STEM courses for marginalized student identities. While there are limitations, we found important differences in the development of SRL for marginalized students as they transitioned to higher education. We suggest instructors continue to improve student engagement, student use of metacognitive strategies, and provide feedback focused on improvement in learning - not solely grades.

Paper ID: 171

Improving outcomes for transfer students through pre-transfer exposure to problem-based learning

Jen Teshera-Levye (East Carolina University)*; Heather D. Vance-Chalcraft (East Carolina University); Tammy Atchison (Pitt Community College); John Stiller (East Carolina University); Jean-Luc Scemama (East Carolina University)

Research Question: The ability to transfer from a two-year to a four-year institution is a key component of increasing equity in higher education generally, and in STEM in particular, but this pathway is not without challenges. One of the primary concerns expressed by students who transfer to our four-year institution is the fear that they are unprepared for the teaching style of classes after they transfer. We partnered with a local community college to create an introductory biology sequence that would emphasize problem-based learning, more closely aligning it with the sequence at our institution. Our goal was to increase students' feelings of self-efficacy and biology identity through increased exposure to these formative assessments. We ask whether students taking these revised courses found these activities to be valuable, and if they identify themselves as "biologists" following these courses. Moreover, we investigate whether exposure to problem-based activities at community college decreased the perception of

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different teaching styles at the two institutions after transfer. Finally, we evaluate how student responses to these questions were impacted as these courses changed from in person, to hybrid, to fully online due to COVID-19.

Research Design: Students in multiple semesters of the modified, problem-based introductory biology sequence were asked to complete two validated instruments from the published literature: a biology identity instrument and a survey of student buy-in to formative assessments (the FABUS). We also have collected demographic data (both institutional and self-reported) and academic performance data from both institutions (e.g. GPA). In addition, we have conducted semi-structured interviews with students who have completed the course, some immediately following course completion and some after they have transferred.

Analyses and interpretations: Both survey and interview results suggest that students generally found the problem-based activities implemented in the course to be beneficial to them: over 80% of survey respondents agreed or strongly agreed that the course activities were useful, and students most strongly agreed with the statements that the activities helped them understand and prioritize course material; these sentiments were echoed in the open-response portion of the instrument. About a third of FABUS respondents particularly emphasized the hands-on nature of the course activities, as did a similar proportion of students interviewed. In interviews, students also emphasized the rigor of the course as good preparation for future classes. Students also reported a high confidence in their understanding of course material and a high curiosity about and enjoyment of biology following these courses. We found no significant differences in students post-course biology identity or FABUS results between students who took the course entirely in-person and students who experienced a switch to distance education, nor were there significant differences among racial groups or genders in either of the instruments given.

Contribution: These results bolster the growing understanding that stronger partnerships between two-year and four-year institutions are needed to support successful biology undergraduate students. Our results highlight ways that four-year institutions can work with community colleges to adapt curricula in a way that reduces a source of anxiety for students who transfer.

Paper ID: 44

High stakes exams exacerbate disparities in scores between students across the lines of gender, race/ethnicity, and socioeconomic class in introductory biology courses.

K Supriya (Arizona State University)*; Min Li (University of Washington); Christian D Wright (Arizona State University); Sara Brownell (Arizona State University)

Background: Grades in introductory STEM college courses play an important role in students' decisions to stay or switch out of STEM majors. However, grades are not always reflective of students' conceptual understanding. Studies have shown that grading structures, particularly the

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types of assessments used and the weights assigned to them, affect student performance and can influence disparities in student grades by social identities. For example, in introductory STEM courses, women score lower on exams but higher on non-exam assessments compared to men, even after controlling for prior academic performance. Such disparities in exam scores might arise due to biases in exam questions themselves. For example, six questions on the force concept inventory were found to be biased against women and removing those questions from total score calculation substantially decreased the gender gap.

Research Question: Here, our goal was to (1) Examine the disparities in student scores by gender, race/ethnicity and socioeconomic status in exams compared to non-exam assessments (2) Assess whether disparities in exam scores might be a consequence of bias in questions.

Research Design: To explore this, we evaluated 48 exams taken from 10 introductory biology courses taught by different instructors at a large R1 university. Using linear mixed models with course as a random effect, we determined if there were disparities in exam scores between demographic groups on exams and on other assignments that were a part of their overall course performance but not directly related to exam scores (e.g., homework assignments, practice quizzes) after controlling for high school GPA. Next, we used differential item functioning (DIF) analyses to explore if there were differences in student performance based on their social identities at the level of individual exam questions.

Analyses and Interpretations: Compared to non-exam assessments, we found larger score disparities by gender, race/ethnicity, and socioeconomic status in exams. More specifically, on non-exam assessments, Hispanic/Latinx students, Pell-eligible students and First-generation students scored 0.08, 0.1 and 0.09 standard deviations (SD) less than white, non-pell eligible, and continuing generation students respectively (all $p<0.05$). However, on exams, these students scored about 0.2 SD less than their more privileged counterparts. In addition, women scored 0.4 SD less than men, and Black and Indigenous students scored 0.36 and 0.33 SD less than white students respectively (all $p<0.05$) on exams, but there was no significant difference in non-exam scores between these groups. Despite these large disparities in exam scores, we found little evidence for differential item functioning in exam items by gender, race/ethnicity or socioeconomic status.

Contribution: Our results suggest that non-exam assessments might be more equitable than high-stakes exams, and observed disparities in exam scores are likely not a result of bias on individual exam questions, but rather a result of other mechanisms. These high stakes assessments may activate test anxiety or stereotype threat, both of which are more likely to impact less privileged groups. Given the effect of grades in introductory courses on students' choice of major and retention, it is important to evaluate the grading practices used in these courses and consider whether high stakes assessments ought to be continued in introductory courses.

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Friday, July 30th, 2021

Session A: Instrument Development

Paper ID: 52

Measuring critical thinking using the Biology Lab Inventory of Critical Thinking for Ecology: How recency effects may influence students' abilities to make comparisons

Ashley B Heim (Cornell University)*; David Esparza (Cornell University); Cole Walsh (Cornell University); Natasha Holmes (Cornell University); Michelle Smith (Cornell University)

Research Question: Critical thinking, which concerns the evidence-based ways in which individuals make decisions about what to trust and what to do, is paramount to scientists as they evaluate the reliability of scientific data. However, few methods exist to assess the development of students' critical thinking skills, especially within a disciplinary context. To address this, we are developing the Biology Lab Inventory of Critical Thinking for Ecology (Eco-BLIC), an instrument to assess students' critical thinking in the context of ecological field studies that are either experimental or observational. Based on pilot studies and findings from a similar instrument, the Physics Lab Inventory of Critical Thinking, we explored whether the order of experimental lab and observational field scenarios presented to students influences how they respond to items on the Eco-BLIC. Thus, we have focused on the following questions: 1) How do students evaluate the quality of data in experimental vs. observational field ecology studies?; and 2) Do students' evaluations differ depending on whether they see the experimental or observational scenarios first?

Research Design: The Eco-BLIC asks about two scenarios focused on the efforts of biologists researching a predator-prey relationship using closed-response items. The first scenario involves smallmouth bass and mayflies, while the second involves great-horned owls and mice. For each scenario, students compare two studies, one performed in an observational field setting and the other in an experimental lab setting. Students are asked to evaluate the scenarios by exploring: 1) the ecological relationship in hypothetical data; 2) the strengths and weaknesses of the study designs; 3) plausible next steps; and 4) comparisons between both groups' approaches. To date, undergraduate students (N=912) enrolled in 27 ecology courses at 11 U.S. institutions have taken the Eco-BLIC. Approximately half of the students who completed the Eco-BLIC received a version in which the experimental lab setting in both scenarios was presented first, while the other half of participants received a version in which the observational field setting in both scenarios was presented first. This design choice involved the use of a comparison group so that students were always comparing the methods of two hypothetical groups rather than a single group in isolation. Descriptive statistics, t-tests, and ANOVAs were used to evaluate student responses.

Analyses and Interpretation: When comparing whether the question order influenced student response, we found that in general, the comparison group the students saw most recently (i.e., experimental lab or observational field) was the one they ranked as performing a more effective experiment. We observed this recency effect in both predator-prey scenarios. Question ordering had a tangible effect on how students interpreted data and analyses within the Eco-BLIC.

Contribution: Our findings have implications for future instrument development and how instructors measure students' critical thinking skills. We aim to further understand the use of

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contrasts in critical thinking (i.e., the idea that students' thinking varies based on what contrasts are presented to them) as well as explore how instrument development may influence the recency effect we observed on Eco-BLIC items (e.g., by presenting both scenarios simultaneously to students, rather than linearly).

Paper ID: 75

Evaluating problem solving in biochemistry: a decisions-based framework

Argenta Price (Stanford University)*; Roshan Bhaskar (Stanford University); Carl Wieman (Stanford University)

Research Question: A primary goal of science education is to produce good scientific problem solvers, but this has been difficult to teach effectively because much of the problem-solving process is under-specified and difficult to measure. (Contribution) Better measures of students' discipline-specific problem-solving capabilities will allow instructors and departments to provide more helpful feedback to students and guide improvements in teaching.

Research Design: We characterized the detailed problem-solving process of experts across the STEM disciplines and are developing assessments based on that characterization. Based on interviews with 52 STEM experts, we identified a set of 29 specific and measurable decisions that characterize the process through which they solve problems from their work. (Analysis and interpretations) We also found that making these decisions relies heavily on predictive models that embody the relevant disciplinary knowledge. We are now using this decisions framework to develop problem-solving assessments in various science, engineering, and medical disciplines.

We developed a biochemistry assessment in which students make a large subset of the decisions. The problem is based on a typical problem context: students interpret enzyme kinetics data to identify an inhibitor's mode of inhibition. But our assessment has students work through the problem differently. Students start with identifying key features and potential solutions by making predictions based on limited initial information, then decide what information is needed to solve the problem. They then decide how they would like key pieces of information to be represented for subsequent data interpretation, and finally decide on a solution. Students are asked to reflect on their solution and their process of arriving at the solution by describing any remaining uncertainties and next steps. We tested the problem in think-aloud interviews with test-takers ranging from undergraduate intro biochemistry students to experts familiar with this kind of data from biotech industry.

Analysis and interpretations: Based on the pilot interviews, we improved wording and refined the assessment to make it more realistic by including irrelevant data (requiring test-takers to make decisions about key features, relevant information, and problem goals). We are now collecting pre and post data from a small cohort of students taking a biochemistry course. We are also creating a rubric based on "consensus" responses from experts to evaluate how much more expert-like problem solvers the students have become after their experience in the course.

Contribution: We will present the development of the problem-solving decisions framework, its application in the context of the biochemistry assessment, and our findings from this small class study. Assessments based on this framework have the potential to improve how problem solving is measured and taught across STEM disciplines.

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Paper ID: 84

Applying Ecological Diversity Methods to Improve Quantitative Examination of Student Language in Constructed Responses

Megan M Shiroda (Michigan State University)*; Michael Fleming (CSU Stanislaus); Kevin Haudek (Michigan State University

Research Question: Student constructed responses (CRs) offer a wealth of information to both instructors and researchers; however, common lexical diversity measures (e.g. Type to Token Ratio, TTR) and text analysis software provide little insight into student language within a CR corpus. Herein, we hypothesized ecological metrics of diversity (Whittaker's beta (β) and species turnover) and dimension reduction techniques (ordination) would allow us to explore student language in explanations of STEM concepts. Further, these methods would enable quantitative examination of language changes based on known characteristics (Institutional Type, assessment Timing or level of Thinking). We asked 1) Do ecological diversity metrics such as β-diversity and species turnover offer a more meaningful quantification of student language differences compared to TTR? 2) Do ordination techniques aid in exploratory and quantitative analysis of a corpus of CRs over text analysis tools?

Research Design: We utilized a CR corpus on weight loss taken before and after a tutorial at three different institutional types (Primarily Undergraduate Institutions, Two-Year Colleges and Research-Intensive Institutions). CRs were also categorized into developing, mixed or scientific thinking based on the inclusion of normative and non-normative ideas. We calculated TTR, β-diversity and species turnover of the entire data set and individual subsets based on Institutional Type, Timing and Thinking. We also performed two types of dimension reduction (Detrended Correspondence Analysis & Principal Component Analysis), which are both widely used in ecology and other fields to visually represent and quantitatively complex data.

Analyses and Interpretations: We created a data matrix of the corpus with each response (rows, n=444) being equivalent to ecological samples, and each word being equivalent to species in a sample (columns, n=694). β-diversity and species turnover demonstrated that the largest intra-group difference was among Scientific Thinking CRs (β=57.3; Range=31-57.3) TTR was less informative as it simply calculates a percent of repeated words (range: 0.103-0.176). Ordination using a reduced matrix with uninformative data points removed (rows=418; columns=254) provided meaningful, holistic representations of the data by grouping similar CRs closest to each other in a two-dimensional plot, wherein each response is a data point. This simplified examination of the CRs and drew attention to unique responses. Using the plots, we also examined how different groups of CRs relate to each other. We observed little overall difference among Institutional Types (0.07 SD; 3.5% of matrix is different, p=0.084, PERMANOVA), moderate differences between Timing (0.45 Standard Deviations; 22%; p=0.0002), and the most difference among Thinking (1.34 SD; 67%; p=0.0002), which was also supported by text analysis (number of significantly different words (Type=8; Timing=17; Thinking=34).

Contribution: This work provides a novel application of established ecology methods for examining lexical diversity in CRs. Written explanations are important for understanding how students explain complex topics in science, and exploring student language quantitatively opens new avenues for analyzing student language in written responses. Additional applications of this method include examining student language development over time and the effects of context on student explanations of cross-cutting concepts.

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Paper ID: 23

Relationships between prediction accuracy, metacognitive awareness, and performance in introductory genetics students

Jenny Knight (MCDB)*; Melanie Peffer (University of Colorado Boulder)

Research Question: Prior work on student cognition has shown a disconnect between students' perceptions and the reality of their practice and performance. Similarly, we have identified that during problem solving, introductory genetics students often report engaging in strategies that are not observable in their written work. Without an awareness of one's own understanding and thought processes (metacognitive awareness), a student may not be able to shift their learning strategies (metacognitive regulation) to achieve success. Thus, our research question is: What is the relationship between students' perception of performance, metacognitive awareness, and performance at multiple time points across a semester?

Research Design: We gathered multiple forms of data from students enrolled in a large introductory Genetics course (n=357 students). Students answered demographic and general metacognition questions at the beginning of the course and completed the Genetics Concept Assessment (GCA) both pre and post. To gauge perception of performance, students predicted their quiz grade at the end of each of 6 quizzes during the semester. We then calculated how much students over predicted, under predicted or matched their actual grade by subtracting their predicted grade from their actual grade (F=0, A=4). When they received their graded quizzes, they answered two question to stimulate metacognitive awareness. Using an emergent coding process, we developed categories to describe students' reflections, as well as giving each answer a 0/1 score of unaware/aware. Awareness scores were then totaled per quiz and averaged across quizzes.

Analyses: For all consenting students (n=234), a linear regression analysis showed that students' average metacognitive awareness score significantly predicted their overall performance- on quizzes, final exam, and post GCA. Students with high metacognitive awareness post-quiz were also more likely to be accurate in predicting their quiz grades than those with low awareness, who on average over-predicted by nearly a letter grade. We used a subset of students (n=154) who gave reflections for at least four quizzes to look at changes in awareness. Students whose metacognitive awareness increased over the semester performed significantly better on the final exam than those whose awareness decreased. We also identified four categories within student reflections. Students most frequently mentioned performance ("I didn't get an A") followed by responsibility ("I should have practiced solving more problems"), knowledge ("I understood how to interpret pedigrees"), and blame ("The questions were confusing"). Students who stated being unsatisfied had a higher proportion of blame statements (20%) than those who were satisfied (2%). We are still analyzing whether over-predicting performance on a quiz triggers metacognitive awareness and then influences performance on the next quiz. Overall, we have identified that those who can accurately predict their grades are more likely to demonstrate metacognitive awareness, and that an increase in awareness predicts higher performance.

Contribution: Confronting students with their misperceptions of performance and triggering their metacognitive awareness may lead students to identify and use better learning strategies.

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Ultimately, we hope to uncover ways to train students in becoming more aware and thus more successful.

Paper ID: 173

Introductory biology students' learning dispositions and proficiency with building conceptual models

Amanda J Sebesta (Saint Louis University)*; Elena Bray-Speth (Saint Louis University)

Research Question: Model-based instruction and assessment in which students create, interpret, and revise models to reason about biological systems promotes content mastery and use of higher-order cognitive skills. However, modeling tasks are often unfamiliar and cognitively demanding, requiring time and practice to develop proficiency. We hypothesized that introductory biology students' dispositions towards learning, representing an underlying tendency for how students might approach learning tasks, can explain their modeling proficiency. In a large, learner-centered, introductory biology course for majors, we investigated whether students' dispositions towards persisting at challenging tasks and using higher-order cognitive skills could explain their modeling proficiency on exams.

Research Design: In the first week of the course, students (n=224) were trained how to construct conceptual models based in Structure-Behavior-Function (SBF) theory (articulating and organizing relationships between system components to convey a system's overall function). Students then practiced making models to explain how genotype determines phenotype in various case studies through homework assignments and in-class group work activities. Model-building tasks were included on three of the four course exams (1, 2, and 4) and represented a substantial proportion of the exam score (~16% for exams 1 and 2; ~8% for exam 4, the cumulative final). Exams included multiple-choice and short-answer (MC/SA) questions assessing the same concepts as the SBF models. One week before exam 1, we administered a survey with validated scales for several dispositions: grit, perceived academic control, self-efficacy, need for cognition, critical thinking, and elaboration. Grit, perceived academic control, and self-efficacy represent tendencies to persist at challenges whereas need for cognition, critical thinking, and elaboration represent tendencies to use higher-order thinking.

Analyses and Interpretations: We collected instructors' scores for all exam items, including rubric-based scores for the SBF models. Students' MC/SA score and model score strongly and positively correlated with each other for all exams, and preliminary generalized linear model (GLM) analyses determined that students' MC/SA score (a proxy for content mastery) significantly explained their modeling proficiency for each exam. We then incorporated the disposition measures in GLM analyses to identify whether they explained modeling proficiency beyond general content mastery. We found that students' self-efficacy beliefs, critical thinking tendency, and MC/SA score significantly explained their model score on exam 1. However, only MC/SA score significantly explained model score on exams 2 and 4.

Contribution: Students' dispositions towards learning uniquely explain early modeling proficiency, suggesting that how students approach learning tasks supports initial engagement with a novel, cognitively demanding assessment. However, students' general content mastery (MC/SA score) more consistently explains modeling proficiency, suggesting this modeling task is largely unbiased towards students with particular dispositions. Future work should examine students' perceptions of the modeling task to further understand how they engage with a

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challenging assessment, as well as other attributes that can explain variation in modeling proficiency and content mastery, such as use of feedback on formative assessments.

Paper ID: 152

Targeting instructional interventions to address student thinking about the central dogma revealed by automated analyses of student written responses

Jenifer Saldanha (Michigan State University - East Lansing, MI)*; Juli Uhl (Michigan State University); Kevin Haudek (Michigan State University

Research Question: The processes of genetic information storage and transfer are often taught in introductory biology courses using the framework of the central dogma which is a part of an important core concept identified in AAAS Vision and Change and in the Next Generation Science Standards. The complexity and interconnectedness of these genetic processes can prove challenging for students. In this study, student understanding of the central dogma processes was evaluated using student writing and an automated formative assessment tool. Our research goal was to investigate whether instructional changes adapted in response to the tool's assessment report resulted in improvements in student learning of these genetic concepts.

Research Design: A Constructed Response (CR) question about the central dogma was administered to an initial cohort of 47 students in spring 2019 and their responses were analyzed using the assessment tool. The assessment report informed pedagogical decisions. Additional discussions and activities targeted to the issues uncovered by the report were developed and used, and students' performance on a summative assessment was recorded. The targeted pedagogical strategies and additional interventions were then incorporated into course structure, material, and activities for subsequent cohorts of 47 students each, the same CR question was administered, and student performance on formative and summative assessments was recorded.

Analyses and Interpretations: After initial instruction, the automated assessment tool was used to assess students' written responses in the first cohort. The report generated revealed gaps in student understanding, as well as naive ideas. For example, 45% demonstrated incorrect understanding and 32% demonstrated incomplete understanding of the process of DNA replication. In response, pedagogical changes including targeted small group discussions, transcription and translation worksheets, and related activities were adopted in the classroom post-instruction to address non-scientific ideas. A question related to the central dogma in an end-of-semester summative assessment revealed improved student understanding. The pedagogical interventions were employed again in cohort two. Use of the same CR question with the new cohort and after instruction with the new activities, revealed that only 19% of students demonstrated incorrect understanding of DNA replication. Acknowledging that prior knowledge about the central dogma might have been different between these two cohorts, a third cohort was incorporated into the study. The same CR question was administered pre-instruction to this cohort, out of which approximately 77% stated that they had learned about DNA replication prior to the course. The CR question was administered pre-instruction, and responses were assessed by the tool. The results revealed that prior to instruction, 45% of the students demonstrated incorrect understanding of the process of DNA replication. Instructional interventions from previous semesters have been incorporated into the course content, and post instructional data is being collected to measure learning gains.

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Contribution: The results from this study highlight the effectiveness of using data from the automated formative assessment tool to address student thinking and develop targeted instructional efforts within a relatively short time frame, to guide students towards a better understanding of complex biological concepts.

Session B: Research Experiences – Field Work

Paper ID: 28

How do field experiences in the natural sciences affect undergraduate outcomes: results from a scoping review

Xoco A Shinbrot (Cornell University)*; Kira Treibergs (Cornell University); Lina M Arcila_Hernandez (Cornell University); David Esparza (Cornell University); Kate Ghezzi-Kopel (Cornell University); et al.

Research Question
Evidence has shown that field courses can facilitate transformative learning, build transferable skills, and improve retention. These outcomes are especially impactful for underserved minority students. To understand and synthesize their impact on students, we conducted a scoping review, using an established methodological frameworks and conceptual framework which depicts student cognitive, affective, behavioral and skill-based outcomes from field course participation as the interface between internal student factors and external field course factors. Our research questions include: 1. What influences undergraduate participation in field courses in the natural sciences at US-based academic institutions? And 2.What student outcomes are reported?

Research Design
We conducted a systematic scoping review, a method to synthesize a diverse body of knowledge and identify knowledge gaps. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist to ensure a robust and replicable process. We conducted a systematic search of eight online databases (e.g., Web of Science). Search terms included variations on the terms, “field course,” “undergrad,” and “natural science.” In both title and abstract screening as well as full text screening citations were reviewed for relevance by at least two independent reviewers. For full text analyses, two reviewers independently extracted data and then met to resolve discrepancies through discussion.

Analyses and Interpretations
In total, 61 articles were included for final analyses. The studies spanned institutions across the United States, with a clustering of universities in the Northeast, Great Lakes, and Southwest. These field courses tended to occur in certain ecosystems particularly forests and rivers, with few in urban or agricultural areas. We found few studies reported student demographics, where only 39% reported gender, 18% on race/ethnicity, and 3% on first generation status. Studies were mostly focused on the cognitive outcomes (57%), while affective (48%), behavioral (29%),

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and skills-based outcomes (26%) were less frequently studied. Most studies focused on student self-report and reflection of their experience. The most commonly reported cognitive outcomes were knowledge. We found a broad range of factors have been studied for affective (e.g. confidence, attitudes towards science), behavioral (e.g. career goals, research skills), and skills-based (e.g. collaboration) outcomes. Notably, only 23% of studies used empirical evidence, with a clear description of the study design and rigorous analytical methods.

Contributions
The 61 articles included in this systematic scoping review constitute the rapidly emerging body of research on the impact of US-based field courses in the natural sciences on undergraduate student outcomes. Evidence shows field course participation is associated with student cognitive, affective, behavioral and skill-based outcomes, although the outcomes vary depending on a range of internal and external factors, and more data is needed on internal student actors. The focus on outcomes related to cognitive factors revealed in this review reflects a number of factors, including the increasing recognition of the unique knowledge gains students make in the field. However, the relative scarcity of attention to affective, behavioral and skill-based outcomes is striking. This review reflects the need for protocols on how to assess field courses through validated assessments and research best practices. Our review shows that studies on field courses are gaining in number, suggesting their benefits for students is becoming more well-known and celebrated.

Paper ID: 68

Half-century of student data reveal benefits of biology field course

Lina M Arcila-Hernandez (Cornell University)*; Cinnamon Mittan (Cornell University); Todd C Lamb (Auburn University); Katherine Holmes (Cornell University); Caitlin McDonald (Cornell University); et al.

Research Question: Field courses engage small groups of students in collaborative work while allowing integration and application of conceptual knowledge. All of these strategies are considered to be effective pedagogical tools to increase student’s retention and success in their discipline. However, few studies demonstrate the impact of field courses on retention and career outcomes. Furthermore, despite the perception that field courses play an important role in enhancing community development, scientific skills, and collaborations, field courses are in decline in multiple disciplines. Here we addressed the following questions: how does a biology field course impact career outcomes for graduate students? And what experiences and skills were most useful to the students’ scientific career? We address these questions through the lens of constructivist theory (i.e. learners need to construct their own understanding in order for it to be meaningful). We hypothesized that an immersive field experience would provide novice researchers with opportunities to construct their own knowledge.

Research Design: In a longitudinal study that spans 44 years, we compared performance outcomes of graduate school students (n= 189) who participated in a two-week immersive field

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course on ecology and evolutionary biology to students in the same graduate program who did not participate in the field course (n= 410). We assessed students' (RQ1) completion of their graduate program, (RQ2) number of publications during graduate school and 10 years after graduating, and (RQ3) current career. To compare the impact of the field course on these two students populations, we used contingency tests and Generalized Linear Mixed models. (RQ4) Finally, we surveyed all of the individuals who were in the graduate program since 1973 and had email addresses (n= 447) to determine what experiences or skills were most relevant to their scientific career. We coded the 140 responses using thematic analysis.

Analyses and Interpretation: (RQ1) We found that graduation rates did not differ between groups (X^2= 1.4747, p-value = 0.29). (RQ2) Students who attended the field course published significantly more scientific publications (mean +/- se: 4.18 +/- 0.30) when compared to those that did not attend the course (mean +/- se: 2.87 +/- 0.22; P<0.001; Cohen's d=0.31). However, the magnitude of this difference was smaller after 10 years (Cohen's d=0.19). (RQ3) Most students in both groups continued working in scientific careers. Yet, more field course participants became faculty at either a research or teaching institution (51%) compared to non-participants (34%). (RQ4) We also found through the student experience survey that students obtained important skills from attending field courses, such as opportunities to carry out research and learning from observing nature. Field courses also provided opportunities to engage with activities that were cited as critical to success in graduate school, including student-led environments and mentor feedback.

Contribution: Our work demonstrates that field courses can have profound impacts on students' careers. While retention in graduate school was not affected by the field course experience, scientific publication rates and academic career outcomes were positively impacted. These findings underscore the importance of maintaining field courses in biology departments as effective pedagogical tools to train the next generation of scholars.

Paper ID: 61

Experiences in undergraduate, campus-based field biology: fostering connection towards a Critical Pedagogy of Place

Jeannie Yamazaki (Cornell University)*; Kira Treibergs (Cornell University); David Esparza (Cornell University); Michelle Smith (Cornell University); Marc Goebel (Cornelly University)

Research Question:
Place-based education can foster environmental awareness and action by making large scale environmental issues - such as global climate change - feel more local, familiar, and urgent. While campus-based field courses familiarize students with their local environment, the degree to which they promote pro-environmental and prosocial behavior in students is understudied. To understand the impact of field courses, we investigated how campus-based field courses 1) foster students' interpersonal and environmental connections and 2) influence students' awareness and understanding of environmental issues. We frame this research using the

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Critical Pedagogy of Place (CPP) framework, which combines place-based education with critical pedagogy to address the complex intersection of social justice and environmental issues. While field courses do not typically cover social justice in their curricula, their ability to promote meaningful connections with people and the environment presents opportunities to build foundations towards CPP.

Research Design:
To investigate these questions, we conducted semi-structured interviews with undergraduate students (n=12) who had completed an introductory field biology course in the fall of 2020 at a research-intensive, U.S. university in the Northeastern United States. Interview questions were designed to probe key elements of CPP, including points of interpersonal connection, place attachment, and concern for the environment. Interviews were coded using an iterative process, first deductively with general codes related to the interview questions, then by inductive axial coding to further identify and relate emergent themes.

Analysis and Interpretations:
Analysis of interview data revealed several key themes that support the foundations of CPP in a biology field course setting. Concerning environmental connection, all students (n=12) noted an increased sense of connection to place (i.e. the campus and its environment), with a subset (n=3) explicitly noting feeling “at home” on-campus and in surrounding natural areas. Concerning social connection, several students (n=6) expressed a desire to share their environmental knowledge with others outside the course. Some students (n=3) also experienced an increased sense of optimism for positive environmental change, noting connections with others who share their care for the environment. Finally, three students (n=3), unprompted, expressed views related to indigenous ways of knowing and challenging dominant Western scientific modes of thought.

Contribution:
While campus-based field courses are known to foster transformative learning, rarely do they address social justice issues in their curricula. Our findings suggest that field courses are in fact well-suited to address social and environmental action. The collaborative, rigorous, and hands-on experience of a field biology course prompted the formation of social and environmental connections that are foundational to CPP. We suggest that researchers and instructors can use the CPP framework to draw on the existing connection-building in field courses and their potential to catalyze social and environmental action.

Paper ID: 46

How do introductory field biology students feel in the field? Student reflections provide a window into affective outcomes

Kira Treibergs (Cornell University)*; David Esparza (Cornell University); Jeannie Yamazaki (Cornell University); Michelle Smith (Cornell University); Paul Rodewald (Cornell University); et al

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Research Question:
Field courses provide immersive opportunities for students to link theory to practice while taking on new challenges, learning transferable skills, and gaining disciplinary knowledge. Student affect, in particular, motivation, emotion, and connection to place, is not well documented in the context of field courses. However, positive affect is important for student success, in alignment with van der Hoeven Kraft's 'Model of the Affective Domain for the Geosciences'. Reflective writing helps students process and learn from field experiences while also providing a much-needed opportunity for the assessment of affective outcomes. In our research we ask the following questions: 1) What motivations and emotions do students experience in the field, and during what experiences? 2) What experiences elicit connections to place? 3) What qualities of field experiences catalyze transformative learning by challenging students' previous expectations to cause them to gain a new perspective?

Research Design:
Students (n = 54) were enrolled in a 2019 introductory field biology course for Environment and Sustainability majors at a Ph.D.-granting institution. To understand how campus-based field experiences elicit affective responses we employed inductive and deductive coding and framework analysis of 743 open-ended reflections written by students following each of 12 three-hour field labs and two, full-day field trips. Our framework analysis, based on van der Hoeven Kraft's model, explores the relationship between motivation, emotion and place-based connection and student attitudes towards learning in the field.

Analysis and Interpretations:
Preliminary analysis suggests that while predominantly intrinsically motivated, students are also motivated by a desire to protect the environment, gain career-relevant skills, and earn good grades. Students' emotions varied, but were consistently linked to novel experiences, enjoyment of the outdoors, and encountering challenges. Throughout the semester, prevalent themes included self-efficacy gains when learning to use new equipment, increased enjoyment when working with other students, and career motivation when practicing new discipline-specific skills or interacting with experts in the field. Students also experienced physical discomfort during inclement weather and expressed frustration when handling unfamiliar equipment or navigating outdoor hazards. Field experiences promoted students' connections to nature through aesthetics, interactions with organisms, and by connections to specific field sites. Occasionally, students reflected on disorienting dilemmas, where a field experience challenged their previous understanding (eg. discomfort working with insects) and helped them to gain a new perspective about field biology (eg. deeper understanding of local insect diversity, insight into scientific practice, and appreciation for preserved specimens).

Contribution:
In addition to learning benefits for students, reflections provide a detailed window for researchers and practitioners to assess affective outcomes of field experiences. Our results will help instructors scaffold inclusive experiences for students who are new to fieldwork by identifying factors that promote or inhibit positive student affect. A better understanding of the

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affective outcomes of field courses is of great importance due to the inextricable connection between positive affect and student success.

Paper ID: 33

Constructing Biology Education Research Scholar Identities: A Duoethnography

Rou-Jia Sung (Carleton College)*; Emily Holt (University of Northern Colorado); Stanley Lo (UCSD)

RESEARCH DESIGN
Here, a duoethnographic approach is used to explore the experiences of three faculty who have entered BER at different career stages and engage with BER to different degrees based on professional responsibilities. Duoethnography is a specific ethnographic approach that compares and contrasts experiences from two or more individuals to describe the commonalities and variations of how different people may experience the same phenomenon. The goal of duoethnographic inquiries are not predefined, and the discussions are emergent rather than prescriptive. Even though all three of us engage in BER, our different professional identities help establish validity of the qualitative duoethnography data through multiple triangulations. Here, through co-constructed dialogues and exposition, we use our own collective experiences in BER to explore potential professional trajectories into BER.

RESEARCH QUESTION
We explored three guiding questions: 1) What were our pathways into BER?; 2) What driving factors facilitated our continued participation in BER?; 3) How did we develop our professional identities within BER?

ANALYSES AND INTERPRETATION
We share our experiences not as a commentary for how others should behave but as examples of our own learning process. An important commonality that emerges is our experience of BER as a community of practice, in which we were consistently supported by strong mentor figures within the community to perform authentic and legitimate tasks despite our novice status. These interactions, with individual mentors and the community as a whole, were pivotal in our entry into BER.

CONTRIBUTION
The process of entering and establishing oneself in a new research field can be a daunting process. For many biology education research (BER) scholars who began their careers in a life sciences discipline, their career trajectories have necessitated this challenge. We hope that the dialogues of this duoethnography can spark reflection for our continuing discussions as a community to both support current BER scholars and provide guidance for recruiting and retaining new BER scholars in our field.

Paper ID: 65

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Exploring how Graduate Students Perceive their Role as an Instructor in the CURE Classroom

Emma C Goodwin (Portland State University)*; Jessica Cary (Portland State University); Erin E Shortlidge (Portland State University

Research Question: Efforts to reform undergraduate biology education have led to increased implementation of course-based undergraduate research experiences (CUREs). While there is evidence of positive student outcomes from CURE participation across course contexts, previous research rarely considers that graduate teaching assistants (GTAs) often teach introductory labs. The classroom role of GTAs expands in a CURE—they no longer need to simply teach a lab class, but also to serve as research mentors. GTAs, who may be novice researchers and/or teachers, likely vary in their interest in teaching a CURE, which could impact their students' experiences. We used Expectancy-Value Theory (EVT; Eccles & Wigfield, 2002) to guide our study, hypothesizing that how GTAs teach CUREs will be impacted by their subjective task value (attainment, intrinsic, utility, and cost) for the CURE. Specifically, GTAs who have high value for the CURE may be more likely to teach in accordance with CURE expectations, and to fulfill their role as CURE mentors.

Research Design: As part of a larger case study conducted at a research institution that implements the SEA-PHAGEs CURE curriculum (Jordan et al., 2014), we interviewed nine GTAs who taught the CURE. In the interviews, we first prompted GTAs to reflect on teaching the CURE using a card-sort activity. GTAs ranked the relevance of statements matched to specific subjective task values. This activity guided initial discussions, and GTAs additionally answered semi-structured questions on their perceived value and role in the CURE. Interview questions and card sort items were iteratively developed prior to the interviews.

Analyses and Interpretations: We generated a codebook informed by previous work with CURE instructors to capture EVT themes and CURE perceptions. Two researchers read through all interview transcripts and revised the codebook as needed. Researchers then independently coded interviews and met to discuss each code designation to consensus. Informed by the interview coding, we developed three profiles to describe GTA perceptions of their role: "Student Supporters," who prioritize providing emotional support for students, "Research Mentors," who prioritize developing student's research skills, and "Content Deliverers," who prioritize didactic teaching.

Many GTAs held a multifaceted perspective on the value of a CURE. Attainment value was frequently emphasized—specifically that GTAs valued the CURE because it benefits students. GTAs found some intrinsic (enjoyment/interest) and utility value (professional development or financial benefits) in teaching the CURE. GTAs varied widely in how often they referenced costs associated with the CURE—time and emotional exhaustion were very salient for a few GTAs.

Four GTAs perceived they had dual roles in the CURE: to balance acting as a "Student Supporter" and a "Research Mentor." The remaining GTAs described their roles primarily as a

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"Student Supporter," "Research Mentor," or a "Content Deliverer".

Contributions: This work is among the first to report on the experiences and beliefs of GTAs who teach CUREs. Those implementing GTA-led CUREs should consider that GTAs likely have different perceptions of the costs of teaching a CURE and of their role in the classroom—suggesting that students of different GTAs are unlikely to experience the CURE equivalently. GTAs therefore may need more support in managing perceived costs and developing their role as a CURE mentor.

Session C: Evolution Education

Paper ID: 124

The contribution of family-level variables to evolution education outcomes and degree pursuits in minoritized biology majors

Ross Nehm (Stony Brook University)*; Gena C Sbeglia (Stony Brook University)

The field of ecology and evolutionary biology is the least diverse life science discipline (NCES) spurring data-driven efforts to dismantle institutional barriers and address systemic racism in degree pathways. Most research has focused on individual-level variables even though family-level variables are known to be important.

RESEARCH QUESTIONS: (1) What patterns characterize family-level variables relevant to evolutionary biology among students from different racial/ethnic groups? (2) Do family-level variables explain evolution-related degree pursuits above and beyond individual-level variables (e.g., evolution knowledge, acceptance, personal conflict)? (3) How should family-level variables be considered in institutional change initiatives seeking to dismantle barriers to minoritized student career participation?

RESEARCH DESIGN: Methodologically, we used quantitative survey research methods and validated instruments to (a) characterize key variables documented in the literature as having meaningful relationships to the field of evolutionary biology: evolution knowledge (CANS instrument), evolution acceptance (I-SEA instrument), evolution conflict (SECM instrument, including family conflict with evolution [FAMCONFL]), family reactions to evolutionary biology degree pursuits (FAMREAC), family compatibility with evolution (FAMCOMP), and likelihood of pursuing a major or degree in evolutionary biology (EVODEG). These and background variables were studied in biology majors ($n = 1115$). ANOVAs were used to compare variables among groups, and GLMs were used to quantify the extent to which familial variables added unique explanatory power above and beyond individual-level measures.

ANALYSES AND INTERPRETATIONS: Rasch reliability measures (> 0.7) and item fit for all constructs were acceptable. ANOVAs for all three family-level variables (FAMCONFL, FAMREAC, FAMCOMP) displayed significant ($p < 0.01$) and meaningful ($\eta^2 = 0.4$-0.8)

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differences among race groups, with lower family compatibility, higher family conflict, and less positive family reactions to evolution student career choice in Black/African American students. Concerningly, Black/African American students also had the lowest EVODEG ($p < 0.05$), and family-level variables may contribute to this pattern. Specifically, while GLM 1 (which included only individual variables) explained 10.5% of variance in EVODEG, GLM 2 (which included individual AND family-level variables) explained 14.2% of the variance in EVODEG. A likelihood ratio test (GLM 1 vs. 2) indicated that adding family-level variables significantly improved the explanatory power of the model (AIC = 5024, BIC = 5106 vs. AIC = 5093, BIC = 5164, $p < 0.001$). These results indicated that both individual-level (i.e. ISEA human acceptance, religiosity) AND family-level (i.e. FAMCOMP, and FAMREAC) variables were significant predictors of EVODEG. These results confirm the importance of family-level variables.

CONTRIBUTION: This study (a) identifies familial variables as crucial but missing dimensions of evolution education research and evolution degree pursuits, (b) empirically supports links between family-level variables and minoritized students' anticipated degree pursuits, and (c) concludes that institutional change initiatives must integrate family-level considerations into biology degree coursework.

Paper ID: 211

Using evidence to target and dismantle barriers to evolutionary biology degree interest in introductory courses

Gena C Sbeglia (Stony Brook University)*; Ross Nehm (Stony Brook University)

Evidence is needed to inform the modification of institutional structures that serve as barriers to participation in ecology and evolution (E&E) careers. Extreme underrepresentation of Blacks and Hispanics in E&E points to the likelihood of institutional barriers and systemic racism. Evidence is therefore needed to inform discipline-specific reform.

RESEARCH QUESTIONS. (RQ1) Which student variables may be salient to E&E learning and career interests, and are they adequately addressed for minoritized groups? (RQ2) How might salient variables be used to identify and dismantle inequitable experiences in introductory biology courses? (RQ3) Do evidence-informed modifications that consider inequitable experiences positively impact students from diverse backgrounds?

RESEARCH DESIGN. A quantitative, quasi-experimental design employed pre- and post-course surveys to 1864 students entering introductory biology courses. Validated instruments were used to measure variables salient to E&E: evolution acceptance (I-SEA: micro, macro, human), evolution conflict (SECM: individual, family, community), religiosity, evolution knowledge (CANS), family-evolution identity compatibility (ICFamEvo), anticipated family reactions to evolution career pursuits (FamEvoReact) and likelihood of pursuing an evolution-related degree (EvoDegree). Instrument scores were converted into linear Rasch measures and displayed acceptable reliability and fit. To address RQ1, pre-course measures from biology

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majors (N=1115) from each self-identified racial-ethnic group were examined. To address RQ2, a curriculum analysis examined opportunities for modifications to address inequitable student experiences. Evidence-based modifications were then implemented in the next course version (i.e. barrier-reduced course [BRC]; N=318). To address RQ3, pre-post changes in the BRC vs. Traditional Course (TC; N=363) were compared across student groups using GLM and repeated measures ANOVAs for each construct and instructional type.

ANALYSIS/INTERPRETATIONS. Biology majors showed significant differences by race-ethnicity for all E&E-relevant variables ($p<0.001$, $\eta2=0.02-0.07$). Therefore, dismantling barriers to E&E-related degrees and careers may require engagement with these variables. These variables guided a curriculum analysis that identified numerous opportunities for change: (a) development of a new unit on religion, science, and conflict (b) improvement of Black and Hispanic scientist representation throughout the course, (c) addition of evolution-social justice examples, (d) inclusion of URM scientist contributions. The BRC and TC were found to produce outcome differences: 1) In the BRC, Black, Hispanic, and White students significantly increased in evolution acceptance ($p<0.05$, $\eta2G=0.01-0.07$) whereas only White students increased in the TC; 2) In the BRC, White and Black students had reductions in both personal and family evolution conflict ($p<0.05$, $\eta2G=0.01-0.02$) compared to no significant TC reductions; 3) Compared to a significant reduction in EvoDegree in Black students in the TC ($\beta=-0.52$, CI: 0.10-0.96), Black students in the BRC did not show this reduction; change in EvoDegree was dependent on course condition ($\beta=0.64$, CI: 0.01-1.23). Hispanic and White students did not display differences in EvoDegree change across conditions.

CONTRIBUTION. This study illustrates how evidence may be used to target and dismantle course-level barriers to E&E outcomes in minoritized students.

Paper ID: 177

Enabling nonscientists' transformative experiences regarding evolution

Rachel A Sparks (Illinois State University)*; Rebekka Darner (Illinois State University)

Contribution & Research Question
Literature shows that active learning practices and connecting content to students' experiences facilitate students' use of biological concepts, including evolution, in understanding the world. However, much of evolution education literature does not include non-science majors, who make up most of our students. Thus, investigating how instructional practices in non-majors' courses foster students' use of biological concepts to understand the world has the potential to impact thousands of students' biology experiences through the creation and dissemination of evidence-based curricula. We used mixed methods to evaluate a non-majors' introductory biology course designed to facilitate connections between evolution, biological concepts, and students' daily lives. We specifically analyzed how the course prompted students' use of evolutionary concepts in their daily lives, their descriptions of how these concepts affect their worldview, and the value they attribute to these concepts.

Research Design
We used the Teaching for Transformative Experiences in Science (TTES) model as an

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instructional framework to develop a non-majors' curriculum teaching biology through evolutionary concepts shown to be critical to a scientific understanding of evolution: variation, inheritance, adaptation, domestication, speciation, and extinction. TTES fosters students' transformative experiences (TEs) such that they use scientific knowledge in their daily lives. TEs can occur in three ways: active use (AU) occurs when students apply concepts outside of class; expansion of perception (EP) occurs when students' understanding of the world is changed by content encountered in class; and experiential value (EV) occurs when students appreciate content for its ability to enhance one's worldview. Students' TEs were elicited through reflection questions about how evolutionary concepts relate to other biological concepts and students' lives, how these concepts expand one's worldview, and the value of evolutionary concepts in explaining phenomena.

Analyses & Interpretations
The Likert-scored Transformative Experience Survey (TES) was administered at the end of the course and re-administered to consenting participants at least one semester later to quantitatively assess TEs. We conducted one-sample Wilcoxon signed-rank tests on each dimension of TEs (AU, EP, and EV) compared to a theoretical median response of “slightly agree.” On the TES at the end of the course, students (n=131) reported TEs at a level significantly above “slightly agree” on each dimension. These analyses were repeated for the follow-up TES (n=20), which found that TEs did not persist in the dimensions of active use and experiential value but did persist in the dimension of expansion of perception.
Interviews were conducted with consenting participants, which were qualitatively analyzed to identify type(s) of TEs experienced, evolutionary concepts that were relevant to TEs, and situations that prompted TEs. Transcripts were qualitatively analyzed by two coders using a codebook that was iteratively developed through open coding. Participants expressed that knowing evolutionary concepts gave them a greater sense of awareness of how evolution has impacted their lives in biological (e.g., the domestication of dogs) and social (e.g., structural racism) contexts. This study demonstrates the utility of TTES in promoting non-scientists' use of evolution to expand their worldviews.

Paper ID: 174

Integrating critical thinking into an advanced biology course

Stewart Frankel (University of Hartford)*

Research Question: Critical thinking (CT) is a learning outcome in most biology courses. How it is defined and taught will differ in introductory and advanced biology courses. In this study we developed a new approach to CT in an advanced molecular cell biology course. Background: CT can be defined in a general manner, applicable to any discipline, or in terms of cognitive skills relevant to a particular discipline. Studies on the teaching of CT in biology courses have used either the framework of higher order cognitive skills (HOCS) or concept inventories. We defined CT as inquiry informed by the scientific method and devised an instrument to measure mastery of this type of reasoning. The most common CT tests are general instruments with no disciplinary content. However, the post-2015 MCAT examination explicitly defines and measures CT skills in an advanced biology context, emphasizing key aspects of the scientific method. The pre-2015 version of the MCAT has been shown to correlate with mastery of HOCS and concept inventories. The validity of the post-2015 exam as a CT instrument has not been measured, but since the pre-2015 exam was more focused on content and the post-2015 exam

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is more focused on CT skills, the post-2015 exam would be expected to correlate with HOCS as well. MCAT passages, consisting of 2-3 paragraphs of data and several questions based upon the data, were used as a model for designing a measurement of CT mastery in the context of an advanced molecular cell biology course. The effectiveness of this CT framework and the CT instrument has been followed over multiple semesters of this course.

Research Design: The course that is the subject of this study has had CT as a learning goal for 12 years. A new framework was designed to enhance the effectiveness of this learning goal and encourage metacognition. While the syllabus, textbook, and tests remained the same, the following changes were introduced. (1) CT was defined as a series of conceptual operations, with an emphasis on the scientific method. (2) Every assignment, exercise, and test in the class was presented as an opportunity to use CT. Rubrics for assignments, laboratory reports, and tests illustrated CT in each context. (3) A CT test modelled on MCAT passage questions was given at the beginning and end the course (pre and post). (4) Surveys gauged attitudes about CT and learning.

Analysis and Interpretations: Data was analyzed for 6 semesters, 3 prior to (n=41) and 3 after (n=64) implementation of the CT framework; further data will be collected once in-person teaching resumes. The percentage of students scoring A- or higher on regular class tests rose from 7% to 23% after introduction of the CT framework (p=0.027). While CT skills were integrated into assignments and tests, facility with CT was also measured at the beginning and end of the course using a new CT test presupposing some knowledge of biology and the scientific method. The average score on the CT test increased from 52% to 64% pre to post (p<0.001) with students in the A- or higher cohort averaging 75% on the CT test and the remainder of the students averaging 61% (p=0.001). The relative improvement of a student's grades on class test 3 relative to test 1 correlated with their scores on the CT post-test, providing some validity to the CT assessment (Pearson correlation 0.28, p=0.029). Surveys indicated students entered with high regard for CT skills and there was little change pre to post.

Contribution: This study defined CT as a set of conceptual processes that incorporates the scientific method, in order to facilitate teaching CT in the context of an advanced biology course. These CT skills were incorporated into all aspects of the course, and students were provided with rubrics emphasizing CT content. CT mastery was measured using a relatively short test emphasizing the scientific method. The approach taken in this study can be adapted to the teaching of any advanced biology course.

Paper ID: 236

Eliminating vaccine misconceptions to promote health literacy in adolescents through a short-duration health-focused science curriculum

Revati Masilamani (Tufts University)*; Finn Payne (Northeastern University); Ava Fascetti (Harvey Mudd College); Abdimajid Mohamed (Tufts University); Peter Rogers (Tufts University); Berri Jacque (Tufts University

Scientific literacy enables a student to apply scientific knowledge in real-world situations by employing various skills such as problem-solving, critical thinking, oral and written communication, and the ability to interpret data. Though science educators strive for the development of these essential skills, there may be a disconnect between skills mentioned in

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the curriculum, taught, and assessed during the course. Through the use of Test for Scientific Literacy Skills (TOSLS) we aim at bridging that disconnect by measuring the gains in scientific literacy in various freshman biology courses. Using TOSLS we will quantify various teaching strategies that foster student success through scientific literacy.

Session D: Collaborative Practice

Paper ID: 39

Social Metacognition in Small Group Problem-Solving

Stephanie M Halmo (University of Georgia)*; Emily Bremers (University of Georgia); Sammantha Fuller (University of Georgia); Julie Dangremond Stanton (University of Georgia)

Question or Problem. Metacognition is defined as awareness and control of thinking for the purpose of learning. Stronger metacognitive skills are related to higher academic achievement. However, most metacognition research has focused on the level of the individual learner. A handful of studies have shown that while working in small groups, students can stimulate metacognitive processes in each other leading to improved learning and reasoning. Given the increased adoption of group work in active learning life science classrooms, there is a need to study the role of metacognition in these unique social learning contexts. Guided by the social metacognition framework, we asked 1) What metacognitive statements and questions (utterances) do students use during small group problem solving in a life science course? and 2) Which metacognitive utterances transition small groups to exchanges of high-quality reasoning in a life science course?

Research Design. To address our research questions, four groups of three students each agreed to be audio-recorded during two consecutive breakout sessions in an upper division biology course during the fall semester of 2018. During these breakout sessions, students worked in small groups to solve problem sets designed using guided inquiry principles that incorporated analysis of published data. We used discourse analysis to analyze transcripts and accompanying audio from two of the four groups. Discourse analysis was selected because of its compatibility with a sociocultural perspective of learning.

Analyses and Interpretations. In order to investigate metacognition and reasoning during small group problem-solving, two coding schemes were developed. The first codebook was developed to capture metacognitive utterances from student interactions. The second codebook was developed to capture the reasoning quality present in the discourse. We were particularly interested in the nature of the metacognitive utterances that preceded or followed episodes of higher levels of reasoning. Through our analysis we identified metacognitive utterances that included students assessing their own thinking, evaluating co-constructed thinking, and correcting each other. In particular, we found that metacognitive utterances consisting of open-ended questions, such as “So wait, why did you write it was critical?”, led to exchanges of higher-quality reasoning. Additionally, assigned group roles affected how students engaged in

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group problem-solving and thus the metacognitive utterances they made. We also found a relationship between more successful group problem-solving and the presence of silent portions during the discourse where students spent time thinking. This idea of silent thinking time may be counterintuitive to the notion that effective collaboration involves constant conversation.

Contribution. Students likely need structured guidance on how to be socially metacognitive. This rich, qualitative work provides the foundational knowledge needed to develop this guidance. The metacognitive utterances students use during small group problem-solving have not been documented in the life sciences. To our knowledge, our analysis of the relationship between metacognitive utterances and reasoning quality during group work in undergraduate life sciences is the first of its kind. From this analysis, we offer suggestions for life science educators interested in promoting social metacognition in their active learning classrooms.

Paper ID: 233

Framing Active Learning in terms of Sociocultural Mediation of Learning

Laurel M Hartley (CU Denver)*; Andrew L McDevitt (University of Colorado Denver); Jeff Boyer (North Dakota State University); Sarah Hugg (University of Colorado); Paul Le (Red Rocks Community College); et al.

Research Problem: Increasing use of active learning in undergraduate STEM classrooms has been a major focus of higher education in the US. However, we know a given activity/technique may not have the same effects on student outcomes regardless of where, how, or with whom the technique is used, highlighting that we do not yet fully understand the mechanisms by which active learning works. We suggest that the concept of mediation in a sociocultural context, developed by Vygotsky, Wertsch and others, could be helpfully incorporated into studies of and applications of active learning. Mediation refers to what “comes between”. This can be in the form of interactions with people, engagements with socially constructed artifacts (e.g., active learning worksheets), or the use of tools to make meaning. Mediation is focused on the social situatedness of learning and considers what is learned, who is learning it, and how it is learned. This presentation will describe two courses through the lens of mediation and outline a potential framework for data collection and interpretation for studies of active learning.

Research Design: We studied two large enrollment, introductory biology courses at two state universities. We attended all class sessions every other week for one semester. While attending the class sessions, we made observations using the Classroom Observation Protocol for Undergraduate STEM (COPUS), video recorded classes for later analysis of teaching discourse and actions, and collected all activities used during those class sessions. We also collected DFW rates and learning gains from the Introductory Molecular and Cellular Biology Assessment (IMCA). We analyzed the activities using an adaptation of the Three-Dimensional Learning Assessment Protocol (Laverty et al., 2016). After the conclusion of the course, we conducted interviews (~ 1 hr) with each of the instructors. In the interviews, we showed the instructors video clips of active learning episodes in their courses and asked questions about their

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intentions for the activity, their role in facilitation, and the mediational tools (e.g., worksheets) used.

Analysis and Interpretations: These courses were very similar in terms of percentage of class time spent in active learning based on COPUS (roughly 40-50% of 2 minute intervals), DFW rate (10-12%), and learning gains on the IMCA (<g> 0.23 and 0.24). However, applying the mediation framework allowed us to see differences in terms of the types and intent of mediating artifacts employed to support learning, and the norms of the courses as they related to facilitation and agency of students, Learning Assistants, and instructors. Instructor A created scaffolded worksheet and peer feedback activities that built in complexity, focused on improving student conceptual understanding of biological concepts, and encouraged growth mindset. Instructor B used a variety of mediational tools with the primary goals of promoting belonging and student persistence in the course. Instructor B discussed the diverse student body, including many working and first-generation students, and would modify activities based on the needs of students. Instructor A's activities scored as more 3-dimensional than Instructor B's activities. That said, our interviews about instructor intention highlighted that Instructor B's intentions were slightly less aligned to the 3D learning framework because they were prioritizing belonging over conceptual understanding. The lens of mediation revealed differences in instructor motivations and their goals for students, something often overlooked in existing literature.

Contribution: Using the lens of mediation could lead to deeper understanding of the mechanisms by which active learning works or doesn't. For us, this focus on who is learning, what is learned, why it is learned, and how is it learned helped us recognize shortcomings in our data collection tools and protocols and deepened our analyses and interpretations.

Paper ID: 219

A class structure with collaborative bones results in increased student learning

Pavan Kadandale (University of California Irvine)*; Vivian Chi (University of California, Irvine)

In many classes - even ones with high structure, and active learning - getting students to meaningfully collaborate with each other is still an elusive goal. The competitive "pre-med" mentality that many students in the Biology major harbor often poses an additional challenge to building collaborative classes. Another major impediment is assessment. When student grades are affected by the performance of all the members of their group, this very often leads to feelings of inequality, loss of control, and frustration with the system, which reduces meaningful and productive collaboration.

Based on lessons learned from behavioral economics, we present a class format that uses collaboration in every aspect of the student experience - from learning to assessment - to foster productive interactions within student groups. Participation in student learning groups is voluntary, and students have to agree to actively participate in a group before they are assigned to one. For this study, we chose to create student groups such that every group had the same average (self-reported) GPA, but other criteria could also be used to create student groups. This structure is relatively easy to implement, only requiring the instructor to create the student groups at the beginning of the class, and provide some guidance on how to create an effective learning community. When implemented in-person, the instructor also assigns seating, so that student groups are seated together for the entire quarter/semester. A novel assessment strategy provides time for students to collaborate with each other before submitting their final answers individually. Since answers are submitted by an individual student, and not as a group, we have decoupled an individual student's performance from the group's performance, sidestepping many of the issues that causes traditional group work to be ineffective.

Using Generalized Linear regression Models (GLM) for data from a large (n=576) lower division Biochemistry course (taught at a large, research-intensive university in the western US), we show that participating in these student groups results in increased performance in exams, even after normalizing for demographic variables such as incoming GPA, gender, minoritized status, etc. Further, we show that this increased performance is not just a result of the academically better students "pulling up" the academically worse students, but that the increase is due to actual student learning. From our models, we also show that this class structure reduces "learning gaps" seen for females, minoritized students, and students with lower preparation from previous classes. Finally, based on student comments, we show that the student experience of this class structure is overwhelmingly positive.

This relatively easy-to-implement class format (or parts, thereof) can be another tool for instructors looking for ways to create a more collaborative environment for their students, and which results in improved outcomes for their students.

Paper ID: 82

Automated Writing Assessment of Undergraduate Learning After Completion of a Computer-based Cellular Respiration Tutorial

Juli Uhl (Michigan State University)*; Kamali Sripathi (UC Davis); Eli Meir (SimBio); John Merrill (Michigan State University); Mark Urban-Lurain (Michigan State University); et al.

Research Question: The goals of recent science education reforms include focusing on learning core concepts and cross-cutting concepts such as energy and matter, which applies to cellular respiration processes in biology. Concurrently, instructors and students increasingly interact with computer-based teaching and learning tools. Assessments of student conceptual learning should thus be applied to computer-based learning tools. Importantly, such assessments must consider student learning in diverse contexts, including two-year colleges (TYCs), primarily undergraduate institutions (PUIs), and research-intensive colleges and universities (RICUs). Thus, we investigated the following research question: Do descriptions about cellular respiration vary among students from different institution types?

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Research Design: We previously developed a computer-automated scoring model capable of categorizing common ideas in student written responses to a question about cellular respiration. This model produces scores with high reliability to human raters. We administered this question in a computer-based interactive tutorial on the processes of cellular respiration. Students answered the question pre- and post-tutorial. Our sample contains 841 students in 19 undergraduate biology courses: 69 from TYCs, 212 from PUIs, and 560 from RICUs. We used our computer model to identify normative and non-normative ideas about cellular respiration in each student's pre- and post-tutorial written response. We analyzed the ideas in each response across institution types, then classified responses as one of three types of descriptions (scientific, mixed, and developing), where mixed includes normative and non-normative ideas, scientific only normative, and developing only non-normative.

Analyses and Interpretations: Both pre- and post-tutorial, students from all three institution types included similar numbers of ideas in their written responses. Before the tutorial, student written responses included a similar number of normative ideas (mean ± 95% confidence interval: TYC = 0.48 ± 0.19, PUI = 0.66 ± 0.13, and RICU = 0.46 ± 0.07 ($p = 0.06$). On average, students from all institution types included more normative ideas in their post tutorial responses than pre-tutorial (TYC = 1.12 ± 0.22, PUI = 1.17 ± 0.12, and RICU = 1.33 ± 0.08). We also found that the student scientific descriptions increased while developing descriptions, which include only non-normative ideas, decreased across all institutions. For example, TYC students' descriptions change from pre 72% developing or no ideas categorized to 35% post, from 23% mixed pre to 45% post, and from 4% scientific pre to to 20% post. Mixed descriptions, which combine normative and non-normative ideas, were the most common type of response from all institution types.

Contribution: As faculty adopt computer-automated teaching and assessment tools, it is important to be aware of the efficacy of the tools for all students to guide refinement of tools to improve learning. We suggest that computer-automated assessment of student writing can provide valuable information about student thinking, including when students mix ideas, for instructional designers and educators.

Paper ID: 212

Why students do not turn on their video cameras during online classes and an equitable and inclusive plan to encourage them to do so

Frank R. Castelli (Cornell University)*; Mark A. Sarvary (Cornell University)

RESEARCH QUESTION: Instructors that switch to remote teaching may be met with the new challenge of students not turning on their cameras during synchronous class meetings. We faced this challenge in our large intro biology course after shifting from in-person lab sections to remote meetings held via Zoom in response to COVID-19. Given the benefits reported in the literature for students to turn on their cameras during class (e.g., non-verbal communication

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cues, higher satisfaction, greater rapport, etc.), we took an evidence-based approach to address the problem of low camera use. First, we asked the question: “why do students not turn on their video cameras during online classes?” We also wondered: “are we correct in suspecting that students have many legitimate reasons for not turning on their cameras and mandating their use would be inappropriate and unfair?”

RESEARCH DESIGN: We anonymously surveyed students in our large intro bio lab course (312 students, 24 sections, 12 instructors) at a PhD-granting institution in the northeast United States as part of our end-of-semester student evaluations of teaching in spring 2020. The main question asked was, “If you ever left your video off during the live Zoom lab meetings, why did you leave it off? (check all that apply).” Students could select up to 12 reasons we hypothesized a priori or select “Not Applicable – I always had my camera on.” When selecting “Other,” students also had the option of typing a reason not listed that was later emergently coded. We also collected demographics to compare sub groups.

ANALYSIS AND INTERPRETATIONS: Responses were quantified and broken down by males compared with females, freshmen compared with non-freshmen, and underrepresented minorities (URMs) in science and engineering (as defined by the NSF) compared with non-URMs. Differences were tested using Fisher’s exact tests. “Other” reasons were emergently coded and categorized. We confirmed several predicted reasons including the most frequently reported: being concerned about appearance. Additional reasons included being concerned about other people and the physical location being seen in the background and having a weak internet connection, all of which our final exploratory analyses suggest may disproportionately influence URMs. Thus, we were justified in not requiring camera use as it would be inappropriate and unfair. Analysis of “other” reasons revealed that classroom social norms are also at play when it comes to camera use. The results of this completed study, along with evidence from the literature, were used to generate strategies for instructors to encourage camera use while not requiring it. We will also present data from a follow-up study that adds detail to some original findings and provides some measure of the efficacy of the strategies generated in our original study.

CONTRIBUTION: This timely research fills a gap in the literature on student camera use in remote courses, an important issue because of increased social distancing in response to pandemics and the increasing trend of enrollments and offerings of remote online courses in general. While our data were collected from an intro biology course, this research addresses a widespread issue faced by many instructors who teach remotely across disciplines. The results were used, in combination with evidence from the literature, to develop clear strategies to encourage—without requiring—camera use while promoting equity and inclusion.

Paper ID: 149

What we’ve learned about online biology education: A three-year study of progressive intervention

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Jamie L Jensen (Brigham Young University)*; Mahealani Kaloi (Brigham Young University); Megan Niu (Brigham Young University); Porter Fife (Brigham Young University)

RESEARCH QUESTION: Online education is well-established and has become increasingly (and abruptly in 2020) more popular as a means to deliver education at the undergraduate level. However, approaches to design have been wildly variable and are often not informed by pedagogical rationale or data of effectiveness. The research literature is mixed on whether online alternatives can be as successful as face-to-face courses. Our controlled comparison of a fully in-person course to a fully online replica showed non-equivalence. Thus, the research question guiding our work is what components make an online course as successful as a face-to-face experience? Our hypotheses, based on social constructivist theories of learning, included instructor scaffolding, instructor feedback, and peer collaboration, which we tested through various means.

RESEARCH DESIGN: We selected a non-majors introductory biology course that is offered both in-person and online at a large private university in the Western US. After running the course in an in-person flipped format, we designed an equivalent online version. Then, over the course of seven semesters, we iteratively added components to the course to test each of our hypotheses, maintaining previous components that showed promise in improving performance. To test the effects of instructor scaffolding, we tried online tutorials to scaffold concept application activities versus in-person weekly recitation sessions. To test the effect of instructor feedback, we implemented practice exams versus forced second attempts of homework with provided answers. To test the effects of peer collaborations, we incorporated synchronous versus asynchronous peer study sessions. Lastly, to control for potential self-selection of our study population, we repeated our most successful trial in Fall 2020 when all students were forced into the online format.

ANALYSES & INTERPRETATIONS: Success of each treatment was measured by performance on unit exams and the final comprehensive exam and by final grades in the course. ANCOVA analysis, using scientific reasoning ability as a covariate to account for potential group non-equivalence, we show that, despite all of the added components, we were unable to replicate the success of an in-person course, in which students consistently performed at least a half letter grade better than the online alternative on summative learning. These results suggest that we have yet to identify the component of in-person education that we are failing to replicate in an online experience and suggests that perhaps online courses require supplementation beyond what is traditionally seen.

CONTRIBUTION: As we attempt to (and are sometimes forced to) adapt our teaching to online modalities, these results serve as a precaution to consider all the components that go into a successful learning experience and to think deeply about what can and what cannot be replicated in a digital environment. Then, we can determine what novel components may be required to successfully teach in an online world.

Session E: Science Skills

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Paper ID: 226

Exploring student construction of causal mechanistic explanations across chemistry and biology courses: connecting intermolecular forces, protein structure and function, and phenotypic variation.

Keenan Noyes (Michigan State University); Clare Carlson (Michigan State University); Joelyn de Lima (Michigan State University); Devin Babi (Michigan State University); Elijah Persson-Gordon (Michigan State University); et al.

1. Research Problem or Question: Undergraduate STEM curricula link courses across disciplines using prerequisites. This implies that students should be connecting ideas between courses and building more complex understanding as they progress through the curriculum. Making these connections can be challenging for multiple reasons, one being the scale, atomic through community, at which content is discussed in STEM courses. Based on the 3D learning framework, causal mechanistic reasoning is a powerful tool that integrates a science practice (constructing explanations) and a cross-cutting concept (cause and effect) and can help students make connections across scalar levels. Analysis of students' explanations can also provide insight into if and how students' understanding changes as they progress through a curriculum. This study addresses the following research questions: 1) How do students connect ideas across disciplines to construct explanations? and 2) How does the sophistication of students' explanations vary at different points in the curriculum?

2. Research Design: In this cross-sectional study, we explore students' abilities to construct causal mechanistic explanations (CMEs) related to the core idea of structure and function. Our interdisciplinary team used iterative pilot studies to develop a prompt that engages students in causal mechanistic reasoning across the scalar levels that are typically the focus of individual chemistry, biology, and biochemistry courses with specific parts of the explanation related to intermolecular forces (IMFs), protein structure and function (PSF), and phenotypic variation (PV). We collected 4,092 explanations across seven courses and coded 396 of these explanations that represent groups of explanations from nine distinct time points in this curriculum. Coding schemes were developed using a grounded approach in combination with coding schemes developed during previous work. Pairs of coders coded explanations individually, then discussed differences to reach consensus. Percent agreement between raters ranged from 91% to 96% and Cohen's Kappa ranged from 0.76 to 0.90.

3. Analyses and Interpretations: Overall, 25%, 41%, and 27% of explanations were coded as CMEs for the IMF, PSF, and PV portions of the coding scheme. However only 8% of explanations connected genetic information to differences in protein-ligand binding and and only 9% of explanations were coded as CMEs for all three parts of the explanation. There was a trend toward more CMEs from students in courses later in the curriculum. For example, CMEs for IMF, PSF, and PV portions of the prompt from students in chemistry 1, the first course in the curriculum, were 1%,16%, and 5% as compared to 52%, 64%, and 38% for students in

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biochemistry 2, the final course in the curriculum. However the increase was not progressive as some courses in the middle of the curriculum had lower percentages of CMEs than prerequisite courses.

4. Contributions: This study extends our understanding of how students used core ideas to construct explanations at different points in a biology curriculum. Our results indicate that while students can and do meaningfully combine ideas across courses to develop mechanistic explanations, there is significant room for improvement. Specifically, instruction and curricula need to provide students with additional opportunities to practice constructing CMEs that explicitly require students to connect ideas across courses.

Paper ID: 228

Frames matter: How task structure affects student use of resources in argumentation

Jessie Arneson (Washington State University); Brett Baerlocher (Idaho State University); Jeffery Erickson (Washington State University); Guraustin Brar (Washington State University); Andy Cavagnetto (Washington State University); et al.

Biologists engage in argumentation every day. Every lab group meeting, research presentation, and peer-reviewed paper is a form of argumentation whereby biologists use data to make claims about the natural world. Unsurprisingly, the BioSkills guide identifies the ability to “interpret, evaluate, and draw conclusions from data in order to make evidence-based arguments about the natural world” as a desirable learning outcome for undergraduate biology.

Argumentation For Learning (AFL) is a research framework for investigating how engaging students in the practice of scientific argumentation promotes deep understanding of core disciplinary ideas. We initially used this framework to design and implement two argumentation modules in large-lecture intro biology. Each module directs students’ attention to a “big question” (i.e., What is the role of alternative splicing in the regulation of gene expression?). Then students collaborate in groups to (1) interpret biological models and data from the primary literature and (2) propose hypotheses and evidence-based explanations in response to the big question.

AFL research suggests that how an argumentation task is framed affects the nature of argumentation and the quality of student learning. Framing is a construct that originated in linguistics but has been extended to STEM to understand how individuals make sense of and behave during a task. We previously documented the effects of framing our modules as inductive versus deductive reasoning tasks. We found that students’ exam performance was higher after participating in deductive modules and that increases were greater for lower-performing students than for those in the top quartile. In the present study, we answer the question, “What are the potential mechanisms by which argumentation task framing produces differences in student performance?”

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The framing of a task influences what features of a problem are attended to, the information retrieved by an individual while solving a problem, and the ways in which the individual uses these resources to construct and organize knowledge. We hypothesize that the deductive framing increased exam performance by cueing students to retrieve and/or connect across more resources than during the inductive tasks, thereby providing better scaffolds for integrating new information with existing cognitive schema. When framed as a deductive task, we observed a positive correlation between exam performance and length of students' response to the "big question" immediately following the argumentation task. We further analyzed these responses to characterize the task resources students utilized, the degree to which they integrated those resources to answer the "big question", and how responses compared to those collected when the argumentation module was framed as an inductive task.

Preliminary findings indicate that students (1) leverage more resources when engaged in argumentation modules framed as deductive (hypothesis-testing) tasks and (2) are more likely to integrate and connect resources during deductive tasks. This work and future studies will allow for better understanding of how framing influences how students leverage and integrate cognitive resources to construct new knowledge.

Paper ID: 80

The Decision is in the Details: Justifying the Selection of Knowledge Sources Across Two Socioscientific Issues

Jordan D Bader (University of New Hampshire)*; Melissa L Aikens (University of New Hampshire); Andrew Coppens (UNH); Kelsey Ahearn (UNH); Diya Anand (UNH); et al.

Research Problem
Scientific literacy goals within undergraduate science curricula, such as the ability to utilize scientific content when making decisions, have been developed to create responsible societal players (Deboer, 2000). Yet, controversial scientific issues, or socioscientific issues (SSIs) demand the consideration of more than scientific content when constructing decisions. Because undergraduate students are participants of democracy, it is critical to understand how students are weighing information sources when thinking about SSIs, for these decisions can have complex implications. The Justification for Knowing framework (Ferguson et al., 2013) was developed to categorize the information sources drawn upon when making SSI decisions. These information sources stem from personal sources (JPS; e.g., personal experiences), authoritative sources (JAS; e.g., academic topic), or multiple sources (JMS; e.g., corroboration between several sources). The selection of these information sources is dependent upon context, for contextual features may elicit specific decision-making strategies (Sinatra, 2016). Ferguson et al's (2013) framework does not recognize these features, limiting its efficacy when studying SSI decision making. The research question for this study is how do contextual features of an SSI influence the selection of information sources when supporting a decision?

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Research Design
Study participants (N=199) were recruited from multiple sections of a mixed-majors science course from an R1 public institution over the course of one year. Participants responded to a modified Decision-Making Questionnaire (DMQ; Bell & Lederman, 1999) via Qualtrics. The modified DMQ consisted of two SSI context scenarios: fetal tissue uses in medical research and climate change. The fetal tissue scenario presented the decision of a couple to donate fetal tissue for medical research, and the climate change scenario presented the decision to tax vehicle owners. After each scenario, participants responded to open-ended prompts asking them whether they agreed or disagreed with the presented SSI decisions and to explain why.

Analyses and Interpretations
We deductively coded each participant's responses to the SSIs as either JPS, JAS, or JMS. We then inductively coded each justification, aiming to expand how each justification is defined and to acknowledge any emerging themes. Coding was done independently with a consensus coding session for IRR (k= .91). We found several sub-dimensions within each Justification for Knowing in both SSI contexts. In both SSIs, a major finding within the JPS dimension was the presence of "self", or a gut feeling/intuition as an information source. This suggests that despite sources of contextual knowledge, the nature of being plays an essential role in SSI decision making. We also found a strong presence of identity commitment as a form of reasoning when justifying SSI decisions. SSI context ignites specific identity commitments that operate as a vehicle toward the selection of knowledge sources when an individual is justifying their SSI decisions.

Contribution
The results of this study provide insight on the information sources students rely upon when justifying SSI decisions. Understanding the processes of selecting these information sources may inform the development of a formal SSI decision model. This model can be used within the classroom when SSI decision making is integrated within the curriculum.

Paper ID 69:

STEM department chairs' perspectives: Current teaching evaluation metrics undermine change initiative viability

Ariel E Marcy (University of Nebraska-Lincoln)*; Blake Whitt (University of Virginia); Brian Couch (University of Nebraska-Lincoln); Luanna Prevost (University of South Florida); Marilyne Stains (University of Virginia); et al.

Research Problem: To facilitate evidence-based instructional practices (EBIP) adoption among faculty in STEM departments, change initiatives focus on the faculty's cultural contexts. Department chairs communicate and enact both departmental and institutional expectations, making them key change agents during such initiatives. Using the STEM-specific four frames model of organizational change, we analyzed chair responses on teaching culture and existing

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change processes. Here, we characterize chair perceptions of undergraduate teaching culture and their vision for an institution-wide change initiative within their department.

Research Design: We conducted semi-structured interviews with 14 STEM chairs whose departments were about to participate in a change initiative at one US R1 institution. Open-ended questions prompted the chairs to reflect on their teaching, familiarity with EBIPs, and priorities as chair. Questions also prompted chair descriptions of how change occurs as well as the structures, symbols, and people reinforcing the department's teaching culture.

Analyses and Interpretations: We open-coded interviews using the four frames model (structures, symbols, power, and people) with at least two authors confirming code designations. Among many other patterns, we found a large portion of codes relating to teaching evaluation structures, including faculty roles, routines, and incentives. Despite all departments reporting some mechanisms for peer, student, and self-evaluation, over 80% of chairs considered these data insufficient to inform change-related decisions, particularly compared with accepted metrics for research. Despite an overwhelmingly positive view of the importance of teaching, chairs identified evaluation metrics as the bottleneck for identifying, directing, and rewarding successful pedagogical changes. Indeed, we found an association between a chair's wariness of these metrics with their perception that teaching is personality-based, therefore change interventions do not benefit most faculty. Given the central role of evaluation in promotion and tenure, increasing confidence in metric validity and actionability could lay the foundation for other changes, such as wider EBIP adoption.

Contribution: Our detailed interview dataset of STEM chairs highlights their perceived need for robust and research-based teaching evaluation metrics and underscores the urgency. Our findings uniquely reinforces the literature calling for improved evaluation systems by providing the perspective of chairs, a key change agent. Indeed, confidence in the metrics reflecting teaching and learning are critical to convince and motivate chairs to facilitate the meaningful changes usually championed in change initiatives. The diversity of chairs in our sample suggests that specific needs and requirements vary by department and even by subfields. Therefore, we recommend that future change initiatives include individualized support to departments regarding their evaluation structures. Not only will this increase the initiative's lasting viability, it will also likely increase participation by appealing to a need most chairs already identify, independent of their individual views on EBIPs.

Paper ID: 157

How can Academic Culture be more Inclusive toward Interdisciplinary Work?

Brie Tripp (San Francisco State University)*; Erin E Shortlidge (Portland State University)

RESEARCH PROBLEM: In the past decade, interdisciplinary (ID) science research has become a central component of many initiatives and funding agendas. Leading stakeholders postulate that partnerships within and between STEM and non-STEM disciplines will lead to a greater

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ability to address increasingly complex societal issues. However, literature suggests that the practice of ID science is undervalued and difficult to conduct. The irony of an increase in national ID science calls, but a lack of acceptance of ID science work at the institutional level has yet to be systematically studied from the perspective of faculty. Thus, there is a priority to empirically examine barriers faculty may face in conducting ID science work and identify ways to move the field forward.

RESEARCH QUESTION: How do current institutional structures affect ID science opportunities in academia?

RESEARCH DESIGN: We nationally recruited faculty who practice or are interested in ID science for interviews via an online survey to gain insight on experts' perspectives and mindsets surrounding ID science work. We conducted semi-structured interviews with individuals (n=29) who held faculty positions at a variety of universities. Interview questions were designed to identify common ground among faculty on what ID science means, viewpoints surrounding interdisciplinarity within and between STEM and non-STEM disciplines, barriers that inhibit ID science research, and ways to mitigate these barriers.

ANALYSIS AND INTERPRETATION: Three researchers used axial coding and inductive analysis to analyze the faculty interviews to consensus, followed by two researchers finalizing the coding scheme. Three prominent themes arose emphasizing significant barriers to ID science work due to academic culture: disciplinary hierarchy, disciplinary hegemony, and disciplinary identity. Participants also expressed a path for overcoming these obstacles through a fourth theme, disciplinary humility. We used these four themes to create the Interdisciplinary Collaboration Framework (ICF) that explains the barriers to ID science work and how to move beyond these limitations. In the first theme, 'disciplinary hierarchy' (76%, n=22) faculty reflected on latent hierarchies between STEM and non-STEM disciplines, highlighting racism, sexism, classism, and power dynamics as mechanisms that perpetuate disparities among disciplines. Faculty participants (62%, n=18) discussed 'disciplinary hegemony', characterized by disenfranchisement of ID studies through academic reward systems, such as funding, promotion and tenure, and publication outlets. Participants also recognized 'disciplinary identities' (52%, n=15) as a key factor propelling the discipline-based culture of science. These three salient themes are intimately intertwined, further propagating the culture of STEM disciplines as "one way of knowing". Lastly, almost all participants suggested a way to change this discipline-based culture within science by cultivating a mindset that embodies 'disciplinary humility' (97%, n=28) and an acceptance of various epistemic perspectives when conducting ID work across disciplines.

CONTRIBUTIONS: This work contributes a framework to assist faculty in recognizing common barriers and puts forth possible solutions for overcoming ID science challenges.

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Professors' Professionalization Networks: a Systems-level Roadmap for Change

Dan Grunspan (University of Guelph)*; Anna Abraham (Arizona State University); Sara M Etebari (Arizona State University); Samantha Maas (ASU School of Life Sciences Biology Education Lab); Julie A Roberts (Arizona State University); et al.

Reforming university instruction to align with evidence-based practices has emerged as a critical goal across science, technology, engineering, and math (STEM) fields across higher education. Unfortunately, wide-scale change has proven difficult to achieve, leading to increased interest in how university professors develop as instructors. This professional development starts early, when professors gain their first real experience in college classrooms as undergraduates. While the commonly cited phrase that college instructors “teach how they were taught” is an oversimplification, research does indicate that these past experiences are influential on instructional behavior. This offers an opportunity for sustainable change if current undergraduates, who are the source population for future professors, are more likely to use evidence-based practices in the future if they experienced these practices as undergraduates.

To the extent that past experiences matter for one’s pedagogical development, it is important to understand where these experiences occur. If undergraduate instruction can be offered in a way that generates a future generation of professors who, uncompelled, adopt evidence-based practices, then studying patterns in where faculty underwent their professionalization can be instrumental in driving large scale cultural change.
In this study, we describe the professionalization network of tenured and tenure-track professors in physics. We collected data on where faculty earned their undergraduate degree, PhD, and where they currently work from physics faculty across 591 physics departments in the US, representing a total of 7,739 faculty. We used these data to construct a network that connects universities by where current faculty work to where they earned their undergraduate degrees.

To understand the network structure, we used block modeling procedures. Block modeling is a social network method that clusters nodes into “blocks” based on a specified measure of equivalence. We clustered nodes (universities) based on their approximate structural equivalence using Euclidean distance. Universities were more likely to cluster together if they hire faculty from similar other universities and if they graduate undergraduates who go on to work in similar other universities. In total, the 591 different universities clustered into 5 distinct blocks, with a sixth block representing the sum of all foreign universities.

The resulting block model of the network indicates a strong and layered core-periphery structure, where a small subset of prestigious universities is highly central in the network, followed by a second layer of slightly less prestigious universities, and so on. A similar structural pattern was previously found in faculty hiring networks based on doctoral training.

To measure imbalance in where faculty earned their undergraduate degrees, we plotted Lorenz curves and calculated Gini coefficients. We found large disparity in where faculty come from,

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with 20% of universities training approximately 70% of the faculty. While this imbalance may have historically led to a stasis in pedagogical practices, it provides opportunities for focal interventions to influence long-term change.

Lastly, we found that institutions outside of the US excerpt considerable influence, with at least 42.5% of tenured and tenure-track physics faculty having earned their undergraduate degrees at non-US institutions. While these faculty come from 668 universities across 101 different countries, disparity is found by country and university, with universities in China, India, Russia, Germany, England, and Canada responsible for granting undergraduate degrees to ~20% of all tenure-track faculty. This raises important questions about how academic preparation varies internationally and how instructors whose undergraduate degrees come from non-US institutions integrate these experiences.

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76 **Students' beliefs correlate with alternative conceptions and knowledge about the flu vaccine.** Keying Deng (University of California San Diego)*; Ola Mostafa (University of California San Diego); Melinda T Owens (UC San Diego)

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ADDITIONAL CONFERENCE ACTIVITIES

DBER Scholars-in-Training Career Panel

Thursday, July 22, 2021, 11:00 AM CDT
The Society for the Advancement of Biology Education Research (SABER) DBER SiT Professional Development Committee hosted a professional panel discussion, including colleagues who are working in positions that are lecture-track, in informal education settings, associated with teaching and learning centers, research-based--even combinations thereof! After the panel, the event featured small group discussions (via breakout rooms) to allow early-career scholars to have productive in-depth conversations about the many routes available for a career in DBER. Topics included finding positions, applying for jobs, the day-day experience of different positions, how advancement works, and openings for questions from attendees.

Panelist:
Dr. Jerrod Henderson, Associate Professor & Program Director, University of Houston
Dr. Mays Imad, Professor & Coordinator of the Teaching and Learning Center, Pima Community College
Dr. Marcos Garcia-Ojeda, Associate Teaching Professor, University of California- Merced
Dr. Beth Luoma, Assistant Director, Center for Teaching & Learning, Yale University
Dr. Shannon Schmoll, Director Abrams Planetarium, Michigan State University
Dr. Colin Harrison, Academic Professional, Georgia Tech

Pre-Conference Workshop

Assess What's Important: Creating assessments that show how students use their knowledge and how instruction promotes that knowledge.

Thursday, July 29, 2021, 12:00 PM CDT

Abstract: Assessment of student learning is critically important for teaching biology and evaluating our teaching of biology. If we don't assess what is important, what is assessed becomes important! Designing assessments that demonstrate what students know and are able to do in biology are key to transforming undergraduate biology advocated by Vision and Change in Undergraduate Biology Education and other reports such as the Ecological Society of America's (ESA) Four-dimensional Ecology Education (4DEE) Framework. These two reports provide conceptual frameworks for thinking about and designing undergraduate biology courses and curricula. Importantly, both work with the idea of multidimensional learning that helps instructors define what they want students to learn (core ideas), what they want students to do with their knowledge (scientific practices), and how they want students to focus their knowledge through multiple lenses (crosscutting concepts). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas 2012) advocates the same framework for pre-college students.

Originating from this framework, researchers (Laverty et al 2016 and Bain et al 2020) are working to transform gateway science courses by moving beyond active learning to incorporate what is known as three-dimensional learning (3DL), the dimensions that are used in concert by practicing scientists and engineers when they apply their knowledge to investigate and reason about phenomena. The 3DL is a response to the status quo of traditional science learning environments, where instruction and assessment typically focus on collections of facts and skills that often result in disaggregated and fragmented knowledge for students. In contrast, 3DL is

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designed to promote the development and use of interconnected knowledge that is more expert-like in nature. The afore cited research team has developed two protocols that characterize the extent to which assessments and instruction in introductory biology, physics, and chemistry courses provide opportunities for students to engage with three dimensions. The resulting tools are useful for both research and teaching professional development.

During this workshop, participants will engage in groups based on the courses they teach or are researching in biology to redesign and develop open-ended and multiple-choice assessment items, use case studies, and apply the criteria we have developed as part of the Three Dimensional Learning Assessment Protocol (3D-LAP; Laverty et al 2016). Within this workshop facilitators will assist participants by providing guidance for item development using scientific practices. In addition, participants will be introduced to the Three-Dimensional Learning Observation Protocol (3D-LOP, Bain et al 2020) that was developed to characterize instruction in introductory biology, chemistry and physics courses. This tool can be used to evaluate courses, individual classes, and support research on course transformation efforts. Please bring a sample exam that you wish to work with as well as the core ideas students should learn in the course. Upon completion of the workshop, you will be able to design and/or characterize any assessment item using the 3D-LAP. Concurrently, you will be able to use the 3D-LOP to characterize instruction. Both tools are useful for research because they can reliably document how assessments change in a course(s) over time and how instruction changes over time. Participants will leave with a working knowledge of how to apply multidimensional (3D-LAP) learning to modify existing assessment items and build new ones, how to apply multidimensional teaching (3DLOP) to modify existing instruction, and how to use the 3D-LAP and 3D-LOP as research tools.

Presenters:

Diane Ebert-May, Michigan State University ebertmay@msu.edu, University Distinguished Professor, Department of Plant Biology. Provides national and international leadership in biology education research, teaching and assessment. Member of the ESA 4DEE Framework taskforce, co-author of the 3D-Learning Assessment Protocol, and contributing author to Vision and Change in Undergraduate Biology Education.

Jennifer Doherty, University of Washington doherty2@uw.edu, Teaching Professor, Department of Biology: Eleven years as an education researcher and faculty development provider. Member of the ESA 4DEE Framework taskforce.

Amanda Sorensen, Michigan State University, soren109@msu.edu, communication and outreach specialist in the Department of Community Sustainability. Member of the ESA 4DEE Framework taskforce.

Luanna Prevost, University of South Florida, prevost@usf.edu, Associate Professor, Ten years of research on biology assessment and faculty professional development. Member of the ESA 4DEE Framework Subcommittee.

Participants will be able to:

a) Describe and use the 3D-LAP and 4DEE frameworks.
b) Design and characterize any assessment item using the 3D-LAP.
c) Apply multi-dimensional learning to modify existing assessment items and build new ones.

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d) Use the 3D-LAP as a research tool for evaluating assessments for research and teaching.
e) Use the 3D-LOP as a research tool for providing feedback to support the development and modification of instructional practice and materials.

Workshop Timeline

Participants will spend most of their time working in small groups using provided materials and their own. They will experience interactive, brief presentations at the beginning of the workshop, and short introductions/practice to each activity listed below.

Activities

- Use the 3D-LAP to characterize participants' own research or teaching assessment items.
- Use 3D-LAP and 4DEE Framework to redesign, develop and evaluate open-ended and multiple-choice assessment items. Consider embedding these assessments in case studies. Use the 3D-LOP to characterize and evaluate instruction from sample videos and own teaching.

Each activity will conclude with a discussion among the participants led by the facilitators (10 minutes).

SABER Business Meeting

Friday, August 6th, 2021, 12:00 PM CDT
Slides

Items for the business meeting
- Approximately 60 attendees
- Huge thank you to Jaime Sabel, especially the poster group and the website and the abstract reviewers
- Bill Wood Award
  - Jennifer Doherty talked about including a rubric
  - Announcement - Angela Google, Krista Donis, Tatianne Russo-Tait
  - Committee provided a review of why the winners were so impressive. It is very affirming to describe why these students deserve these awards.
- SABER's budget
  - Income: $23k membership; $28.5k annual meeting, $1k sponsorship
  - Expenses: $10k virtual conference, $6.5 web, $8k committees, honorariums
- Election results - welcome to Marcos (president-elect) and Miriam (secretary)
- Committees and SIGs - need volunteers
- Annual Meeting
  - 1400 participants in 2020, 777 participants in 2021
  - A lot of graduate students (24%), undergraduate (12%), about 31% are from bacc, ms granting, and community colleges

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  - Demographic data from annual meeting - 60% returners (first time over 50%), still mostly White although uptick in people identifying as Asian, Latinx, multiracial; uptick in males, downtick in LGBTQ+
  - Average attendance of about 250 for long and keynote talks, concurrent sessions averaged 30-80 attendee
  - 73 waivers
  - Expanding the scope of the Awards Committee beyond the Bill Wood Award Committee (coming in 2022)
- 2020-21 recap
  - Continue work on diversity, equity, & inclusion efforts
    - Seminar series, A Call to Action, organized by Sara Brownell
    - Registration waivers
    - ASL interpreter for keynote and long talks
    - Solicited input from D&I committee, Sense of Place committee on locations for annual meeting
  - Promote community building between annual meetings
    - Applied for/received NSF conference grant to support more virtual seminars
    - Moved our listserv to Google Groups
  - Increase transparency and communication
    - Historian and newsletters approach didn't work as well as we'd hoped
    - New approach: Open monthly meetings with representatives from each committee, SIG; public agenda/meeting minutes
    - Host semi-annual business meetings (July, January)
    - Share our budget
  - Grow SABER
    - Initiated a new committee, Growth & Development
- Looking ahead to 2021-22
  - 2022 annual meeting
    - Executive director: Brian Sato; Assistant director: Jaime Sabel - will work with SABER committees to organize & run
    - TBD dates, format, location
    - We will continue to have virtual components!
  - Continue work on diversity, equity, & inclusion efforts
    - Seminar series, A Call to Action, will continue - announcements soon!
    - Survey membership about potential meeting locations: Minneapolis, St Louis
  - Develop awards to recognize our members
  - Initiate a conversation on the philosophy underpinning short talk selection
    - What is the purpose of a short talk at SABER? Finished research? Work in progress? Something else?
    - Is our approach to selecting short talks ultimately acting as a gatekeeper?
  - Strategic plan development
- SABER West to be held Jan 15-16 in U California Irvine. Possibly in person or virtual, depending on conditions
- Questions/Comments/Recommendations
  - Consider a town hall (at beginning of meeting) to learn more about the different committees/SIGs/Exec
  - When will decisions be made about location - a lot of background work has been done (reservations of rooms), but a lot will happen shortly
  - Maybe move the buddies meeting time so it is not concurrent with SIGs meeting
  - Videos and Slack channels will remain

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- Shout-out to Laurel and Pavan for the SABER buddies program. Lots of work to do that.
- Call to action seminar series 3 in fall and 3 in spring - Sept 16th is first one. More information to come
- Meeting talks
    - Short talks - the quality and the number of finished projects has definitely increased. +1 to keep the short talks more finished products and leave the posters and round tables to work in progress and long talks for work that spans multiple papers.
        - Are some institutions underrepresented (e.g., community colleges)
    - Is there any way to determine scheduling such that first-time presenters are placed opposite well known researchers?
    - Is there an intermediate length talk/abstract - maybe 20 minutes and 10 minutes. Maybe lightning talk idea (idea generator, see Nat'l Assoc for Enviro Educators Bright Spots sessions)
    - What about oral sessions organized quarterly to allow more people to be included
    - Maybe an annotated abstract that is acts as a guide for abstract writers. Could these be specific to qual or quant (or mixed methods)?
    - Maybe roundtable purpose can be more clear. Too much variation. Maybe there could be questions for the audience in the abstract?
    - Maybe organized sessions around a topic that includes a diversity of ideas/people.
        - Concern was raised if this could inadvertently privilege people with strong social networks
        - Rubric (for organized oral session) could include how this is an inclusive organized session? Or metrics for representation of diverse scholars or institutions
    - Maybe a decision tree about where to submit your abstract - roundtables, posters, short talks including the purpose of these.
- Feedback on the poster networking program where people requested visitors?
    - This seemed to be a really good idea. Can we continue in-person?
    - How can we reduce the pressure on presenters to recruit visitors
- Can we do more formalized calls for committees that could help people recognize where the needs exist. Emphasize that prior experience is not necessary
- Maybe virtual component needs to be thought through more closely. Could the remote portion be over a longer period and the in-person is a one-shot thing
- Does there need to be a community engagement committee?
- Are we going to continue to use Sched, even if in-person? People seemed to like it even if it costs money.

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