Abstracts
Roundtable sessions
SATURDAY

Diversity 312 Table 1

Bridging Worlds for Diversity and Inclusion: The Inclusion of Social Science with Biology Education Research Through the iEMBER Network Joshua Reid*, Middle Tennessee State University; Emily Weigel, Georgia Institute of Technology; Alison Crowe, University of Washington; Jana Marcette, Harris-Stowe State University; Michael Moore, Baylor University; Erin Solomon, Washington University in St. Louis; Rachel Tennial, University of Arkansas at Little Rock [Abstract #23]

Current reform efforts in biology education have focused on promoting both biological literacy, and retention, diversity, and inclusion in biology (AAAS, 2011). Multiple factors have been shown to be associated with these goals of biology education reform, including stereotype threat, science identity, and other affective and social dimensions (Beasley & Fischer, 2012; Chang et al., 2014; Eddy, Brownell, & Wenderoth, 2014; Espinosa, 2011). However, within biology education, a focus has been on the content aspects of the discipline (i.e., biology concepts) and the practices within the discipline (i.e., reform-based teaching strategies). However, the field of biology education has only recently begun to focus on sociological implications that mitigate these reform elements. To address these factors and reform efforts in biology education, from a sociological and multidisciplinary perspective, the Inclusive Environments and Metrics in Biology Education and Research (iEMBER) change initiative seeks to build a network of scholars to promote collaborations between scholars in biology education and social sciences. The outcomes of this NSF funded change initiative thus far has resulted in three, internally funded proposals which focus on the following: the impact of interventions on students' science identity; the effectiveness of biology mentoring triads of faculty, postdocs and/or graduate students, and undergraduates; and mindset and transitional periods. This roundtable will focus on extending discussions about the iEMBER change initiative through discussions that revolve around the following attributes of the network: evidence-based advice on how to create inclusive learning environments in biology, advice on how to develop networks between biology education researchers and social scientists discussion about existing tools and resources from social sciences and how they can be applied to biology education research discussion about the challenges and benefits of working within multidisciplinary networks. Furthermore, this roundtable will be of particular interest to those in the biology education community interested in the interdisciplinarity between social science research and biology education research. Interdisciplinary topics include science identity, affect in biology education, motivation, faculty and graduate teaching assistant development, and more. Participants will leave the discussion with thumb drives that include various resources that are designed to promote reflection in the multidisciplinary collaborations between social scientists, biologists, and biology education researchers. Note to Program Committee: this roundtable abstract is directly related to the roundtable abstract titled “Science Identity Intervention: Example of a collaboration between social scientists and biology education researchers through the iEMBER network”. If both abstracts are accepted, please schedule these two abstracts at the same roundtable.

Using Professional Development Programming to Promote Inclusive Teaching by Teaching Assistants in Undergraduate Biology Seth Thompson*, University of Minnesota; Meaghan Stein, University of Minnesota [Abstract #45]
Research over the last decade has indicated that a diverse student population can positively contribute to better learning outcomes in undergraduate biology courses. Transforming the instructional methods at the undergraduate level to specifically incorporate diversity and

inclusion is vital for promoting an inclusive culture of student learning. This is particularly true in the science laboratory course, where there is often an emphasis on collaborative group work. In North America, the primary instructor of these laboratory classes is often a graduate or undergraduate student teaching assistant. These novice instructors often lack the pedagogical knowledge and experience to effectively implement inclusive instructional practices and require targeted support to develop the knowledge and skills needed to promote an inclusive classroom environment. Given the reliance on teaching assistants to teach laboratory courses in many North American Universities, providing opportunities for teaching-centered professional development is imperative for improving student learning. This is particularly true as universities shift from traditional cookbook style labs, where students follow a prescribed lesson plan from a laboratory manual, to more student-driven inquiry labs. These inquiry-based labs require very different pedagogical skills for teaching assistants and implementing inquiry activities in inclusive ways can be challenging for novice instructors. This project describes a professional development program for teaching assistants that focuses on inclusive teaching practice. We offered three consecutive iterations of the program resulting in 50 trained teaching assistants. Assessment included both qualitative and quantitative metrics. Quantitatively, we measured changes in teaching assistants' knowledge and confidence with respect to implementing inclusive teaching practices using a locally designed pre- and post-survey. During the programming, teaching assistants submitted several reflective writings that we qualitatively analyzed using the grounded-theory framework to describe how participant understandings changed over the course of their experience. Preliminary data analysis shows that teaching assistants reported an increase in their knowledge of strategies for creating an inclusive classroom, minimizing the impact of implicit bias, minimizing stereotype threat in the classroom, and issues associated with bias in the sciences. Teaching assistants also reported increased confidence in implementing strategies to achieve more inclusive classrooms. Overall, preliminary data demonstrates that professional development focused on diversity and inclusion for teaching assistants results in increased knowledge and confidence related to inclusive teaching practice. Our work provides guidance for other groups designing and implementing targeted professional development for teaching assistants, particularly programming focused on inclusive teaching practice.

Science Identity Intervention: Example of a collaboration between social scientists and biology education researchers through the iEMBER network Alison Crowe*, University of Washington; Erica Cline, University of Washington Tacoma; Heather Heinz, University of Washington Tacoma; Jana Marcette, Harris-Stowe State University; Liz Martinez, Illinois Mathematics and Science Academy; Michael Moore, Baylor University; Joshua Reid, Middle Tennessee State University; Rachel Tennial, University of Arkansas at Little Rock; Emily Weigel, Georgia Institute of Technology [Abstract #72]

At the current rate of college graduation, the US will fall well short of the demand for STEM professionals in the next decade (PCAST, 2012). One proposed solution to address this need, as well as to diversify the STEM workforce, is to reform science education to attract and retain traditionally underrepresented groups in the sciences (PCAST, 2012; NRC, 2012). For biology education researchers, this means gaining a greater understanding not only of what motivates students to become biology majors, but also how classroom environment and science culture impact a student's decision to stay in the major. Addressing these questions requires a collaborative effort between biology education researchers and social scientists. The Inclusive Environments and Metrics in Biology Education and Research (iEMBER) group is a new national research coordination network that brings together STEM program directors, biology educators, biology education researchers and social scientists to better understand the experience of biology students and support initiatives that promote inclusive teaching. One project supported by the iEMBER initiative focuses on increasing student self-identification as scientists. Science identity is positively correlated with persistence and performance in STEM (Carlone & Johnson, 2007; Graham et al., 2013). The project's premise is that having students place themselves in the role of scientist while completing discipline-specific problem-solving scenarios will increase their self-identity as scientists, as measured by responses on a science-identity survey. To facilitate implementation at multiple institutions, scenarios focus on topics commonly taught in introductory biology courses (e.g. Mendelian inheritance and natural selection) and all interventions will be administered online. The effect of the interventions will be compared to a non-science role control scenario and measured as change in science identity score. The long-term goal of the project is to develop and validate a series of easily administered interventions that promote student self-identify as scientists to increase retention in STEM, particularly for students from underrepresented groups. Researchers involved in this study, including a K-12 expert, biology education researchers, and a social scientist will share their experience working in a multidisciplinary group. Specifically, they will describe their motivations for engaging in a multidisciplinary group, how the group was formed, how the study's methodological approaches evolved, and how they established a common language to communicate across disciplines. Authors will also share and solicit feedback from attendees on the discipline-specific problem-solving scenarios. Authors will then lead a general discussion on the challenges and benefits of working across disciplines with the goal of establishing a set of recommendations for best practices in forming and maintaining multi-disciplinary research collaborations.

URMs 312 Table 2

ISMs: A workshop model for opening dialogues about race in STEM Caroline Dahlberg*, Western Washington University; Regina Barber DeGraaff, Western Washington University; Robin Kodner, Western Washington University [Abstract #87]

Educators risk alienating students from diverse backgrounds when they avoid learning about and addressing issues such as race, racism, and bias. We have created a four-part series of professional and personal development workshops designed to guide conversations and enable actions around issues of race in STEM. Our workshops, titled Inclusion and Social Mindfulness in STEM (ISMs), provide STEM faculty and staff tools and time to reflect on how race and ethnicity affect the climate of and accessible to the STEM community. A structured curriculum and student-centered pedagogy helps scientists and science-affiliated staff learn to engage in productive dialog to ensure a more inclusive community as our student body becomes more diverse. The series consists of four two-hour workshops that build on each other and must be taken in order: (1) Cultural Awareness of self, (2) Experiences of others, (3) Critical Conversations, (4) A Call to Action. Participants may attend the complete sequence in anywhere from two weeks to one year, or longer. The workshops begin by developing an awareness of self as the foundation for understanding others and providing a forum for participants to recognize their own role(s) in society (1). Participants then confront difficult situations that may arise during teaching and/or mentoring using case studies that were solicited from the STEM community on our campus. By discussing the case studies, participants begin to identify the roots of microaggressive cultures (2) and to practice effective problem solving strategies and word-choices in response to hostile situations (3). The workshop series concludes with an open discussion about issues of equity and inclusion, along with a brainstorming session on ideas for campus climate change at three levels: the University, the Department, and the Classroom (4). Because the ISMs workshops are created for, and facilitated by, scientists, they are an accessible entry point to discussing race within STEM. More than 40 faculty and staff completed all four of our workshops in a single year and we are currently assessing the workshops to determine their efficacy in increasing communication around issues of race and in creating change at the institutional level. In the future, we plan to create a multi-level curriculum for workshops that will promote personal growth and community conversations with regard to race, racism, equity and inclusion for STEM faculty and staff. We are also working to transform our workshops into a portable structure that will lead to sustainability by creating a model that works for other institutions.

Improving civic and scientific literacy among minority students with collaborative experiences Davida Smyth*, Prof.; Mary Knopp Kelly, Mercy College; Kasey Powers, Mercy College; Kelly Colby, Mercy College [Abstract #226]
At our college, we're piloting the inclusion of collaborative classroom and research experiences to encourage civic and scientific literacy among our student population, composed of mostly first generation, underrepresented students. Using a scaffolded approach, ranging from modifying and adapting existing basic courses to the development of a novel and innovative classroom based undergraduate research experience course, our goal is to improve their literacy while exposing them to collaborative projects and research. At the novice level, we have targeted the lecture component of two courses including the non-majors Environmental Science course and the majors, Introductory Biology course. Novice students are also engaging in peer led team learning workshops and recitations. At the intermediate level, we've targeted the more advanced course, Microbiology. To develop mastery in the scientific method, a novel classroom based authentic research experience has been developed in the area of urban microbial ecology and the study of antibiotic resistant Staphylococci. To encourage literacy, students are given textbook surveys, strategic reading assignments and instructed in concept mapping. The classroom experiences include think-pair-share moments, case studies, active learning assignments and plenty of teamwork and collaboration. Students in all classes work in teams and engage in student chosen and student driven research into topics of civic import relevant to each course. Through these literature-based projects, students are able to take their first steps towards understanding and immersing themselves in the scientific method using authentic student-driven discovery. To date student feedback has been positive and they enjoy participating in the activities as indicated through the SALG and end of course surveys. Many students found concept mapping to be the most useful literacy technique. Our students gain experience with the generation of posters, educational brochures and bibliographies at the novice level, which they can bring with them throughout their college careers. These pilots have shown the feasibility of promoting collaboration across the curriculum, to enhance civic engagement and scientific literacy while exposing all students to research and the scientific method. A notable success has been in the increased number of students presenting at local, national and international conferences.

Teaching science across cultures: Tibetan Buddhist monastic experiences, attitudes, and beliefs related to biology education Kelsey Gray*, Emory University; Jacob Shreckengost, Georgia State University; Carol Worthman, Emory University; Arri Eisen, Emory University [Abstract #243]
Strategies to foster inclusive teaching environments have aimed to draw students of diverse backgrounds into the scientific community, yet have been grounded in a Western worldview. Inclusiveness of such efforts may be enhanced by consideration of worldviews outside those typically encountered. In this way, we may not only work to remove obstacles that discourage the participation of certain groups in science, but to also innovate approaches to the entire field of scientific study. To that purpose, in 2017 we surveyed students from three Tibetan Buddhist monasteries in India who were participating in the first four years of a six-year science curriculum that commenced in 2014. On a four-point scale (None, Low, Medium, High), 93% of first year students (n=253) reported no to low previous experience with science prior to their participation in this science curriculum. Since student buy-in is important for learning, we

surveyed monastics' interest in learning biology and its perceived importance for their monastic education. 53% of all students (n=775) indicated high levels and another 33% reported medium levels of interest in learning biology. 36% believed learning biology to be highly relevant to their monastic studies, while 40% endorsed medium relevance. Considering the low levels of previous interaction with science materials, we expected that as students progressed through the curriculum, more would read the specially prepared Introduction to Biology textbook in Tibetan that was designed to increase science exposure in the monasteries. 62% of first-year students (n=239) had not read the textbook; however, only 9% of second-years (n=178) had not. By their fourth year, 21% (n=177) of students had read "a lot". Finally, because 2017 was the first year Tibetan Buddhist nuns entered the curriculum, we compared their previous experience with science with that of monks entering the curriculum that year. Although monks (n=253) and nuns (n=41) did not differ in self-reported science background (p=0.277, Welch's t-test), they did differ in proportion having not read the Introduction to Biology textbook (62 vs. 85%; p=0.008, Welch's t-test). While monastic students are interested in science, it is likely that factors such as competing demands for their study of other subjects, time constraints, and access to Biology resources hinder their full engagement with the current science materials. This preliminary investigation of science education within monasteries has suggested the presence of some barriers to full engagement with the current science curriculum and provides the groundwork for future studies delving more deeply into specific content areas and the process of learning itself. In particular, future research aimed at identifying strengths in monastic approaches to education will add to the tools available for creating inclusive classrooms that incorporate approaching science from a variety of worldviews.

Teaching Tools 330 Table 1

Using 3-D Printing to Create Manipulatives for Undergraduate Active Learning Biology Classrooms Kim Pigford*, NC State University; Miriam Ferzli, NC State University; Sarah Crump, NC State University [Abstract #212]

The use of hands-on manipulatives in the classroom has been shown to increase student engagement with and understanding of abstract concepts. Evolution through geological time is one of those concepts with which students have a lot of difficulty connecting and conceptualizing. By using 3-D printing at our institution's Makerspaces, we were able to create manipulatives to demonstrate evolution in equine species. We obtained 3-D scans of fossils from online databases to design an activity that utilized equine fossil teeth and leg bones to illustrate the concept of natural selection in an introductory biology course. We used the manipulatives with students enrolled in an active, collaborative learning biology classroom (n=96) known as SCALE-UP (Student-Centered Active Learning Environments with Upside-down Pedagogies). In a jigsaw activity, "expert" student groups were given a set of nine fossil teeth belonging to different equine species, information on each species and the climate in which they lived, or a set of fossil leg bones further illustrating the changes that took place in equid species over time. After studying the materials and answering questions, students went back to "home groups" to combine the various pieces of information based on what they learned in their expert groups. They were then asked to provide a hypothesis for what drove the changes seen in equid species and a class discussion followed in which students shared their hypotheses, eventually getting to the conclusion that a changing climate was the driving force behind changes seen in the fossil record. To examine the impact of the manipulatives on student understanding of this concept, students' scores on an open-ended exam question was compared to students enrolled in a lecture section of the same course. During class time students in the lecture section had the opportunity to discuss the same information, see the same fossils as a demo, and answer the same questions; but they were not able to interact directly with the manipulatives due to the class size (n=240). Students in both sections received the same question on horse evolution. Exam responses were graded by the same persons to ensure interrater reliability. A between-group comparison of question scores was analyzed using an independent t-test. Furthermore, student responses to the exam question were qualitatively coded to examine any misconceptions that emerged for students in both sections regarding equid evolution. Students who had direct access to the fossil models performed significantly better on the exam question and exhibited fewer misconceptions regarding equid evolution and the forces driving it. The results of this study illustrate the importance of using hands on activities involving tangible models for helping students understand difficult and/or abstract biological concepts. It also demonstrates the use of 3D printed models as an easy and cost-effective option for accomplishing this goal.

The Power of Phenomenology in STEM Teaching and Learning Mays Imad, Pima County Community College; Petra Tineo, Pima Community College; Jenna Wild*, Pima Community College [Abstract #213]

Education is a cornerstone of modern society. Strong educational institutions foster the development of skills citizens need to innovate and produce tangible results, bolstering economies and sustaining progress. Physical innovation and economic progress, however, are not traditionally the purpose of education. They are instead a fortunate byproduct of a system that has long been more concerned with students as holistic individuals and engaged citizens. Holistic education reflects the interdependent real world and involves the learner's body, thoughts, feelings, senses, and intuition in learning experiences that unify knowledge. Such is the ideological backbone behind colleges and universities that aim to create an idyllic sanctuary where students can explore and learn about themselves and the world. A salient question remains: do students care about self-transformation and acquiring contemplative skills or is their primary focus to become workforce competitive? To find out, we administered a 20-item survey to first- and second-year students at a community college and a university to investigate what matters to them. Statistical factor analysis extracted three factors: i) Sense of Belonging, ii) Sense of Empowerment, and iii) Meaning-Centered. One construct variable in holistic education was created by the index of the three extracted factors into one construct with an interval measurement. We compared students' perspective to that of the professors' perception of what students seek from their education and found a misalignment of professors' perception. In this talk, we will present our findings and provide concrete, evidence-informed strategies to (1) align what students expect from their education with what faculty think; (2) transform the classroom into a sanctuary where all students can explore life, the inner and the outer. We will conclude with an examination of characteristics of a holistically educated student.

Teaching Tools 330 Table 2

Comparing perceptions of social media among biology and non-biology majors. Zach Nolen*, Texas State University; Kristy Daniel, Texas State University [Abstract #57]

Social media has become an integral part of students' lives and has garnered much attention as a potential instructional tool. There is currently little evidence about the integration of social media into science classrooms despite it being successfully incorporated into business, economics, and marketing classrooms. Current social media studies build on the assumption that students want to use social media in their courses but provide little evidence to support this. Our goal was to provide evidence about how students perceive the use of social media in their science courses using the newly developed Perceptions of Social Media (POSoM) questionnaire as well as how these perceptions differ among biology majors and non-majors. We assessed the perceptions of 240 students (majors=178, non-majors=62) enrolled in a science course. After conducting a Welch's t-test, we found that there were no significant differences ($p>0.05$) between majors and non-majors for each POSoM factor. We found that the majority of students held either a positive or neutral perception of using social media for academic use, while majority of students held a negative perception of using social media for academic communication. Our findings support the prior assumptions about integrating social media into science courses and can be used to help inform instructors about the most efficient ways of integrating social media into their courses.

Deployment of a simulation-based teaching module designed to counter student misconceptions about adaptive immunity Jeffrey Klemens*, Thomas Jefferson University; Sarah Gift, Bryn Mawr College [Abstract #153]

Adaptive immunity, in which the immune system acquires the ability to respond more effectively to previously encountered antigens, can be a difficult concept for biology students to grasp. Adaptive immunity is a result of clonal selection, or differential reproduction amongst cell lineages (clones) that share receptors specific to a particular antigen. In this regard it is similar to natural selection, another concept that is difficult for students to internalize. As with natural selection, student misconceptions may result from a tendency to favor explanations in which solutions are generated in response to a stimulus rather than those in which solutions are selected from existing variation. In order to address student misconceptions regarding adaptive immunity, we developed an agent-based simulation model in the the Netlogo programming language. Agents in the model represent B-lymphocytes (including memory and plasma cells) of different clones, antibodies, antigens, and vaccine particles. The model is capable of demonstrating 1) adaptive immunity acquired via repeated exposure to a pathogen, 2) vaccination as a method for generating an adaptive immune response, and 3) "measles-induced immunomodulation," in which acquired immunity is degraded by the action of the measles virus. A lesson plan was developed for presenting the model in either a small group or independent lab setting, this lesson plan was presented to three sections of an introductory biology class (43 students completed the study). All students had received lectures, been assigned readings, and completed Mastering Biology assignments on the immune system prior to the model presentation. Students were given identical pre- and post-tests before and immediately following the model presentation. The testing instrument consisted of six questions; four questions were designed to differentiate between correct concepts and common misconceptions and two questions were content-based questions designed to filter students who had not completed readings and activities or did not engage with the model presentation. In one class section, students were given another identical post-test five weeks following model presentation as part of a mid-term exam. Pre-test scores confirmed our suspicions that a small minority of students possessed correct concepts regarding clonal selection and adaptive immunity before participating in the model activity. Post-testing indicated small but statistically significant shifts in student concepts for three of our four misconception questions as measured by increase in correct concepts and declines in student misconceptions. Student responses regarding the key question of whether antigen-specific lymphocytes were present before infection increased from 15 to 33 percent of the sample (Chi-square = 15.1, $p < 0.005$). Neither of the two content-based questions was a significant predictor of student concept knowledge gains. Responses to one fact-based question, on whether secondary immune responses differed from primary responses in speed or magnitude, increased after the model presentation, as expected. A question on whether the immune system consisted of specific or non-specific defenses showed a negative change, as 8 percent of students shifted their answer from the correct choice (both) to specific defenses only (Chi-Square = 25.8, $p \ll 0.001$). Subsequent interviews with student respondents revealed that the emphasis of the activity on specific defenses undermined their confidence in the correct choice. The survey instrument deployed in this study was, in retrospect, somewhat difficult to interpret. As the education research community makes progress on developing concept inventories and concept assessments, a future avenue of progress may be in the development of smaller-scale validated instruments that can be deployed during the course of a single course module.

Virtual Reality Field Trips for Introductory Biology Students Miriam Ferzli*, NC State University; Kim Pigford, NC State University; Lisa Paciulli, NC State University; Betty Black, NC State University [Abstract #203]
Giving students field experiences in large lecture courses, like those common in the Introductory Biology courses, is a huge challenge. It is both costly and logistically difficult. In collaboration with the Distance Education and Learning Technologies Applications unit (DELTA), we developed virtual reality (VR) ecosystems that can allow students to have an experience very similar to one they would have in the field. We made this available to various section formats of the first semester of Introductory Biology: Evolution, Ecology, and Biodiversity: traditional lecture (four sections of 240 students), Student-Centered Active Learning with Upside-down Pedagogies (SCALE-UP; n=96), and distance education (n=100). Our work features a temperate forest, a coastal ecosystem, and a swamp. The goal of this project is to give students an immersive experience at these ecosystems without having to physically be there. Learning objectives include learning specific concepts related to ecosystem dynamics and biodiversity. The DELTA team filmed 360° video at ecosystems located in our state. They provided the background video and we took additional video of live organisms present at each location. Using video editing software, we made video clips of the organisms with narration and these were embedded as hotspots on the 360° videos. The VR ecosystems allow students to “walk” through an ecosystem and find the organisms at various locations by following hints that pop up as they are “walking” throughout a particular area of the environment. An accompanying assignment that focuses on biodiversity and species interactions prompts students to focus on specific aspects of the organisms’ characteristics and locations. Students can access the VR ecosystems using VR headsets, their mobile devices, or on their laptops. The most immersive experience is through the VR headsets, which can range from basic Google® cardboard to more sophisticated head gear. We were able to provide headsets to students accessing the ecosystems in the classroom, but students can also rent out headsets from the library or use the other available platforms for completing the assignment outside of class. Preliminary evaluation of the project addresses two main questions: 1- Did the 360° virtual environments and activities have a positive impact on the student learning process and outcomes in the course? 2 - How did the 360° virtual environments and activities support the process of learning concepts and skills in the course?

Mentored Research 512A

Undergraduate Research Mentoring Curricula Across Institutions Evelyn Frazier*, Florida Atlantic UNiversity [Abstract #98]

Research universities have been training undergraduate and graduate students to do research for centuries under the apprenticeship model where an expert individually trains the apprentice in the skills required in the field. Undergraduate research experiences have greatly increased over the years and have been found to increase student confidence, clarify career paths, increase subject knowledge, increase oral and written communication skills, critical thinking skills and students’ interest in pursuing advanced academic degrees and careers in science. Undergraduate research experiences also vary widely ranging from exposure level courses and programs, to summer intensive experiences lasting 8-10 weeks, to year-long intensive experiences of 12 months or more. In general, students involved in long term research experiences of 12 months or more, report greater benefits. A tiered research mentoring approach that trains students on scientific communication skills in addition to the laboratory or field research skills in STEM have shown to be very effective in retaining students within STEM research. During this roundtable, panelists will walk through ways in which they have developed new and adapted existing materials to scaffold the research learning experience for their students and share the challenges and successes they experienced while developing, teaching and assessing student learning. After the models are briefly presented, participants will be encouraged to ask questions and share challenges and/or their own creative approaches to providing mentee training to undergraduate students. The first panelist will present curricula for four courses at the research exposure and research intensive levels developed for juniors and seniors, as well as, two other exposure level courses developed for the unique needs of freshman and transfer students. Panelist two will present curriculum for a one semester course that was developed for a mixed group of novice and experienced undergraduate researchers as well as a description of how the course has been embedded within the requirements for a major in Biology. Panelist three will describe a workshop series and course for beginning undergraduate researchers, as well as strategies to integrate these types of research gateway activities to serve and leverage the unique experiences of students from a variety academic majors.

Assessment of Learning Gains and Changes in Student Perception of the Process of Science from Implementation of a Modular CURE Adam Kleinschmit*, Adams State University; Elizabeth Genne-Bacon, Tufts University School of Medicine; Carol Bascom-Slack, Tufts University School of Medicine [Abstract #117]

Course-based undergraduate research experiences (CUREs) are a trending approach to increase student engagement and retention in STEM, through the introduction of authentic research in the classroom. Although, widely adopted in the life sciences, reports indicate existing barriers for implementation by interested faculty include needed technical training, fiscal limitations, and in many cases the dedication of a full semester of class time. The Assessing the Prevalence of Antibiotic-Resistance in the Environment (PARE) CURE faculty consortium was designed to address these barriers by providing faculty with a series of low-cost authentic research modules based on standard microbiology techniques that instructors can combine in a custom manner depending on instructor time limitations and course learning objectives. Like many CUREs, the PARE Project aims to teach students the process of science (POS) through student designed experimental questions, collection and analysis of data, iterative experimentation, reflection, and dissemination to the larger scientific community. We have developed a pilot skills survey instrument to determine if the modular PARE CURE results in measurable student learning gains and can facilitate the development of students understanding of the POS. We administered our pilot pre-post skills survey to a voluntary cohort of PARE participants across five institutions. Our assessment instrument was composed of a combination of knowledge-based multiple choice and open-response questions, which included an experimental situation question to gauge student perceptions of the POS. Specifically, the POS question asked students to reconcile data, obtained using an established laboratory technique, that conflicted with experimental predictions. Anonymous survey responses to the POS open-response question were blindly coded into three repeating themes, including respondents that (1) viewed the experiment as a failure, (2) initially viewed the experiment as a failure, but were open to accepting the results after additional experimental trials, and (3) accepted the data and considered revising or addressing the hypothesis with another method. Coded responses were matched and sorted by pre-post and then grouped to determine the frequency of each assigned code for a comparison between pre-post. Preliminary data analysis with a subset of the data set suggests that there are discernible learning gains ($p<0.0001$, $n=30$, paired t-test) and that students may be receptive in shifting their perception of the POS from novice to views more in line with a professional scientist. Ongoing efforts are currently focused on statistical analysis of the POS perceptions data and collection of additional data to increase the statistical power of the pilot study.

DBER 512B

CBE-Life Sciences Education's "Anatomy of an Education Study": annotating articles to introduce biology education research to a larger audience Rebecca Price*, University of Washington Bothell; Clark Coffman, Iowa State University [Abstract #25]

Biology education research has often been conducted by individuals who have transitioned from training or work in natural science research. However, as the field matures and as research questions and methods become more sophisticated, it is harder for researchers without formal training in the social sciences to apply relevant methodologies to current questions in the field. The "Anatomy of an Education Study" feature in CBE-Life Sciences Education aims to address this problem by annotating articles to explicate various aspects of the design, conduct, interpretation, and presentation of education studies. This roundtable will introduce SABER attendees to the "Anatomy of an Education Study" feature. We annotate articles through five lenses: background, definitions, research design, writing tips, and instructional practice. The papers we are annotating aim to highlight a range of research designs and methods, from instrument development and validation to the study of effective and inclusive teaching practices. Our three goals for this roundtable discussion are to: (1) seek feedback on the annotations published thus far, (2) solicit suggestions of additional articles to annotate, keeping in mind our goal to annotate nine more articles over the next two to three years, and (3) gather input on how the SABER community might use this resource. This roundtable represents an opportunity for the SABER community to contribute to developing and refining this feature that guides researchers who are new to the field on how to read, interpret, and conduct research on the frontiers of biology education.

Using student thinking to identify research priorities in ecology and evolution education Mindi Summers*, University of Calgary; Michelle Smith, University of Maine [Abstract #104]

Targeted scientific teaching requires understanding of student thinking and identification of both the concepts that students understand and struggle to learn, as well as the variance and context to their knowledge. Several evidence-based quantitative and qualitative assessment tools have been developed to target specific concepts and skills in evolution (natural selection, genetics, evolutionary developmental biology, genetic drift, macroevolution, and tree-reading) and to explore energy and matter in ecology. In developing a new ecology and evolution assessment tool, EcoEvo-MAPS (Ecology and Evolution Measuring Achievement and Progress in Science), we sought to explore what concepts students know entering an undergraduate major, learn through a major, or continue to struggle with upon graduation. In this roundtable, we will discuss results from administering EcoEvo-MAPS to over 3000 biology students at 34 institutions and conducting over 80 think-aloud interviews. We will focus our discussion on student thinking revealed in interviews on topics where students struggled on the EcoEvo-MAPS assessment both at the beginning and end of a biology degree (<50% correct and <10% difference) – such as dominance, mutation, variation, genetic drift, phylogenetic relationships, and energy and matter – and topics where graduating seniors performed higher than first-year students (>10% difference) – including heritability, evolutionary fitness, tree-reading, and the impact of humans. While sharing our results, we will ask participants to contribute their own experiences teaching about these topics and to identify additional ecology and evolution concepts and skills that are challenging to undergraduates. During our conversation, we will identify common themes, rank research and instructional priorities, and share ideas for future collaborations. Our overarching goal of this roundtable will be to create a versatile framework for designing, studying, and sharing student thinking in ecology and evolution.

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Active Learning 312 Table 1

Improving supplemental instruction through active-learning modules in introductory biology James Boyett, University of Alabama at Birmingham; Sebastian Schormann, University of Alabama at Birmingham; Samiksha Raut*, UAB [Abstract #91]
In parallel with many universities across the nation, the biology department at the researched university has a downward trend in declared and graduating biology majors despite an increase in incoming freshman. Studies have shown that incorporating active-learning—AL—practices in these classrooms can retain students in the major, and greatly benefit first generation and underrepresented minority students. Despite these advantages, AL is challenging to implement in the classroom as the student-to-instructor ratio increases. A recommended solution is the introduction of AL in peer-led sessions known as Supplemental Instruction—SI. With the smaller size and more personal nature, SI is an ideal environment for the implemention of active learning. Another benefit of SI, as opposed to other avenues, is the emphasis on out of class sessions which encourages students to follow up on course material. Unfortunately, the existing precedent for SI at the university does not take advantage of these benefits and continues to utilize passive learning tactics. This passive approach has been the basis for overhauling SI and implementing instruction training for SI leaders at other universities due to its inefficacy. As expected, the current SI at the university has not shown to improve understanding nor curb attrition rates for biology majors. The aim of this study is to introduce AL modules in SI and investigate the impact on student understanding and performance. New SI sessions involve placing students in groups and posing open ended, discussion-based questions based on the highest domains of Bloom's Taxonomy—Apply, Analyze, Evaluate, Create—with the SI leader facilitating student-led discussion throughout each session. This model was implemented during the spring 2018 Introductory Biology I & II courses. By utilizing semi-qualititative, end-of-term surveys that use a five-point Likert Scale, we will assess student preference between SI sessions with and without AL. The survey is developed in house as no other study has looked at student preference as a measure of success even though this measure is crucial for determining individual student retention in the major. These survey results will be correlated with final course grades as a quantitative measure of effectiveness of the suggested implementations. Currently, we are in the process of data analysis and determining the project's next course of action. The goal is to receive feedback about the survey and data collection methodology to gain insight into the validity and reliability of the findings. This information will then be used to implement a follow up study in the 2019 fall semester, with an emphasis on helping at-risk populations such as transfer students and underrepresented minorities. The end goal is to develop further improvements to SI and other similar programs at universities which use them.

Instructional Practices in Reformed Undergraduate STEM Learning Environments: A Study of Instructor and Student Behaviors in Biology Courses Petra Kranzfelder, University of Minnesota; Alexander Lo, University of Minnesota - Twin Cities; Marin Melloy, University of Minnesota - Twin Cities; Lindsey Walker, University of Minnesota; Abdi Warfa*, University of Minnesota [Abstract #144]

Theoretically, organizational culture, the training of instructors, and the design of a learning space influence how faculty teach. Specifically, the interaction of classroom behaviors, particularly discursive practices and their sequencing, can influence the occurrence of student learning. Previous studies have used classroom observation protocols to characterize the range of STEM teaching practices in mostly teacher-centered, traditional classrooms. However, undergraduate STEM learning environments are rarely rich enough in evidence-based, active-learning activities to explore how organizational culture, instructor training, and physical spaces interact to influence classroom pedagogy. In this study, we used classroom observational data from 13 faculty teaching biology courses in a reformed undergraduate STEM learning environment to explore the spectrum of teaching practices in such environment. Based on 37 video-recorded class sessions, we used Classroom Observation Protocol for Undergraduate STEM (COPUS) to answer two questions: 1) What are the types of teaching practices observed in a reformed undergraduate STEM learning environment? 2) How does the degree of active-engagement instruction influence the sequence of instructor and student behaviors in reformed classrooms? Our findings indicate that instructors teaching in this reformed environment guided students (58.4 ± 1.9%) almost three times more than they presented information (20.4 ± 2.2%) in an average class session. In contrast, students spent roughly equivalent amounts of time receiving information (35.4 ± 1.9%) and working individually or in groups (36.5 ± 2.6%), but less time talking to the whole class (20.7 ± 1.7%). Based on the COPUS codes, we found a positive correlation between instructor presenting information and students receiving information ($r= 0.751$, $p<0.001$) and instructor guiding and students working ($r= 0.462$, $p<0.01$), suggesting that instructors can change their own classroom behaviors and expect changes in their student behaviors. Further analysis showed statistically significant variations in student and instructor behaviors between instructors based on non-parametric Kruskal-Wallis H tests. Finally, grouping of instructor behaviors by guiding allowed us to develop an illustrative model that demonstrated high active-engagement classrooms having more dynamic sequence of behaviors than moderate active-engagement classrooms. In the talk, we will discuss insights from these findings that have implications for acculturating evidence-based teaching practices in STEM departments.

Teacher Resources 312 Table 2

CourseSource: Sharing Evidence-Based Teaching Resources for Undergraduate Biology Education Jessamina Blum, University of Minnesota; Michelle Smith, University of Maine; Erin Vinson*, University of Maine [Abstract #146]

Fostered by national reports such as Vision and Change, changes in the way colleges and universities are approaching their undergraduate STEM courses can be observed nationwide: initiatives dedicated to advancing evidence-based science education practices, research-based undergraduate courses, and other efforts that aim to provide educators with the tools and strategies needed to transform their classrooms. To improve undergraduate biology education, there is an urgent need for instructors to publish their innovative active learning instructional materials in peer-reviewed journals. To do this, instructors can measure student knowledge about a variety of biology concepts, iteratively design activities, explore student learning outcomes, and publish the results. Creating a set of well-vetted activities, searchable through a journal interface, saves other instructors time and encourages the use of active-learning instructional practices. For authors, these publications offer new opportunities to collaborate and can provide evidence of a commitment to using active-learning instructional techniques in the classroom. In response to this need for instructors to publish instructional materials a peer-reviewed, open access journal of active-learning life science education resources was created: CourseSource. CourseSource (http://www.coursesource.org) provides life science educators with tested, evidence-based activities that make difficult concepts accessible to undergraduates. CourseSource includes teaching materials that 1) incorporate active-learning, evidence-based pedagogy; 2) are aligned with professional society-developed (ex. GSA, ESA) learning goals; and 3) are organized and formatted so that use in other classrooms can easily occur. This roundtable discussion will help prospective CourseSource authors share ideas about writing up their work for publication and receive feedback from peers as well as from editorial staff. We will also: 1) review the CourseSource “Instructions to Authors” and compare directions with traditional scientific and education research journals, 2) discuss common author pitfalls, such as presenting lessons in a way that is not easily replicable, and how to avoid them, and 3) help participants network to form writing and peer-review groups.

A novel, constructive model of fostering teaching excellence Rachelle Spell*, Emory University [Abstract #264]

In 2018, Emory College of Arts and Sciences implemented a higher standard for tenure and promotion that requires excellence in teaching. A novel, constructive model of fostering teaching excellence that emphasizes supportive advising, objective feedback, and personal reflection was initiated in 2017. Examination of the implementation and impact of this model can help elucidate the role of institutional organization and evaluation structures on attitudes about teaching. The initiative incorporates four categories of change strategies based on the work of Henderson, Beach, and Finklestein, 2011, in a constructive model of fostering teaching excellence. The actions taken in this model included: 1) restructuring the mentoring of all new faculty to include an assigned teaching mentor from the department’s lecture-track faculty who serve as teaching specialists; 2) involving faculty in defining new standards for evaluating teaching excellence for tenure and promotion; 3) supporting faculty reflection on their use of evidence-based instructional practices as evidence of commitment to excellence; 4) institutionalizing a teaching evaluation protocol that includes pre- and post-observation discussion and multiple classroom observations using a common rubric, and 5) establishing an annual departmental teaching retreat to provide practical support for course reform. Steps taken to develop this model, create departmental buy-in, elicit administrative support, and pilot implementation of this will be presented. Analysis of the impacts of the initiative and institutional factors on faculty attitudes will use data from surveys pre- and post-implementation of the higher teaching standards. The survey analysis grows from a two-year collaboration with an NSF-funded Research Coordination Network: Faculty Developers Network for Undergraduate Biology Education (FDN-UBE). The preliminary results from the implementation of this model will be presented, and roundtable feedback will be used to design qualitative analysis of faculty interviews.

Outcomes and Assessments 330 Table 1

Student Outcomes for Team-Based Versus Standard Classes David Gross*, University of Massachusetts Amherst; Sarah Pociask, Wellesley College; Mei-Yau Shih, University of Massachusetts Amherst [Abstract #63]

Team-based pedagogy in which persistent teams collaborate on in-class and out-of-class activities features substantial pre-class preparation and active learning in the classroom. This study asks if the team-based collaborative classroom advantages student learning over a classroom that has the same active learning components but lacks team work. The use of collaborative pedagogies in the college classroom has been under active development for many years. Among the developments are specific pedagogical approaches that employ student collaboration in a structured but informal way, such as think-pair-share, in a more structured way, such as in group work in and out of class, and in a highly structured way. The term “team” used here indicates that student groups persist for the entirety of the course. Key features of the highly structured collaborative pedagogies employed include team work, pre-class preparation with aligned course content practice during class, and peer review by students. The present study compares two sections of the same upper level undergraduate biochemistry course, one team-based and one not, from each of two semesters where all other in-class and out-of-class course components were identical. Each section employed substantial active learning content, was populated by students from one major who were dominantly juniors and seniors, and had the same instructor for all semesters. Assessments were identical for both sections in a given semester, and assessments between semesters, if not identical, probed student knowledge at similar Bloom's levels over similar course content. The two pedagogical approaches showed no statistical differences in student performance, as measured by raw exam scores, quiz scores, online homework completion, participation in class, and student effort. Student responses to a mid- and end-of-semester survey produced largely similar opinions for the two pedagogies, though students in the team-based sections were more likely to report positive opinions about team-based courses as compared to their peers in the non-team-based course. When asked "Do you feel connected to other students in this course?", students in the non-team-based sections were twice as likely to reply negatively than students in the team-based sections. Although the team-based course provided no advantage over a non-team-based course in terms of course content mastery, students in the team-based course did have the advantage of practice in prolonged collaboration and peer-peer communication. Such skills, particularly in the context of STEM course content, reflect the real-world atmosphere in STEM careers. Therefore, team-based pedagogies provide advantages to students while providing them with course content comparable to that from non-team-based pedagogies.

Developing Progressive Assessments to monitor the growth of disciplinary sophistication Mike Klymkowsky*, UC Boulder; Bilge Birsoy, University of Colorado Boulder; Melanie Cooper, Michigan State University [Abstract #80]

With the advent of concept tests, such as the Force Concept Inventory (FCI) and our own Biological Concepts Instrument (BCI), more than a decade ago, it has been possible to efficiently flag non-normative scientific ideas in a range of disciplines. Such instruments, however, are not designed to characterize students' use of knowledge, and therefore often provide an incomplete picture of what students know and are able to do. To address this deficit we are exploring the development of what we term progressive assessments that provide tasks that can be addressed at increasing levels of understanding, as a student moves through a curriculum. To exploit the fact that students reveal much about their thinking when drawing diagrams and graphs, a progressive assessment task includes items that involve graphical responses that can be captured either on paper or through our beSocratic system. Our design process begins with specifying a performance expectation that involves both a core topic and a scientific practice. Preliminary versions are used in think aloud interviews and administered to small groups of students. The prompts are modified based on student responses and administered to larger groups. The data are analyzed to identify the level of student response. We are in the process of developing progressive assessments on topics ranging from the effects of mutations on gene expression and product function, protein assembly and targeting, intracellular and intercellular signaling, and chromosome behavior during meiosis. We are interested in suggestions from the community to identify other core topics for assessment development. While very much a work in progress, we will present preliminary observations on the outcomes and implications of one or two of these assessments.

Science Skills 330 Table 2

Drawing and visualization in biology: professional practice and active-learning technique Mindi Summers*, University of Calgary; Natasha Morden, University of Calgary; Austin Ashbaugh, University of Calgary; Jessica Theodor, University of Calgary [Abstract #107]

Scientific visualization and visual literacy are foundational scientific practices incorporated in most biology courses. Reading scientific articles, observing specimens, analyzing or presenting data, and generating presentations requires students to interpret and communicate with visuals and translate between verbal and visual information. Drawing is also an active-learning technique that is advocated in the literature to help students develop observational, organizational, process, and relational thinking. However, recent reviews of Drawing-to-Learn in science and biology have identified gaps in knowledge on student motivation to learn visualization, how students develop visual skills, and effective instructional approaches for biology settings. In this roundtable, we will present new tools developed to study and advance student visual literacy in an upper-level biology course series that emphasize two Vision & Change key concepts: structure-function and evolution. We will first discuss the development, including evidence of validity and reliability, of a 25-question Likert survey to infer student motivation (attitude, self-efficacy, interest, and value) to draw and learn visually. Student scores on pilot administrations of this assessment show high levels of interest, value, and overall motivation regarding drawing in biology. These initial findings counter prevalent instructor perceptions of low student interest or discomfort in drawing commonly found the drawing-to-learn literature. We also identified two themes from student interviews. First, they perceived that drawing entailed a high cost relative to the benefits gained. Second, many felt low levels of self-efficacy when deploying different visual learning strategies. In response, we are currently developing a set of visual literacy instructional tools with embedded assessment and reflection that can be incorporated in lecture, laboratories, and online tutorials. To assist us in generating widely-applicable resources for biologists, we will ask roundtable participants to share visual literacy learning outcomes and instructional strategies from their courses. We will then engage participants in a discussion of key science visualization themes for biology and priorities for visualization research. The overarching aim of this roundtable will be to develop a collaborative community of instructors that can both study and effectively incorporate ways to teach visual literacy across biological sub-disciplines.

Setting the Dial: How Do We Construct Scalable and Sustainable Laboratory Environments that Foster Students' Science Identity, Science Process Skills, and Affect in the Biological Sciences? Kevin Floyd, University of Texas at El Paso; Ginger Fisher, University of Northern Colorado; David Esparza, University of Texas at El Paso; Jeffrey Olimpo*, The University of Texas at El Paso [Abstract #118]

Recent calls for reform within the science, technology, engineering, and mathematics disciplines have emphasized the need to engage emergent scholars at all academic levels in the rigorous process of scientific discovery and research. With specific regard to post-secondary biology learning environments, this need has largely been addressed through the genesis of inquiry- or course-based undergraduate research experiences (CUREs). Empirical evidence within the bioeducation literature indicates that student participation in CUREs leads to enhancement in their ability to "think like a scientist," persistence in the domain, and interest in conducting scientific research. However, the financial and logistical constraints related to such efforts, particularly in large-enrollment introductory courses, elicit questions about the sustainability of this model of laboratory education. We therefore sought to critically re-evaluate the extent to which frequency of inquiry-oriented exercises, student and faculty demographics, and broader institutional characteristics mediated cognitive and non-cognitive student outcomes within "traditional" laboratory contexts across three, diverse university settings. These institutions included a small minority-serving women's college, large Hispanic-serving institution, and small liberal arts college. A quasi-experimental, pre-/post-semester approach was utilized to assess students' ($n = 234$) development of science identity, scientific process skills, and motivation in the domain as measured via the Science Identity Instrument (SI; Estrada et al., 2011), Expanded Experimental Design Ability Tool (E-EDAT; Brownell et al., 2013), and Biology Motivation Questionnaire (BMQ; Glynn et al., 2011), respectively. Inquiry levels for laboratory exercises at each institution were evaluated using an adapted version of Buck et al.'s (2008) rubric. In addition to demographic data, instructors' pedagogical approaches and teaching self-efficacy were evaluated using the Approaches to Teaching Inventory (Trigwell & Prosser, 2004) and Teaching Self-Efficacy Scale (DeChenne et al., 2012). Preliminary results obtained from generalized linear mixed modeling (GLMM) and analysis of covariance (ANCOVA) procedures indicated that frequency of student-centered approaches, student demographic characteristics (e.g., first-generation status and ESL status), and average inquiry level of laboratory exercises impacted the aforementioned cognitive and non-cognitive student outcomes to varying degrees across institutions ($p \leq 0.040$ for all comparisons). SI, E-EDAT, and BMQ dimensions were furthermore found to be moderately correlated. Collectively, these findings suggest that attention to instructor professional development, overarching laboratory structure, and accessibility of instructional materials are central factors that warrant consideration when designing laboratory experiences that are ideally scalable and sustainable in nature.

Sharing and Collecting Community Feedback on Core Competencies Learning Outcomes (BioSkills Guide) Alexa Clemmons, University of Washhington [Abstract #271]

To be competitive in a modern STEM career, biology students will benefit from training and mastery in an array of competencies, or skills. These competencies include scientific practices, such as experimental design, modeling, and quantitative reasoning, and "soft skills", including teamwork, ethical decision making, and scientific communication. The six core competencies described in the 2011 report "Vision and Change" established a framework of skills-focused learning goals agreed upon by over 500 stakeholders with modern biology jobs and education in mind. The next step in this nationwide education transformation process is to review and update undergraduate curricula to ensure adequate training in the core competencies. To help facilitate teaching, mapping, and assessment of the Vision and Change core competencies across the curriculum, we are elaborating the competencies into measurable learning outcomes, which we are collectively calling the BioSkills Guide. In this interactive round table, we will provide an overview of the collaborative and iterative process we are using to develop a validated set of core competency learning outcomes. We will share a draft of the BioSkills Guide and participants will choose one of the six core competencies to explore more deeply in a small group. Participants will be asked to draw from their expertise related to their unique teaching backgrounds (e.g., institution type, biology subdiscipline). We hope this discussion will give participants an opportunity to reflect on past teaching experiences related to skills and leave with future goals for teaching core competencies in their own classrooms. Participant feedback will be used to revise and improve the guide. By doing this work collaboratively, we aim to build and distribute a resource for undergraduate skills training that all college biology educators will find valuable.

Gender and Self-Efficacy 512A

Gender and subjective social status in scientific group discussions in Face-to-face and online teaching settings Kristine Callis-Duehl*, East Carolina University; Rebekka Gougis, Illinois State University; Joi Walker, East Carolina university; Steven Wolf, East Carolina university [Abstract #16]

Engaging students in authentic scientific discourse is a primary goal of science education, but there are many challenges to accomplishing this in the classroom. Our study aims to understand the impact of gender and subjective social status (how students view their own social standing in relationship to their perception of other group members' social standings) on productivity of group discussions about data-driven problems and how satisfied are group members with those discussions. We created gender-based groups in introductory undergraduate biology, chemistry and physics classes (N=420) at two different research universities in both face-to-face classrooms and online/distance education classrooms. Groups included: all male groups, all female groups, equal gender groups, more-male groups and more-female groups. We will be presenting on a preliminary comparison between the face-to-face classes and the online classes in terms pre/post content surveys, pre/post subjective social status surveys and a post-discussion satisfaction survey.

Shaping Academic Success: How Declines in Motivation, Self-Efficacy, and Self-Regulation Influence Academic Performance in Introductory College Biology Students
Erika Nadile*, University of Massachusetts, Lowell [Abstract #35]

Research suggests that K-12 students with high self-efficacy and intrinsic motivation tend to be more academically driven in the classroom. At the college level, most studies explore the impact of only one social-psychological factor or explore multiple factors but only in the context of an intervention. Our study utilizes the Motivated Strategies for Learning Questionnaire (MSLQ) to measure extrinsic and intrinsic motivation, self-efficacy, and self-regulation in the context of varying demographics; this was completed at various time points in an introductory biology course without an intervention to better understand which factors generally contribute to academic. Based on preliminary findings, we hypothesized that A/B students would initially demonstrate higher extrinsic motivation and lower intrinsic motivation than C/D/F students. However, over the semester, A/B students would begin using more metacognitive strategies, resulting in increased intrinsic motivation (IM) and academic success; meanwhile, C/D/F students would recognize the need to improve grades, resulting in increased extrinsic motivation (EM). Furthermore, we hypothesized that first-generation college students would struggle more academically and also exhibit lower self-efficacy and self-regulation. Our cumulative (2015-2017) pre-survey results indicate that C/D/F students and A/B students were initially similar in self-efficacy, self-regulation as well as extrinsic and intrinsic motivation. However, by the end of the semester, C/D/F students exhibited statistically significant declines in each factor, respectively ($n=79$, $p<.001$; $n=79$, $p<.01$; $n=77$, $p<.05$; $n=77$, $p<.001$); conversely, A/B students maintained their levels in all of these factors. Furthermore, when comparing A/B to C/D/F students, we find that initially, they are comparable in both self-efficacy and self-regulation; however, due to the post-survey drop in both factors for C/D/F students, the post-survey difference is significant (self-efficacy: C/D/F ($n=79$), A/B ($n=117$), $p<.001$; self-regulation: C/D/F ($n=79$), A/B ($n=118$), $p<.001$). Additionally, while A/B and C/D/F students initially self-reported similar EM and IM, both groups of students were initially higher in EM than IM (A/B: ($n=120$), $p<0.001$; C/D/F: ($n=77$), $p=0.001$); however, because of the drop in both EM and IM for C/D/F students, the post-survey difference between them and A/B students is significant (A/B $n=120$; C/D/F $n=77$, EM $p=0.003$, IM $p<0.001$). Finally, preliminary demographic data suggests that those students whose parents didn’t attend a four-year college (includes students whose parents attended community college) had lower self-efficacy than those students whose parents attended at least a four-year college. Together, our findings suggest that these factors, or a combination thereof, may play a crucial role in enhancing academic success in those undergraduate biology students who perform below average and who struggle academically.

Contextual Differences Influence Model Architecture Joelyn de Lima*, Michigan State University; tammy long, Michigan State University [Abstract #123]

Scientific models are specialised representations that explain or predict a concept, process, or phenomenon. Educators and researchers agree that models are of great importance in the generation, evaluation, and communication of scientific knowledge. As a consequence, models have been included in the standards and required curricula for science at K-12 and university levels in multiple countries. As a tool, models lend themselves to both authentic instruction and assessment. However, student-constructed models can give us insights into student thinking and reasoning that are not captured in multiple choice or even narrative responses. Features of model architecture have been used in previous studies to gain insights into aspects of students’ cognitive structures (CS), such as the robustness or connectedness of their understanding. In this study, we ask whether item feature context (i.e., variables in a question prompt) impacts the architecture of students’ constructed models of evolution by natural selection. Previous studies have reported influences of contextual features on students’ reasoning about evolution, but only in their narrative responses. We asked students in 2 large ($n=384$) introductory biology courses how a biologist would explain the evolution of traits in humans and in cheetahs. Students had to provide their responses both as narratives and by constructing models. An analysis of the narrative data showed that students generated explanations with more scientific concepts when reasoning about cheetahs than about humans.We then analysed model architecture by measuring size (number of structures) and complexity (Web-Causality Index, WCI) . We found that: (1) number of structures was comparable for both human and cheetah contexts , (2) models about cheetahs were more complex than models about humans, (3) models about humans were more likely to be linear (zero complexity), and (4) student performance (measured by incoming GPA) did not contribute to explaining much variation in the data. Our results indicate that contextual features of the prompt are eliciting some differences in model architecture. While the context of the prompt did not significantly impact model size, the complexity did vary with context. This could indicate that while students are using the same number of concepts to explain natural selection in both humans and cheetahs, they demonstrate that their cognitive structure is more connected when they are reasoning about cheetahs.

Nature of Science 512B

Quantitative Modeling by Biology Undergraduate Students Joe Dauer*, University of Nebraska-Lincoln [Abstract #131]

Modeling, and quantitative modeling in particular, has become essential to a 21st-century biology workforce. A concerted effort to understand how students learn at the intersection of mathematics and biology will be necessary to prepare undergraduate students to solve biology challenges on a global scale. While quantitative modeling has been identified as a core competency for biology students there has not been a corresponding development of validated assessments to determine potential impacts of quantitative modeling interventions. Quantitative modeling ability relies on the ability to quantify biological relationships, successfully connect concepts to explain phenomena, and evaluate multiple models (hypotheses) to best approximate the phenomena. Moreover, student metacognition about modeling, i.e., the nature and purpose of models can impact students' motivation to model to learn biology. Our goal is to develop a diagnostic assessment to measure undergraduate students' quantitative modeling abilities in biology. The primary challenges in development has been assessing, in closed-form, the ability to quantitatively model given the iterative, context-specific nature of modeling, overlaid on biological knowledge. The assessment we will present for feedback uses plant transpiration, water movement to the atmosphere from aerial parts of a plant, that is introduced early in biology curricula. The mechanisms underpinning this phenomenon are largely unfamiliar to students, allowing students to explore them systematically through quantitative modeling. We will present questions from the four subcategories addressing model formulation, model deployment, quantitative interpretation of models, and meta-modeling knowledge. We will present our guiding framework and results from implementation in Spring 2018 related to the subcategories and discuss the student responses. We seek feedback on assessing student reasoning through closed-form questions and determining whether the assessment allow students the space to represent their modeling ability.

Rationally developing arguments from evidence Andy Martin*, University of Colorado; Kristin Lindquist, Self-employed; Lisa Corwin, University of Colorado Boulder [Abstract #175]

Making and evaluating evidence-based claims is a core disciplinary practice across most disciplines in higher education. While this is arguably one of the most fundamentally important core competencies, making gains in student's abilities to make and evaluate claims is difficult in part because this particular practice depends making gains in effective communicate, construct visualizations of evidence, and interpreting data. Furthermore, making gains depends on student motivation to invest in their work based on a sense that it matters. Too often the contract for the work is between the professor and a student and the work often becomes what has been characterized as disposable. Here I discuss efforts to make gains in the core practice of making and evaluating evidence-based claims using an app called Rationally. Rationally is built on a well developed model of argumentation and the results of students work become public (and are therefore not disposable). The platform is introduced, student products are discussed, and a general framework for teaching this core disciplinary practice with the aid of Rationally is described. We beta-tested the app in two courses and combine quantitative and qualitative data when making claims about the utility and effectiveness of the platform for advancing student gain.

Undergraduates view scientific models as simple explanations Caleb Trujillo*, Michgan State University; Steve Bennett, Bethel University; tammy long, Michigan State University [Abstract #196]

The inclusion of modeling in the science classroom is warranted so that students engage in authentic scientific practices as a way to understand the natural world. Although studies have examined the perspectives that K-12 students have about modeling, little is known about the views held by undergraduates. This study investigates students' perceptions of models in a model-based course by asking: what attributes do biology students associate with scientific models? To address this research question, we conducted an exploratory mixed-method study with participants recruited from two model-based introductory biology courses. First, students were interviewed about the definition, purpose, and value of models. Next, students sorted model attributes with different representations from the taxonomy of models by Harrison and Treagust. Inductive analysis of transcripts and correspondence analysis of sorting tasks both suggest that students associate scientific models with explanations that aid learning by making complex content simple and comprehensible. Conversely, students perceive the attributes of empirical support and predictive power as distinct from scientific models. Findings indicate that students' views of models only partially aligned with the scientists' views. The contributions of this study further an understanding of students' perspectives of models in biology classrooms and inform potential changes to model-based instruction.