**Group 1 Bruininks 512a**

**44 Diversifying discussions: How do we facilitate talking about biology in our classes?**  
Marin Melloy (University of Minnesota - Twin Cities)*; Sagal Mohammed (University of Minnesota); Abdi Warfa (University of Minnesota); Petra Kranzfelder (University of Minnesota); Marcos García-Ojeda (University of California, Merced); Jennifer Bankers-Fulbright (Augsburg University)

Active learning strategies increase student-instructor interactions, creating opportunities for rich classroom discussions. Most observational protocols used in undergraduate STEM classrooms focus on classroom behaviors, but they are not designed to reliably measure the ways in which instructors initiate classroom discussions, also known as teacher discourse moves (TDMs). TDMs are essential features of active learning environments and can be powerful tools for orchestrating productive classroom discourse by promoting student thinking and generation of knowledge. We describe the development and validation of a new instrument, called the Classroom Discourse Observation Protocol (CDOP), which characterizes and quantifies TDMs from observational data in undergraduate STEM classrooms. Through an inductive–deductive coding process, we identify commonly occurring 15 TDMs among a group of biology instructors (n = 13, 37 class sessions) teaching in active learning environments. We describe the CDOP coding scheme and its associated matrix that allows observers to reliably characterize TDMs in 2-min time intervals over the course of a class period. We present the protocol, reliability and content validity analysis, and sample discourses that illustrate its utility for assessing STEM teaching practices. Preliminary results suggest that this protocol is able to distinguish differences in CDOP codes, even in classrooms with equivalent active engagement instruction. An implication of our study is the importance of how STEM instructors effectively use discourse moves in active learning environments.

**249 Development of Epistasis and Epigenetics Concept Inventories: Phase One**  
Nancy Boury (Iowa State University)*; Rebecca Seipelt-Theiman (Middle Tennessee State University)

Our research group has recently developed the learning objectives and open-ended questions for two concept inventories: one on epistasis and a second on epigenetics. The learning objectives for each concept inventory were crafted based on Genetics Society of America (GSA) guidelines and included input from multiple faculty teaching general genetics at different schools. These learning objectives were the basis for an open ended version (phase I) of both the epistasis and epigenetics concept inventories. Both phase I inventories were administered in four different classrooms in fall 2018. We are in the process of identifying themes in the student data and converting questions to their equivalent multiple choice versions with distractors based on themes identified by student responses. During this roundtable or poster session, we would like to review the qualitative data from phase I, gather feedback for improvements to the multiple choice questions, and recruit SABER members that teach genetics to be part of the group to test the phase II (multiple choice) concept inventories in the fall of 2019.

**Group 2 Bruininks 512b**

**151 Designing Professional Development Initiatives for Graduate Teaching Assistants Facilitating Course-based Undergraduate Research Experiences (CUREs)**  
Amie Kern (University of Texas at El Paso)*; David Esparza (University of Texas at El Paso); Amy Kulesza (Center for Life Sciences Education); Corrie Pieterse (Center for Life Sciences Education); Seema Rivera (Clarkson University); Jeffrey T. Olimpo (The University of Texas at El Paso)

Current national efforts to reform postsecondary laboratory education have emphasized incorporation of authentic research opportunities into science, technology, engineering, and mathematics (STEM) curricula. Within the last decade, course-based undergraduate research experiences (CUREs) have emerged as a viable mechanism to achieve this goal. Evidence within the bioeducation literature suggests that student engagement in CUREs has the potential to positively
impact their development of scientific inquiry and process skills, content knowledge, and affect in the domain. While the majority of studies have focused on student outcomes, such as those cited above, few studies have examined instructor preparation and pedagogy in CURE learning environments. This is especially true for graduate teaching assistants (GTAs), who are frequently tasked with facilitating CUREs, yet who often receive little, if any, professional development (PD) to improve teaching skills that are vital to this type of instruction. In this interactive roundtable session, we will address this need by engaging participants in discussion around two central objectives: (i) identifying core elements of CURE GTA PD initiatives, which will be informed by existent GTA PD literature as well as our own preliminary mixed methods work in this area (i.e., national CURE GTA PD survey and semi-structured interview data); and (ii) elucidating best practices for developing, implementing, and evaluating CURE GTA PD initiatives that target identified core elements. As a result of this discussion, we hope to begin formation of a CURE GTA PD learning community that will continue to actively address issues in this area through future teaching, mentoring, and scholarship.

164 USING DATA-DRIVEN INQUIRY TO BUILD A COMPUTATIONAL COURSE-BASED UNDERGRADUATE RESEARCH EXPERIENCE IN LIMNOLOGY  

Paper ID 164  
Seth Thompson (University of Minnesota)*; Sehoya Cotner (University of Minnesota); James Cotner (University of Minnesota )  

Engaging undergraduates in research opportunities is imperative for cultivating a new generation of motivated scientists but offering these experiences to a large number of students in the field of limnology is often challenging. Course-based undergraduate researcher experiences (CUREs) represent a powerful training tool for preparing future researchers by providing inclusive research experiences for undergraduates and reducing the systematic biases that have led to underrepresentation of non-white and female scientists. Therefore, applying the CURE framework to engage students in limnological research experiences represents an exciting opportunity for recruiting and training a new generation of limnologists. Here we present a two-semester course series developed at the University of Minnesota to expose undergraduates to research in limnology. Assessment of our early pilot of this course-series used primarily qualitative metrics to categorize the experiences of 10 undergraduate students that participated in the first offering of the course. We specifically explored students perceptions of the authenticity of the science experience (i.e. did they feel like they were doing Ecology through a data-driven project) and development of their confidence in various science process skills. These early results show promise for developing scalable research experiences in limnology that can be implemented with limited resources and still provide measurable gains to students. We hope to hear others feedback on our course structures and assessment strategies to further improve the design of this course and inform future iterations.

Group 3 Bruininks 412

9 Understanding undergraduates’ informal learning experiences at a regional zoo  
Ashley Heim (University of Northern Colorado)*; Emily Holt (University of Northern Colorado)  

Informal learning environments in science are often described as those that occur in out-of-school-time settings, including museums, science centers, zoos, and aquariums (MCZAs). Informal learning in MCZAs both motivates students to persist in the sciences, and increases their understanding of science outside the formal classroom. Unfortunately, informal learning among undergraduates at the post-secondary level is relatively understudied, and those studies that do exist have primarily focused on the influence of social media on self-regulated learning and the preparation of K-12 science teachers, rather than on how places of informal learning (e.g., zoos, aquariums, museums) may influence undergraduate learning and motivation in the sciences. Therefore, my overarching goals for this research, founded on self-determination theory and situated learning theory, were to: 1) measure how informal learning
experiences influence student performance on laboratory practicals in an introductory biology course; 2) compile the intrinsic factors that motivate undergraduates to participate in informal learning experiences and learn science; 3) qualitatively describe undergraduates’ informal learning experiences, including their personal goals during informal learning interventions and how students direct their informal learning experiences; and 4) identify differences in performance, motivation, and goal setting between undergraduates in introductory versus advanced biology courses after/during an informal learning intervention. Students in introductory (n = 37) and advanced (n = 24) biology courses at a public four-year university in the Midwest U.S. completed online questionnaires and open-ended written narratives regarding their motivation and goals to learn science before, during, and after an intervention at a regional zoo (during which students were randomly assigned to formal or informal learning groups), and practical scores were collected for introductory students throughout the semester. Students in the formal learning group had graduate student chaperones to guide them through exhibits in a specific order and in a timely fashion. Students in the informal learning group had autonomy to visit whichever exhibits they chose in whichever order they preferred during the zoo trip. Data were analyzed using pairwise univariate correlations, multivariate correlations, and thematic analyses. Our initial findings suggest that informal learning experiences at regional zoos improve the learning experiences of undergraduates, their motivation to learn biology, and their abilities to fulfill both learning-based and affective goals related to the informal learning setting, regardless of year in the program. Additionally, we found no difference in practical exam performance between formal and informal learning groups. Findings from this research could be useful to biology faculty at post-secondary institutions who plan to implement informal learning in their curricula using best practices, as well as to undergraduates who find that informal learning experiences increase their learning gains and motivation to learn science, both within and beyond the classroom.

39 Middle School Female Interest in STEM and STEM Careers Before and After a Summer-Camp Experience
Kara E Baldwin (Illinois State University)*; Rebekka Darner (Illinois State University)

Gender differences within science, technology, engineering, and mathematics (STEM) fields are of concern. In the last decade, some disciplines, like math and biology, have seen a surge in female graduation rates; however, numbers of women graduating with advanced degrees continues to remain below their male counterparts. The gender gap is often attributed to disinterest in STEM, family responsibilities, implicit bias, and lack of female mentors. Middle school age students are building their identities and future selves. Middle school is an important time for building student identities toward STEM and may increase student engagement with STEM in the future. In addition, providing outside of school STEM experiences may increase female identification with STEM careers. Middle school interventions with female role models or teachers may enhance female interest in STEM and may have an impact on closing the gender gap in STEM careers. Discovery Academy (DA), a two-week STEM camp for middle school students, is designed to enhance all students’ attitudes toward science and mathematics. This day camp is led by three female scientists guiding large and small group STEM activities. Small groups of middle school students are paired with undergraduate STEM mentors to facilitate inquiry-based activities and career exploration. This research explored the questions: What was the impact on students’ attitudes toward mathematics and science when paired with a mentor of the same or opposite gender? What impact did DA have on female interest in STEM careers? To evaluate DA, the validated Science and Mathematics Student Motivation Assessment (SMSMA) was utilized. The SMSMA contains five subscales to assess students’ interest in both math and science and open-ended questions about student’s career plans. Student responses to career goals were categorized by career type, career specificity, and career change. RM-ANOVA were performed comparing gender, categorized career data, and subscale assessments. Before entering DA, middle school students already
had considered a career and most were interested in pursuing STEM. However, DA often increased career specificity (e.g. engineer to computer engineer). There were no notable differences in career choice based on gender. Preliminary findings revealed no significant differences on student interest due to mentor gender pairings. Although not statistically significant, there was a general positive change in attitudes when female students have female mentors and a negative trend in attitudes when female students are paired with male mentors. This research presents a framework for analyzing qualitative career interest data for STEM careers that may be useful for informal summer camps or other career interest evaluations. While inconclusive, patterns may be useful for the design and implementation of STEM camps. Most students attending STEM camp already orient toward STEM careers, organizations with the goal of increasing STEM career pathways should consider partnerships with other organizations to find participants without specific career plans or pathways. In addition, STEM camps may provide opportunities for participants to solidify or expand on their STEM identity or career choices.

**Group 4 Room Bruininks 312**

**101 A proposed model for evaluating an interdisciplinary graduate training program**  Paper ID 101  
Jyothi Kumar (Michigan State University)*; Shin-Han Shiu (Michigan State University); Tammy m Long (Michigan State University)

Interdisciplinary approaches in graduate STEM education aim to develop students’ agility in crossing disciplinary boundaries to solve complex and multifaceted problems. Well-designed programs integrate foundational skills training with authentic problem-solving and diverse opportunities for professional development. Ideally, trainees will compete effectively across a range of career types in a STEM workforce that is unpredictable and ever-changing. IMPACTS (Integrated training Model in Plant And CompuTational Sciences) is an NSF-funded Research Traineeship for doctoral students at the interface of computational, data, and plant sciences at Michigan State University. The program is unique in its specific aim to train doctoral students who can utilize a wide range of cutting-edge computational approaches, either individually or through collaboration, for solving problems that address grand challenges in plant biology. Program components include two project-based computational plant science courses, an annual research symposium, internships, and a weekly forum focused on developing trainees’ skills in communication, interdisciplinary collaboration, outreach, teaching and mentoring, and project management. While designing effective interdisciplinary training can be challenging, evaluating outcomes of such efforts poses even more formidable challenges. Differences in disciplinary cultures, language, and methodological approaches can impede communication, outcomes tend to evolve as programs mature, and few resources exist to provide constructive guidance. In this roundtable, we present our evaluation plan that aims to: (1) inform both project personnel and trainees about how and whether program components are meeting training objectives, (2) establish a mechanism for regular and systematic communication among program components that enable the project to adapt and respond to feedback, and (3) estimate project impact on trainee outcomes in comparison to non-participant peer cohorts. Our evaluation plan is not intended to serve as an exemplar, but as a launching point for engaging discussion about project evaluation more generally. We especially invite input from colleagues experienced in program evaluation, particularly at the graduate level. As a result of this roundtable, we hope to achieve: (a) a supportive network of colleagues from whom to solicit advice and feedback in designing evaluation plans for a range of project types, and (b) a repository of resources to support evaluation efforts that can be shared across the SABER community.

**127 Improving the Laboratory Experience for Undergraduate Students and Graduate Teaching Assistants: A Baseline Study**  Paper ID 127  
Michelle Nugent (NC State University)*; Miriam Ferzli (NC State University)
Graduate teaching assistants (GTAs) play a critical role in the learning experience of undergraduate students. At the college level, many science courses, such as the introductory biology course examined in this study, rely on GTAs to teach the mandatory laboratory component of the course. Existing literature has examined the pros and cons that this model has for the institution, the GTAs, and undergraduate students. The focus of this study was two-fold. We examined the student perception of the laboratory experience in terms of relevance to course material and their instructor interactions, and GTA self-perceptions of performance and preparedness as an instructor. GTAs are not required to be biology majors but they are required to attend a weekly 3-hour lab meeting, wherein the lab activities are simulated with the laboratory coordinator. This study included 29 undergraduate student interviews and post-semester reflections from 16 GTAs. Analysis of interview transcripts revealed that the most common responses from undergraduate students were that they are more comfortable interacting with their GTA than their professor because they find GTAs less intimidating since they are “students too.” However, many students reported that frequently GTAs do not know how to answer their questions, so they stop asking anyone. Many students reported that the lab failed to connect with lecture topics and that lab was simply “mindless busywork” or “going through the motions” rather than engaging in learning. GTAs report that their greatest weaknesses are not knowing how to address student questions, limited knowledge of the material, and not knowing how to grade student work, even with a rubric. These items could be addressed through professional development; however, only 50% of the GTAs indicated that they would be willing to attend additional training. Even more concerning is that 75% of the respondents were first-time GTAs, 31% were not continuing as GTAs in any capacity and 38% were not continuing to part-two of the introductory biology series. It is crucial that GTA training and retention be improved to better serve the undergraduate students who rely on the GTAs for their learning, and so GTAs are more capable, confident instructors. Improvements should include pedagogical training to enhance teaching self-efficacy and realignment of lab activities with lecture materials to ensure that the laboratory experience is meaningful and positively perceived.

Group 5 Bruininks 330 table north

84 Sloganing: A structured activity to help students recall science article content  Paper ID 84
Jacob Adler (Brescia University)*

Scientists spend a lot of their time reading. Inexperienced readers often find difficulty in dissecting the main points of science research articles. Support and structure can help novices navigate new terminology and obtain the main scientific understandings of an article. Here we describe a structured activity that helps students determine the main points of an article in a creative manner. Students individually read an article in advance of class, then in small groups during class briefly discuss what they have read. Importantly, each group designs a creative and unique slogan, headline, or catch phrase that could describe a major aspect of the article on a hand-held dry erase board. To further reinforce their engagement, each group presents their slogan to the class and then the group, instructor, or peers have opportunity to elaborate on their slogan and dig deeper into the background as to why their slogan was selected as important to the main point of the article. This creative memorable way of engaging with the main topic of the article helps with recall of the main ideas and students find the activity to be fun. Students with the structured activity (average +/- error = 55% +/- 11%) demonstrated on summative assessments significantly higher (student’s t-test p-value = 0.04) recall on questions concerning the main point of an article compared to the control group (average +/- error = 24% +/- 10%), sections of the same course that merely had discussed the article in class without the slogan activity. These same sections scored equally (p-value = 0.5) on the overall exam. Similarly, on a different question where both sections were provided a slogan activity, students scored equally (p-value = 0.9). Students in multiple introductory life science courses have benefited from this slogan activity and students have indicated via Likert 5-point self-reported surveys that they overwhelmingly agree that this type of activity has
improved their ability to highlight main points of a scientific article, understand the focus of the paper, broaden their knowledge on a complex topic more so than just reading it, and even helped them prepare for questions on exams. Overall, this activity engages students with scientific articles and allows them to create memorable experiences that helps with overall recall on summative assessments.

48 Are Learning Gains from a Recurring “Teach and Question” Homework Assignment Reproducible in a Variety of Classrooms?  Paper ID 48
Elizabeth G Bailey (Brigham Young University)*; Madeleine McWhorter (Brigham Young University); Clair Wootan (Brigham Young University)

With growing evidence for the benefits of active learning, pedagogical techniques that increase one-on-one interaction are in high demand. Reciprocal peer tutoring (RPT) has been one popular technique to increase student interaction since peers are plentiful and studies show that they can be as effective as experts. Most implementations of RPT in the literature required elaborate planning and/or class time. In 2018, we published a study testing the benefits of implementing RPT as a simple, recurring homework assignment in an introductory biology course. This “Teach and Question” assignment increased student exam performance by an average of two half-letter grades (e.g. raising a B- to a B+) with minimal instructor effort. In this new study, we propose to implement this “Teach and Question” assignment in a variety of undergraduate life sciences courses to see if these increases in student learning could be replicated in courses with different characteristics (different institutions, instructors, class sizes, class levels, etc.). We are recruiting collaborating instructors who would like to implement RPT in their courses. The “Teach and Question” assignment is a simple option for instructors hoping to add more active learning to their curriculum, since it requires only minimal changes to course design but has the potential for large learning gains. Each of these instructors would ideally teach two sections of the same course (either concurrently or consecutively). One section would be required to complete a “Teach and Question” assignment at the end of each unit. In this assignment, one student acts as “Teacher” and explains unit learning outcomes while the “Questioner” asks high-level questions to probe their understanding. The students then switch roles and repeat the exercise, audio recording the exchange for credit. To control for study time required, the other section will be assigned to study the material on their own for the same amount of time. We will compare exam performance and reasoning gains in the two sections to investigate the effect of the RPT assignment. In addition, we will code the audio recordings to examine correlations between tutoring session quality and student performance, and we will investigate student affect with attitudinal surveys. Finally, we will compare the results of our previous study to those of all participating courses to determine whether our original findings are generalizable to different courses and instructors.

Group 6 Bruininks 330 table south

292 Integrating research into undergraduate experiences through a community science program
Paper ID 292
Ana E Garcia Vedrenne (UC Los Angeles)*

Approximately 40% of students who enter US colleges and universities with the intention of majoring in STEM actually graduate with their intended degree, making the challenge of retention in STEM fields a priority that higher education institutions must address. Research shows that student success and persistence in STEM can be increased by exposure to authentic research experiences during the first few years of undergraduate education. Such experiences strengthen student’s science identities by fostering knowledge growth and providing opportunities for them to engage intellectually and build self-perception as a “science person”. However, the logistics associated with providing authentic experiences for all students can be complicated given limited availability of funds, space, and faculty
mentors. Community science provides a low-cost alternative to integrating research into undergraduate experiences. Here we investigate whether having a community science component early in an undergraduate’s degree yields benefits to student learning and persistence in STEM. We created a course that used the California Environmental DNA (CALeDNA) program to increase student engagement through active and inquiry-based learning. CALeDNA is a community science initiative that aims to catalogue and monitor California’s biodiversity through environmental DNA (DNA shed from organisms through fur, mucus, spores, pollen, etc into the environment). Community scientists collect soil and sediment samples that researchers analyze in the lab. Results are shared through the program’s website, a platform with user-friendly analysis tools designed for the public and researchers alike. Student attitudes and learning were assessed via two surveys: pre and post-course. Preliminary results suggest that integration of community science programs to undergraduate degrees might increase student’s confidence in conducting research, communicating their findings, and making an impact in the communities they identify with. Thus, the integration of community science programs to undergraduate curricula has potential as a catalyst to allow larger numbers of undergraduates to experience authentic research early on in their careers and persist in STEM fields.

223 Helping instructors incorporate active learning into their undergraduate biology classrooms: the Promoting Active Learning and Mentoring (PALM) Network  Paper ID 223
Susan Wick (University of Minnesota)*

Many instructors who see the evidence about the benefits of active learning are potentially interested in implementing it in their coursework, but may feel unprepared to dive into the process on their own. A group of biological sciences professional societies established the NSF-funded Promoting Active Learning and Mentoring (PALM) Network to provide individualized one-on-one mentoring on teaching methods linked to effective active learning. PALM is open to instructors, postdocs, and advanced graduate students from all kinds of post-secondary institutions, and includes interaction with an experienced mentor for at least one semester, more often for a year. Each Fellow and mentor pair identifies one or more specific objectives on which to work during the Fellowship period. Monthly journal club videoconferences with current and former “PALMers” provide opportunities to discuss relevant papers and create a community of practice to problem-solve and encourage each other. Twice a year we have half day Gatherings open to all current and former Fellows and mentors and members of the Steering Committee; we use this time to hear about PALM projects and dissemination efforts, and to solicit suggestions for program improvement. We assess changes in the Fellows’ teaching behavior by COPUS analysis of pre-mentoring and post-mentoring teaching and by a series of follow-up surveys for a few years after the Fellowship. We assess program success by the degree to which participants engage with other Fellows and mentors during virtual journal club sessions and Gatherings, by the publications, presentations, and other products that result from the Fellowships, and by indications that the Network is spreading to new participants. Some PALM Fellows and mentors (some pairs of whom were matched at earlier SABER meetings) will present their PALM work at this SABER meeting. At this roundtable discussion, they and the grant PI will discuss their experiences in PALM, the wide diversity of projects Fellows have undertaken, how to find a mentor or be matched with one, and how to write a successful application. We will show COPUS examples of how Fellows have changed their classroom practice in response to objectives they identified with their mentors. We will also present examples of how their involvement in PALM has led to increased awareness of active learning and utilization of evidence-based active learning methods at their institutions and further afield.
Let’s Get Real: Implementation of Authentic Research Experiences
Rachelle Spell (Emory University)*; Christopher Beck (Emory University)

Course-based research offers so many advantages over cookbook labs for student development of critical thinking skills and scientific identity that the expansion of course-based research experiences (CUREs) should be optimized. Granting agencies, national research model systems, and professional-development networks work to support that growth, but assessment of the impact of such support on actual implementation is lacking. Institution-specific narratives about CUREs do not often shed light on the best way to support faculty to develop and implement their own CUREs within the various instructional contexts of their own schools. We have utilized a unique source of data on implementation of CUREs in diverse settings. Follow-up with faculty teams who attended curriculum development workshops to create their own CUREs provides useful information on the impact of such workshops, a realistic snapshot of the level of authentic research in implemented CURES, and indicators of the barriers to implementation. Over 130 participants from 70 teams from a diverse set of institutions were surveyed about their actions following the workshops. Summative survey data indicates that a large majority of workshop attendees implemented a CURE, but the diversity of those CUREs suggest that faculty utilize a broad view of authentic research experiences. Many institutions implemented a CURE designed to generate novel results to the scientific community, while some CUREs worked on a research questions that were unknown only to the students. Some CUREs did not examine novel questions. We also asked whether the CURE incorporated authentic research practices of hypothesis generation, data collection, data analysis, and scientific communication. Analysis of such results bring up questions of whether these CUREs meet definitions of authentic research or of inquiry. These insights help clarify faculty views of CUREs in the context of practical implementation and suggest that restricting new laboratory curricula to those generating novel results may restrict curricular innovation and implementation. Respondents indicated that the PD workshops best helped them overcome barriers to CURE implementation such as lack of instructor preparation, instructor resistance, loss of content coverage, lack of time for CURE development, and assessment planning. Understanding the pragmatic components of new curriculum development and implementation will allow for the design of improved professional development activities. Such insights should be combined with outcomes research that considers the critical factors needed in a laboratory experience for student gains. The use of both types of information may ultimately suggest mechanisms to reach more faculty and refine our message to those faculty in our professional development opportunities.

CURE labs and inquiry-based classrooms improve understanding of science practices in different ways
Bryan D White (University of Washington Bothell)*; Dana Campbell (UW Bothell School of STEM); Thelma Madzima (University of Washington, Bothell); Alaron Lewis (UW Bothell School of STEM)

In an effort to engage students in activities that reflect the practices of scientists, many instructors have integrated course-based authentic research experiences (CURES) into biology curriculums. One of the main goals of this effort is to have students learn the process of science rather than be limited to learning science content. While the transition from “cookbook” labs to CURES helps students understand what it means to do science, such changes in course goals are not common in classrooms. In large teaching environments, content knowledge often takes a primary role. We wondered if a classroom focused on experimental design could have similar benefits as CURES with regard to what students think it means to do science. Additionally, is the number of students who report a change in their understanding of science different? To study these questions we asked students what it means to
do science and if their understanding of how scientists investigate a question changed over the course of the quarter. We queried students that had a CURE lab associated with introductory biology and students that had a traditional lab but an inquiry-based class focused on experimental design. Using a mixed methods approach, we coded student answers to surface common ideas and themes (n = 90 for CURE; n = 57 for class). Although only 50% done with our analysis to date, 64% of students that experienced the CURE said that their understanding changed versus 53% of students in the inquiry-based classroom. Coding student free-written explanations for what changed, students that experienced a CURE lab were much more likely to self-report that they now understand the importance of background knowledge, realize that many trials are necessary to answer a question, and mention aspects of the scientific method (found in 36%, 29%, and 19% of responses). Students that experienced an inquiry-based class self-reported that they can do science, see an essential role of experimental design, and can connect science to their lives (found in 30%, 24%, 18% of responses). Our study shows that CURE labs and inquiry-based classrooms can have a profound impact on how students view the process of science; however, the specific aspects of science practices that students embrace are different depending on pedagogy. Being cognizant of what students learn in a CURE vs in an inquiry-based classroom is helpful when developing a curriculum that helps all students become scientists.

**197 Stand-Alone CUREs for Classrooms Beyond the Research-Intensive University**

Sarah J Adkins (University of Alabama at Birmingham)*; Jeffrey Morris (University of Alabama at Birmingham)

CUREs have gained popularity for their ability to engage STEM students, improving retention and scholastic success. However, as CUREs involve authentic research projects, they often require access to an externally funded research program, limiting their accessibility at teaching-oriented institutions. We developed a novel CURE, "The Art of Microbiology", that attempts to bridge this gap in the microbiology classroom. In this course, students isolate soil microbes, explore ecological interactions with agar art, then use the free-form observations to design and test new hypotheses. Isolates are cryopreserved and data is archived to be accessible to other researchers, leading to the possibility that some of these experiments will kindle future discoveries. Importantly, these experiments do not require specialized equipment nor access to extramural research projects, and are therefore broadly accessible to educators at different types of institutions. We assessed effects of our CURE on student attitudes of science using a mixed methods approach. Compared to a demographically comparable non-CURE course (n=14), students using the Art of Microbiology curriculum (n=42) were 25% more likely to report confidence in generating a research question (PITS instrument) and a small researcher-blind focus group confirmed students affirmed five CURE process of science objectives (Rowland et al. 2016). Data from additional semesters (n=67) showed students found the team-level autonomy aspects of the course the most fun (in contrast to CUREs which are tied to professor-led projects), which was tied to higher confidence in designing an experiment (p<0.05). Preliminary evidence suggests results may be generalizable across professors and lecture styles. Our CURE has been deployed in at least three institutions: an R1 university, a small liberal arts college, and a community college. We are currently also working to build a Research Coordination Network dedicated to increasing exposure of community college biology students to authentic research using CUREs, using both our agar art curriculum and other approaches. We ask roundtable participants to help us i) determine how best to assess student learning gains across different types of institutions, ii) brainstorm more ideas for freeing CUREs from long-term attachment to extramural funding sources, and iii) encourage partnering institutions to invest in laboratory active-learning and CURE-based practices like the Art of Microbiology.
Group 2 Bruininks 512b

186 Development of Constructed Response Items to Elicit Student Thinking About Ecology and Use with Automated Assessment  
Paper ID 186
Michael Fleming (CSU Stanislaus)*; Juli Uhl (Michigan State University); Kevin Haudek (Michigan State University)

Constructed response (CR) questions are a valuable assessment tool which requires students to elaborate their understanding in their own writing. CR questions offer instructors an opportunity to examine students’ ideas and better gauge their conceptual understanding of important topics. The trade off is that they are time-consuming to evaluate meaningfully. As a result, instructors may opt for assessments that are faster to evaluate (e.g., multiple choice, matching), but provide limited insight into students’ thinking. One solution for instructors who wish to use more CR questions in their class is the use of automated analysis tools. Recent efforts in automated analysis have focused on machine learning tools for evaluation of CR questions. Such tools generate predictive models that assign students’ written responses to “bins” or coded categories of important concepts. These scoring models allow for nearly instantaneous, formative feedback for the instructor to see both a general class-level analytic as well as dive into individual-specific students’ thinking. Automated assessment question libraries in biology are well stocked with questions about molecular biology, cell biology, and evolution; questions in other areas such as ecology, organismal biology and epigenetics are underrepresented. This roundtable describes the development of several new undergraduate CR questions to elicit student thinking and reasoning about ecology. The iterative process of question design, expert feedback, data collection and analysis, and rubric development will be discussed. Early and current question versions, literature used to inform question topics, and published learning objectives and frameworks for ecological topics will be shared with participants. Session participants will be provided sample student responses showing various categories of conceptual thinking with a chance to code these student CRs, and an opportunity to provide feedback on question wording, alignment to key concepts and further coding schemes for rubric development. Attendees will have the opportunity to discuss misconceptions and ideas in several areas of ecology that should be included in scoring rubrics, interventions to correct misconceptions, and to share their interest in using automated assessment of ecology CRs in their courses.

163 Development of a Constructed Response Automated Assessment Question to Elicit Student Thinking About Epigenetics  
Paper ID 163
Juli Uhl (Michigan State University)*

Among the calls to improve biology education are efforts to ensure that students learn biology in a way that aligns with current research and practice, including teaching topics like epigenetics. Epigenetics is a rapidly growing area of research that represents a mechanistic link between genes, environment, and phenotype. Epigenetics is applied to research in several fields of study including medicine, biology, education, psychology, and sociology. Instructors are developing and publishing epigenetics case studies, instructional plans, and lesson plans for the K-12 and undergraduate levels. Undergraduate genetics textbooks now include entire chapters on epigenetics, and professional societies include epigenetics among their learning objectives. Because epigenetics is becoming more prevalent in instruction; there is a need to understand how students think about and learn epigenetics. This roundtable describes the development of formative, constructed response (CR) epigenetics assessment questions to reveal student thinking, with the intention of developing associated automated analysis tools. Compared to multiple choice questions, CR questions elicit detailed responses in students’ own writing which can provide instructors with a richer picture of student understanding. However, when CR questions are used at a large scale, it is a challenge to provide timely feedback or find common patterns in the larger dataset. This barrier may be overcome by development of automated analysis models. The goals of this project are to 1 – elicit and assess student thinking and reasoning about epigenetics across
biological scales and 2 - to categorize student ideas about epigenetics by developing a coding rubric that can be used as a basis for developing automated analysis tools. Our research design utilizes an iterative process of question design, expert feedback, data collection, qualitative data analysis, and rubric development. During the session, current questions, sample student responses, and published learning objectives related to epigenetics will be presented. Participants will be asked to provide feedback on question wording, alignment to learning objectives, and example responses. Based on this feedback, we will discuss improvements to the question wording, student ideas and misconceptions to include in the coding rubric, and gauge instructor interest in using epigenetics assessment items in their teaching.

**Group 3 Bruininks 412**

**239 Cooperative Game Play used as a means to Teach and Develop Team-working Skills in the Biological Sciences**  
**Paper ID 239**  
Amanda Salsberg (Bethel University)*; Sara Wyse (Bethel University)

Students in the sciences must possess high levels of teamwork skills. Despite the importance, most receive little direct instruction on effective team skills. Assessing the impact of cooperative game play on team dynamics and students’ development of teamwork skills, this study asked, does the experience playing a cooperative board game related to biology content facilitate the development of more cooperative teamwork skills that persist after game play concludes? Students enrolled in introductory biology (n=35) participated in 4-week lab unit on infectious disease wherein students learned, played, evaluated and adapted the cooperative board game, Pandemic. Student teams determined game assumptions, critiqued and evaluated game play and developed modifications to make the game more accurate. Students gathered data to test their modifications and communicated their findings orally. Before and after the unit, students responded to survey questions focused on group dynamics. Responses were transcribed and categorized according to descriptions of group behavior and specific behaviors listed before, during and after game play. Then, groups were categorized into three phases of group formation (Tuckman, 1965): Performing, Norming and Storming, and frequency distribution differences were determined using Chi-square. As teams played the game, 23% less deconstructive behaviors were used. Students began identifying with constructive behaviors, as teams moved from storming (17%), to norming (30%) to performing (53%) group stages. More responses included mentions of performing group characteristics post-game play (53%). Although only a few groups were ultimately categorized into the “performing” level, most students were aware of what should be expected of them and or how they should function as a unit. In this context, Pandemic appeared an effective tool to help 100-level students learn how to participate in a group. By creating an environment that forces students to work together, each member is recognized as important and a valuable contributor to team success. Thus, collaborative learning facilitated the development of essential team working skills that transferred beyond the cooperative game play.

**71 Group Size Has No Effect on Student Performance or Attitudes in a Student-Centered Biology Class**  
**Paper ID 71**  
Deborah Donovan (Western Washington University)*; Georgianne Connell (Western Washington University)

The use of group work in university classrooms supports implementing student-centered strategies, but there are questions about how to form groups to best support learning for all students. We previously found that low-competence students in a large-enrollment biology class performed better in heterogeneous groups than in homogenous groups, while mid- and high-competence students performed equally well in both group types. In our current study, we tested whether group size affects student learning and attitudes towards group work. We used a pre/post content assessment to measure learning and the Student Attitudes towards Group Environments (SAGE) to measure attitudes about
group work, as well as an exit survey to understand group dynamics. The study took place in two sections of Biol 101 taught during the same quarter by the same instructor. Students were assigned to heterogenous groups of three or six, using GPA and perceived biology competence to group them. There were 31 small groups and 16 large groups in each section. A pre-test was administered on the first day of class and post-test questions were integrated into unit tests, which were given to individuals then to groups. The SAGE was taken online at the beginning and end of class. We used multilevel models to test for differences in test scores and SAGE constructs between students in small and large groups. We found no evidence that groups size affects student learning or attitudes. Low-, mid-, and high-competence students performed equally well in each group size and there was no interaction between group size and post-test score. We also found no differences in the four SAGE constructs: quality of work, interdependence, frustration, and peer interaction. Students in both group sizes rated the dynamics of their group favorably. They could see tests and worksheets, could hear their group members, felt included, and felt accountable for coming to class. Recorded absences supported their perceived accountability. However, 61% of students reported preferring small groups, although most of those students had just finished the term in small groups. For the instructor, groups of three had many costs. It was a challenge to create heterogeneous groups and spacing around the classroom was difficult. There was also additional grading and paperwork. Considering the evidence, we suggest forming larger groups of six to reduce instructor workload, while still maintaining the benefits of students working in groups.

300 Impact of Group Exams in Non-majors Biology: a Mixed Methods Analysis  
Lindsay Chaney (Snow College)*

The effectiveness of group exams was evaluated in a non-majors general biology course at a rural community college. Different group testing methods were administered across three semesters and seven sections under the direction of one professor. Mixed-method strategies were used to evaluate pre/posttest gains, changes in scientific reasoning ability, and students perceptions on group exams. Findings show that students who took group exams had significantly higher scientific reasoning skills than students in the other test treatments. This supports the idea that peer interactions can increase scientific reasoning ability. Additionally, the majority of students saw group exams as a positive learning experience. This study provides empirical evidence on assessment strategies in an undergraduate non-majors introductory biology classroom that can help influence evidence based course design.

Group 4 Bruininks 312

33 You can publish this too! Highlighting and receiving credit for developing innovative instructional activities  
Michelle Smith (Cornell University)*; Erin Vinson (University of Maine)

To improve undergraduate biology education, there is a need for instructors to publish their innovative active-learning activities in peer-reviewed journals. Instructors can develop publishable activities by writing learning goals, measuring student knowledge about related concepts, iteratively designing activities, and exploring student learning outcomes. Arguably, developing classroom activities results in important intellectual contributions that indicate a commitment to using evidence-based teaching. To showcase this work, a peer-reviewed, open access journal of life science education resources was created: CourseSource. This journal includes teaching materials that 1) incorporate active-learning, evidence-based pedagogy; 2) are aligned with professional society-developed learning goals; and 3) are organized and formatted so that use in other classrooms can easily occur. Most importantly, this format means that adopters of active-learning have a place they can go to obtain expert-vetted teaching materials, rather than having to search through the mass of good and bad material on the web. We will help current and future CourseSource authors discuss ways to highlight
their publications in job applications, teaching philosophy statements, and tenure and promotion documents. For example, instructors can list CourseSource publications in the peer-reviewed articles section of their C.V. and report more information in the teaching section of their paperwork. We will explore how metrics such as number of views and downloads can be highlighted and collaborations with co-authors can provide evidence for institutional change. We will also show examples of how authors can publish articles in research journals and the corresponding instructional materials (e.g., clicker questions, lesson plans, web tools) in CourseSource. Finally, we will discuss how CourseSource publications can be a part of the movement to rethink the way teaching effectiveness is evaluated. Notably, there are generally agreed upon metrics for evaluating research success, but evaluating teaching expertise solely through student evaluations can be subject to bias and is not necessarily tied to student learning. However, if faculty publish their activities in peer-reviewed journals like CourseSource, these publications could be counted as evidence for effective teaching.

212 Team Based- Flipped Classroom in Microbiology: Case Based Learning  Paper ID 212
Samantha Giordano-Mooga (UAB)*

It is well known that active learning techniques improve student learning and engagement, it often requires more preparation for both the faculty and the students. I decided to utilize a team based flipped classroom approach in microbiology after the SP2018 to increase student engagement with the material for the SP2019 students. I plan to compare student outcomes and perceptions on learning, with and without the flipped classroom method. Further, since students are worked in teams, I am also fostering soft skills, including teamwork, communication and conflict resolution that can impact student learning and success in both the classroom and beyond. The first semester (SP2018) I taught Microbiology, I used more didactic teaching method, but during the current semester (SP2019) I am utilizing a team based-flipped classroom where students complete case study diagnoses as teams throughout a class period. In SP2019, I implemented a complete flipped classroom for all microorganism lectures, 6 times throughout the semester. I also incorporated other team based activities to facilitate student team relationships. At the end of the semester, a voluntary survey on student perceptions of their learning, of effectiveness of student teamwork, and the flipped classroom will be collected anonymously. To determine student perceptions on learning and teamwork we will analyze both qualitative and quantitative results from the surveys collected from the SP2019 cohort. Student learning outcomes will be assessed by comparing student grade on exams and final grades between the SP2018 and SP2019. Data will be collected for analysis in May 2019 and can therefore, be analyzed before the meeting to discuss with attendees. These results will help me to better prepare my microbiology class for SP2020 to continue to improve my teaching and increase student learning and engagement. The broader implications for this work include discussing way to implement novel active teaching methods to improve student learning outcomes and teamwork skills.

Group 5 Bruininks 330 table north

155 Mapping Core Competencies in the Undergraduate Biology Curriculum  Paper ID 155
Alexa Clemmons (University of Washington)*; Alison Crowe (University of Washington)

To be competitive in a modern STEM career, biology students need training in an array of transferrable skills. These skills include scientific practices, such as experimental design and quantitative reasoning, as well as “soft skills”, such as teamwork and scientific communication. The six core competencies described in 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 educational transformation process is to update undergraduate curricula to ensure adequate training in the core competencies. This will require review, mapping, and revision of existing curricula in alignment with core competency goals. In this round table we will share a case study in
curriculum review focused on competencies. Using systematically collected self-report data from faculty, we have mapped skills taught in individual courses onto the BioSkills Guide – a nationally validated set of learning outcomes based on the Vision and Change core competencies. We will present an overview of (1) the survey used to gather data from faculty, (2) data presentation methods that have been useful when presenting and discussing the data with the departmental curriculum committee, and (3) examples of curriculum policies and revisions that have been enacted based on the resulting data.

We will then open the conversation to the group to hear how different institutions have tackled reforming competency teaching. Specifically, we will lead a discussion on 1) What approaches have been used at your institution to collect curriculum data? 2) What obstacles have you encountered and what curriculum questions remain unanswered? and 3) What additional data would be useful in guiding curriculum discussions? We hope to facilitate a conversation including representatives with a variety of job titles and from a variety of institution types. We also invite constructive feedback on our plans for ongoing work in this area.

162 Teaching an old dog new tricks: Effects of teaching evidence-based study strategies on student learning
Tara Slominski (North Dakota State University)*; Sarah Montplaisir (North Dakota State University); Mary Jo Kenyon (North Dakota State University); Jennifer Momsen (North Dakota State University)

Undergraduate students are rarely taught how to use effective learning strategies like testing and spacing. Instead, students typically rely on the study strategies they used in high school and often find that these approaches are ineffective in their college courses. This misalignment of learning strategies with course objective can result in a greater risk of contributing to the DFW rates that plague STEM courses. In an attempt to reduce DFW rates in an introductory life-science course, we sought to better understand the specific learning strategies students used and if those approaches changed in response to course grades. We were also interested in the potential benefits of teaching students to use evidence-based learning strategies (i.e., retrieval practice, dual-coding, etc.). Finally, we asked whether students would use these new learning strategies and would this impact exam scores and course grades? To address our first research goal of characterizing study behaviors, we surveyed students in Human Anatomy & Physiology (HA&P; n = 330) during the first week of HA&P I and the last week of HA&P II. We asked students to describe their study habits in a number of ways (e.g. how they study, when they study, who taught them to study, etc.). We also used a single-item, open response survey question immediately following the first exam, asking students to describe how they had studied for the exam. Early evidence suggests students lean on passive study techniques (e.g., re-reading) and fail to use skills targeted through in-class activities and course objectives. To test the effect of receiving formal instruction on learning strategies on study behaviors and performance, we designed an optional, one credit prep course and offered it to all students planning to enroll in the HA&P sequence. The course focused on teaching students evidence-based study strategies originating from learning sciences. Thirty-two students successfully completed this 4-week prep course and matriculated into HA&P. We used prep course artifacts and HA&P course performance measures to evaluate the effect of prep course completion on HA&P student success. While early analysis does not show an effect of the prep course on HA&P exam scores, student course evaluations and course artifacts suggest prep course enrollment better equips students to study and learn in HA&P and later classes. Our mixed methods approach provides rich insight into students’ study behaviors. We found that students enter the classroom with very passive study habits, and without instructional intervention, many of those habits persist. Our roundtable discussion will focus on the curriculum used to facilitate our instructional intervention (the HA&P prep course), as well as the multiple course artifacts collected, from which we observe a reported change in student study behavior. We will also discuss what it means “to learn” from the perspective of undergraduate students in a large-enrollment biology classroom.
301 Identifying knowledge bases for graphing in biology: A student theoretical model
Joel K. Abraham (California State University, Fullerton)*, Elizabeth Suazo-Flores (Purdue University), Eli Meir (Simbio Inc), Susan Maruca (Simbio Inc), Stephanie Gardner (Purdue University)

Graphing in biology is a multidisciplinary practice used to explore and analyze data to test hypotheses and predictions, make inferences, and communicate findings. As part of a larger project on student graphing in biology guided by the Evidence-Centered Design framework (Mislevy, 2013), we sought to describe a set of knowledge and skills needed for graph construction in the context of biological inquiry in the form of a student theoretical model (STM). The STM is being developed in stages. First, we brainstormed a list of knowledge and skills for graphing, based on our own teaching and research experiences. Second, we complemented and confirmed this list with a scoping literature review including 115 peer-reviewed articles on graphing from biology education, mathematics education, and statistics education journals. Third, we are conducting focus group interviews with biology and statistics education experts to gather feedback on the STM, specifically on its relevance, wording, and completeness. The current version of the STM for graphing in biology comprises four broad categories of knowledge and skills for constructing graphs: data selection, data exploration, graph assembly, and graph interpretation, each of which includes 3-5 specific skill statements. The STM will serve as a guide for curriculum developers, instructors, or students when teaching or learning about graphs or constructing graphs themselves. As such, we hope to generate additional discussion about the design and relevance of the STM in a roundtable with researchers and instructors. We will present the STM in its current form, share some of the findings from our research on student graph construction in biology using the STM, and discuss other possible approaches to refining the STM to better serve biology instructors and education researchers.

297 Teaching and Assessing Qualitative Reasoning Skills in Undergraduate STEM Courses
Mays Imad (Pima County Community College)*; Kerianne Murphy Wilson (University of California Irvine)

One of the core competencies outlined in the 2011 AAAS "Vision and Change" report is the ability for students to use quantitative reasoning to understand and interpret data. The report further recommends that students can understand the relationship between science and society. While not explicitly stated, critical thinking skills are a subtle theme in the report. The report does not include, explicitly or implicitly, the need for students to develop qualitative reasoning, including logical and ethical reasoning skills. In this discussion, we will assert that for students, including STEM students, to become autonomous thinkers, it is necessary to acquire the ability to critically evaluate arguments and dialectically reason within different points of view. During the first part of this interactive round table discussion, we will present data from first- and second-year undergraduate biology students who were asked to evaluate the soundness and cogency of arguments and decipher whether an argument is fallacious or not. Over 60% of the students who participated in this study could not detect logical fallacies within the various arguments presented to them. We will then deliberate on the value of logical-reasoning. In our STEM courses, what does it mean to think critically? To reason logically? How can we assess it? Do we currently assess whether our students can distinguish between facts and opinions in their daily lives? Do we engage our students in ethical reasoning or dialectical reasoning within different points of view?
128 A Network for Three Communities Centered on Visualizations for Biology Education  
Susan Keen (UC Davis)*; Gael McGill (Harvard Medical School); Jodie Jenkinson (University of Toronto)

The visual media used in undergraduate biology education create a node connecting three groups of people: the scientific research and teaching community, scientific visualization practitioners, and the educational research community. While all three groups contribute to instructional media use, creation, and evaluation, members have limited understanding of each other’s constraints. Media design is a complex process guided by traditions of medical and scientific illustration as well as techniques from animation industries. Research examining the efficacy of educational multimedia has very little bearing or influence on real world practice. Visualization designers working in industry are not generally aware of findings in the educational research domain. Educational researchers have little exposure or access to documentation describing the decision-making process behind the design of scientific visualization. Gaps among three largely siloed communities underscore a need for greater interdisciplinary collaboration. We are developing a network to create a community of practice around key questions. How can we document the design and production decisions made during the creation of educational biovisualizations such that instructors who routinely leverage these materials in their classrooms can better select examples to meet their learning objectives? What methodologies should be deployed to assess the impact of these biovisualizations on learning outcomes in the undergraduate biology classrooms? Our ultimate goals are to improve the quality of instructional media (and thereby increase learning outcomes in students), and to support the educational research community with the availability of higher quality research stimuli. Our roundtable focus is to identify the criteria undergraduate biology educators use to find, select, and integrate instructional multimedia visuals into their curriculum. Faculty have limited time and diverse goals (e.g., increasing student interest with visuals, illustrating concepts and mechanisms, improving visual literacy, teaching students to reason), so we seek to understand faculty access and prioritization strategies. We also seek guidance in framing questions that will elicit useful information from network contributors. Constructive dialogue among all three groups will lead to media targeted toward teaching challenges, tested in typical classroom settings, and