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Welcome from Interim Director
Ginger Holmes Rowell

Twelfth Annual Tennessee STEM Education Research Conference
MTSU Student Union, Murfreesboro, TN
February 1-2, 2018

We are pleased you have chosen to join us for the 12th Annual Tennessee STEM Education Research Conference hosted by the Tennessee STEM Education Center at Middle Tennessee State University (MTSU). As the Interim Director, I am especially appreciative of past center directors Drs. Ray Phillips, Dovie Kimmins, Rick Vanosdall, and Tom Cheatham for their leadership for the center and their leadership for hosting this conference. I have participated in this conference for many years, and it is an honor to work with all the speakers and participants to bring everyone together for the conference’s 12th year. I am very glad you all are here.

STEM education continues to be an area of great need in our state and our country. In Tennessee, we are fortunate to have so many STEM educators committed to helping students of all ages improve their life-long learning of STEM. We sincerely appreciate all that you have done and continue to do to support the STEM education for students in our region. We hope you enjoy the special time these two days provide to learn more about STEM education research and to network with STEM education colleagues. We hope this is also a time to build new friendships and collaborations.

We are very excited about the keynote speakers for this year. Dr. Stacey Lowery Bretz, from Miami University of Ohio, will teach us about what makes learning meaningful in Chemistry laboratories. Mathematics education is well represented with a panel of researchers from the Mathematics Teacher Education Partnership. Drs. Gary Martin, James Martinez, and Alyson Lischka (from Auburn University, University of TN, Knoxville, and MTSU, respectively) will share what the research says about improving the preparation of the secondary mathematics teachers. A lot of changes are coming for K-12 teachers with the new science education standards, and Mr. Brian Caine, Science Coordinator of the TN Department of Education, will help us know how to incorporate three-dimensional science instruction in the classroom. On Thursday afternoon, we will also hear two series of “rapid talks,” which will quickly inform us about STEM education research results and opportunities. We will end Thursday with Dr. Philip Sadler, our banquet speaker from Harvard University, sharing how research helps us separate fact from myths so that we can make better educational decisions to impact student success in STEM.

Friday morning breakout sessions provide research insights into a wide variety of areas in mathematics, science and STEM education. Some examples include research results about important factors for professional development programs and outreach programs in STEM education, specific approaches to improving student learning in mathematics, aerospace, computing, engineering, and sciences.

We extend a special thank you to the Tennessee Space Grant Consortium MTSU PI, Dr. Henrique Momm, Department of Geosciences, and the MTSU Vice Provost for Research and Director of the Office of Research, Dr. David Butler and Mr. Jeff Porter, respectively. Their financial support over the last decade has allowed us to build a venue where TN STEM education professionals can share the results of their research and discuss collaborations with others. We are also especially appreciative of our newest supporter Lincoln Memorial University, School of Mathematics and Sciences Dean, Dr. Adam Rollins, who has helped us bring you this conference this year.
Thursday, February 1, 2018 (Ballroom D/E)

10:00 – 12:00  Registration

11:00 – 12:00  Lunch Provided (Ballroom)

12:15 – 12:45  Welcome and Announcements (Facilitator: Ginger Holmes Rowell, Middle Tennessee State University)
   • Dr. Robert Fischer, Dean, College of Basic & Applied Sciences, MTSU
   • Dr. Adam Rollins, Dean, School of Mathematics & Sciences, Lincoln Memorial University
   • Mr. Jeff Porter, Director of Research Services, Department of Research and Sponsored Programs, MTSU
   • Dr. Henrique Momm, MTSU PI NASA Space Grant & Professor Geoscience, MTSU

12:45 – 1:45  Science Education Keynote, (Facilitator: Amy Phelps, Middle Tennessee State University)
   Inquiry and Meaningful Learning in the Undergraduate Chemistry Laboratory
   Dr. Stacey Lowery Bretz, University Distinguished Professor, Department of Chemistry & Biochemistry, Miami University of Ohio

1:45 – 2:10  Rapid Talks (Facilitator: Ginger Holmes Rowell, Middle Tennessee State University)
   • Engaging Students in Science Understanding Using Literature Circles. Sally Millsap and Tasha Frick (Middle Tennessee State University)
   • MODULE(S2): Mathematics of Doing, Understanding, Learning and Educating for Secondary Schools. Jeremy F. Strayer, Alyson E. Lischka, Candice M. Quinn, Lucy A. Watson (Middle Tennessee State University)
   • Undergraduate Biology Students’ Misconceptions about Pedigrees. Zachary T. Grimes, Joshua W. Reid, Rebecca L. Seipel-Thiemann (Middle Tennessee State University) and Nancy M. Boury (Iowa State University)
   • Using NOS Cards and Plickers to Increase Pre-service Teachers’ Interest and Engagement in Science. Velta Napoleon-Fanis and Grant E. Gardner (Middle Tennessee State University)

2:10 – 2:25  Break/Discussion (Afternoon snacks)

2:25 – 3:25  Mathematics Education Keynote, (Facilitator: Jeremy Strayer, Middle Tennessee State University)
   The Mathematics Teacher Education Partnership: Improving the Preparation of the Next Generation of Secondary Mathematics Teachers
   • Dr. Gary Martin, Emily R. and Gerald S. Leischuck Endowed Professor, Department of Curriculum and Teaching: TEAM-Math, Auburn University, Auburn, AL
   • Dr. James Martinez, Assistant Professor, Department of Educational Leadership and Policy Studies, University of Tennessee, Knoxville, TN
   • Dr. Alyson E. Lischka, Assistant Professor of Mathematics Education, Department of Mathematical Sciences, Middle Tennessee State University

3:25 – 3:45  Rapid Talks (Facilitator: Ginger Holmes Rowell, Middle Tennessee State University)
   • The 2018 Tennessee STEAM Festival. John Hawkins (Discovery Center, Murfreesboro)
   • MTeach & Discovery Center: A Collaborative Model Supporting STEM Teaching & Learning. Dale McCreedy (Discovery Center, Murfreesboro)
   • New Biotechnology Laboratory Enhances Student Learning Opportunities at Lebanon High School. Melissa M. Bunch (Lebanon High School)
   • ASCE Bridge Competition for High School Students. Janey Camp (Vanderbilt University)
4:45 – 4:45  Tennessee K-12 Education Update, *(Facilitator: Sally Pardue, Tennessee Technological University)*

*Science Education in Tennessee: Incorporating Three Dimensions*
Mr. Brian Caine, Science Coordinator, TN Department of Education, Nashville, TN

4:45 – 6:00  Setup for Dinner (all leave the ballroom area, please)

4:45 – 5:45  Individual Meetings

6:00 – 8:00  Banquet and Keynote Speaker, *(Facilitator: Sarah Bleiler-Baxter, Middle Tennessee State University)*

*Separating Facts from Fads: How Our Choices Impact Students’ Performance and Persistence in STEM*
Dr. Philip Sadler, Director, Science Education Department, Harvard Smithsonian Center for Astrophysics, F.W. Wright Senior Lecturer in Astronomy, Harvard University, Cambridge, MA

Friday, February 2, 2018

7:30 – 8:15  Full Breakfast (Set up in hallway, with eating in 224, 210 & 221)

8:15 – 9:55  Concurrent Breakout Session 1 (talks are 25 minutes including questions)

**Mathematics Education Research 1 (RM 220, Facilitator: Lisa Green, Middle Tennessee State University)**
- Integrating Face-to-face Professional Development and a MOOC-Ed to Develop Teachers’ Statistical Knowledge for Teaching. Ryan Seth Jones, Jennifer Lovett, Angela Google (Middle Tennessee State University)
- The Impact of a Drawing Intervention on the Spatial Visualization Skills of Sixth-grade Students. Teresa Schmidt (Middle Tennessee State University)

**Science Education Research 1 (RM 224, Facilitator: Ryan Nivens, East Tennessee State University)**
- Undergraduate Biology Students’ Misconceptions about Mutations. Joshua W. Reid, Zachary Grimes, Rebecca Seipelt Thiemann (Middle Tennessee State University), Nancy Boury (Iowa State University)
- Exploring Science with Students Outdoors through the GLOBE Program. Janey Camp (Vanderbilt University)
- Leveraging GLOBE Resources to Implement Middle Grades Science and Mathematics Standards. Deborah A McAllister (University of Tennessee at Chattanooga)
- iPads in the Cockpit: Policies and Practices for Instructors in Aerospace Education. Tyler Babb (Middle Tennessee State University)

**STEM Education Research 1 (RM 221, Facilitator: Frances Harper, University of Tennessee at Knoxville)**
- Oakley STEM Center – An Evaluation of Outreach Events and Public Services. Sally Pardue, Abir Eldaba (Oakley STEM Center, Tennessee Technological University)
- Characteristics of a Successful STEM Middle School: Developing a Framework for Excellence in STEM Schools. Nikolas McGehee, Meghan Clemons (Tennessee Technological University)
- An Overview of the LMU Summer STEM Academy and Participant Attitudes toward Mathematics and Science. Keven W. Cooper, Ashleigh Thomas (Lincoln Memorial University)
- The Science of Outreach: Meeting the STEM Needs of K-12 Teachers. Thura Mack, Olivia Frederick (University of Tennessee at Knoxville)

9:55 – 10:10  Break/Discussions (Morning snacks)
10:10 – 11:25 Concurrent Breakout Session 2 (talks are 25 minutes including questions)

**Mathematics Education Research 2 (RM 220, Facilitator: Frances Harper, University of Tennessee at Knoxville)**
- INSPIRE-A Hybrid PD Model that Develops Teachers’ Knowledge for Teaching and Changes their Teaching Practice. Dovie Kimmins, Jeremy Winters, Rongjin Huang (Middle Tennessee State University)
- Teacher Learning and Embedded Professional Learning Support. Michael Lawson, Gale Stanley, Ashley Walther, Lynn Hodge (University of Tennessee at Knoxville)
- Using a Diagnostic Test as a Tool to Increase Student Success in College Calculus. Wanda R. Payne, Martene L. Stanberry (Tennessee State University)

**Science Education Research 2 (RM 224, Facilitator: Kevin Cooper, Lincoln Memorial University)**
- Avenues for Embedding Computing in STEM. Ryan Andrew Nivens (East Tennessee State University)
- Ambitious Discursive Moves that Support Explanatory Rigor in an Undergraduate Biology Laboratory Course. Anna Grinath (Middle Tennessee State University).
- Let’s Get Physical! Physics PD for Mathematics Teachers. Jeneva Clark, Peggy Bertrand (University of Tennessee at Knoxville)

**STEM Education Research 2 (RM 221, Facilitator: Grant Gardner, Middle Tennessee State University)**
- STEM and Literacy in Education through Project Based Learning (SLICE-PBL). Chih-Che Tai (East Tennessee State University)
- Is STEM More Than a Buzz Word? Crossing the Boundaries of Theory and Practice. Candice M Quinn, Joshua W. Reid (Middle Tennessee State University)
- Differential Use of Clickers in STEM Faculty. Joshua W. Reid, Zhigang Jia, Grant E. Gardner (Middle Tennessee State University)

11:30 - Lunch/Depart (Set up in hallway, with eating in 224, 210 & 221)
Science Education Keynote

Dr. Stacey Lowery Bretz

University Distinguished Professor, Department of Chemistry & Biochemistry
Miami University of Ohio

Inquiry and Meaningful Learning in the Undergraduate Chemistry Laboratory

While no chemist can imagine teaching chemistry without the undergraduate chemistry laboratory, the role of the laboratory in student learning has largely remained one of confirmation of principles presented in lecture rather than exploration and concept development for many students. Our research group has analyzed faculty goals for laboratory and characterized the level of inquiry in the laboratory experiments that students conduct. The challenge of measuring student learning in the undergraduate chemistry laboratory remains problematic.

Novak's Theory of Meaningful Learning states that the cognitive, affective, and psychomotor domains must be integrated in order for meaningful learning to occur. While the psychomotor domain is obviously integral to the undergraduate chemistry laboratory, the extent to which cognitive and affective processing are present for students is unknown. For meaningful learning to occur, students must actively integrate both the cognitive domain and the affective domain into the doing of their laboratory work. The Meaningful Learning in the Laboratory Instrument (MLLI) was designed to measure students' cognitive and affective expectations and experiences within the context of conducting experiments in the undergraduate chemistry laboratory. MLLI data has been collected in multiple studies: 1) general chemistry and organic chemistry students pre-post for the first semester of laboratory, 2) a national cross-sectional study, 3) a two-year longitudinal study, and 4) faculty expectations for student learning. Results from multiple studies
regarding inquiry and meaningful learning in the undergraduate teaching laboratory will be presented.

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Mathematics Education Keynote

Dr. Gary Martin
Emily R. and Gerald S. Leischuck Endowed Professor, Department of Curriculum and Teaching: TEAM-Math
Auburn University

Dr. James Martinez
Assistant Professor, Department of Educational Leadership and Policy Studies
University of Tennessee at Knoxville

Dr. Alyson E. Lischka
Assistant Professor of Mathematics Education, Department of Mathematical Sciences
Middle Tennessee State University

The Mathematics Teacher Education Partnership: Improving the Preparation of the Next Generation of Secondary Mathematics Teachers

The Mathematics Teacher Education Partnership (MTE-Partnership) was formed by the Association of Public and Land-grant Universities (APLU) in 2012 to address a major problem in secondary mathematics teacher preparation: an undersupply of new mathematics teachers who are well prepared to help their students attain the goals of the Common Core State Standards for Mathematics (CCSS-M) (Common Core State Standards Initiative, 2010) and other rigorous state mathematics standards. This consortium of over 90 universities and over 100 school systems has a common goal of transforming secondary mathematics teacher preparation using the Networked Improvement Community (NIC) design developed by the Carnegie Foundation for the Advancement of Teaching (Bryk, Gomez, Brunow, & LeMahieu, 2015).
The NIC design addressed several challenges identified in the early stages of the partnership, including the need to maintain the engagement of the teams in the work of the Partnership and a focus on disciplined inquiry consistent with the mission of universities (Martin & Gobstein, 2015). NICs are distinguished by four essential characteristics (Bryk, Gomez, Brunow, & LeMahieu, 2015): (1) Focused on a specified common aim; (2) Guided by a deep understanding of the problem and the system that produces it; (3) Disciplined by the rigor of improvement science; and (4) Networked to accelerate progress.

In accordance with this design, five Research Action Clusters (RACs) have been launched addressing key challenges facing secondary mathematics teacher preparation. In this talk, we focus particularly on two of these RACs. First, the MODULE(S2) RAC is focused on developing mathematical knowledge for teaching within upper-level content courses offered in preparation programs. The RAC is developing curriculum materials and accompanying instructional supports for use in College Geometry, Statistics, Abstract Algebra, and Modeling courses which incorporate simulations of classroom practice as a place for exploration of mathematical ideas.

Secondly, we will highlight the work of the Secondary Teacher Retention and Induction in Diverse Educational Settings (STRIDES) RAC, whose aim is to increase retention rates of early-career mathematics teachers serving in the middle and high school levels. Through an analysis of survey data describing reasons why first and second year teachers leave the profession and correlation with other, pertinent research studies, STRIDES members are now developing strict intervention protocols to address three of these areas: (a) lack of substantive on-site mentoring, (b) administrative support, and (c) professional development.

As detailed by Gomez, Russell, Bryk, LeMahieu, and Mejia (2016), the MTE-Partnership has found the NIC design particularly useful in addressing the “wicked problem” of improving secondary mathematics teacher preparation. Having a common aim and problem analysis maintains focus on critical problems. The use of improvement science techniques ensures evidence as the basis for improvement. The network supports a “divide and conquer” approach in which the workload is distributed across the RACs. And maintaining a focus on network identity helps to increase motivation and commitment. As a result, the MTE-Partnership research effort is both developing specific tools and approaches that can help to improve secondary mathematics teacher preparation, as well as pioneering a methodology for undertaking improvement efforts to address other “wicked” problems.

References:


Tennessee K-12 Education Update

Brian Caine

Science Coordinator, Office of Content & Assessment Design
Tennessee Department of Education

Science Education in Tennessee: Incorporating Three Dimensions

In October of 2016, Tennessee State Board of Education approved and adopted a new set of Tennessee Academic Standards for Science. The authors of our new standards leaned heavily on A Framework for K12 Science Education (National Research Council, 2012), following the guidance of this document and explicitly creating three dimensions to the science standards. Since this time, the Tennessee Department of Education has worked to release supports for teachers and secondary institutions, designed to build expertise in three dimensional science instruction and add clarity to the standards. This talk will be overviewing these ideas and materials and provide a hands-on opportunity to experience and engage with science and math content in a multi-dimensional manner.
Keynote Banquet Speaker

Dr. Philip M. Sadler

Director, Science Education Department, Harvard Smithsonian Center for Astrophysics
F.W. Wright Senior Lecturer in Astronomy
Harvard University

Separating Facts from Fads: How Our Choices Impact Students’ Performance and Persistence in STEM

The U.S. is unique in the freedom that teachers enjoy in choosing pedagogies and curricula in STEM classrooms and the wide availability of out-of-school time experiences. We have mined 50,000 college students’ histories to discover predictors of interest in a STEM career and of their success in critical college “gate-keeper” courses in biology, chemistry, physics, computer science, and calculus. In carrying out 5 national, NSF-supported studies, we put to the test STEM educators’ beliefs about the kinds of preparatory experiences and key resources that influence college success. Our findings relate to the impact of: lab experience, graphing calculators, computerized labs and simulations, demonstrations, content coverage, Advanced Placement coursework, project work, coding, and mathematics preparation. In addition, I will present evidence for the influence teacher knowledge, and of professional development on its acquisition, have on how much students learn in their STEM courses.
Rapid Talk: Engaging Students in Science Understanding Using Literature Circles

Sally Millsap (MTeach program coordinator)
Tasha Frick
Middle Tennessee State University

One of the difficulties many students and teachers have is in understanding the nature of science and precisely how chemistry applies to their world. As chemistry instructors, we adapt our role in the classroom to accommodate student learning, which requires continuous reflection and change to our classroom practices. Literature Circles using non-fiction books have been shown to increase understanding of nature of science in preservice teachers (Straits & Nichols, 2007) and we hoped to engage our students in understanding how chemistry knowledge has evolved in the real world using a nonfiction book.

We conducted action research through the implementation of the literature circles in our Dual Enrollment General Chemistry courses spring 2016. As teacher leaders and chemistry educators, we will discuss the role of our collaborative action research experience in adapting classroom practice (Vaughan & Burnaford, 2015). We will also explain how we adapted literature circles (Daniels, 1994) for use with the book “Disappearing Spoon” (Kean, 2011) and reflect on implementation strategies. The research we conducted is not generalizable; however, the story of our experience may help to inform future practice.

As instructors, we had very different classroom experiences before teaching General Chemistry and forming a partnership allowed each of us to bring different strengths to facilitate student growth in chemistry knowledge. Our successful implementation revolved around strategically planning lessons and weekly reflective dialogue. The ability to openly discuss classroom implementation difficulties through action research helped to improve confidence in our teacher efficacy for continued use of literature circles as an instructional strategy in General Chemistry courses at MTSU.

References:


doi:10.1080/09650792.2015.1062408
Rapid Talk: MODULE(S$^2$): Mathematics of Doing, Understanding, Learning and Educating for Secondary Schools

The Mathematics of Doing, Understanding, Learning and Educating for Secondary Schools (MODULE(S$^2$)) project strives to improve preservice secondary mathematics teachers’ mathematical knowledge for teaching (MKT) with a three-pronged approach: (1) refine and expand instructional modules which improved preservice secondary teachers’ mathematical knowledge for teaching in pilot trials; (2) promote effective instruction by university faculty using these modules; and (3) investigate the impact of use of instructional modules and faculty quality of instruction on preservice teachers’ knowledge, so as to inform subsequent efforts in teacher education to develop MKT in Geometry, Algebra, Statistics, and Modeling.

Secondary teachers, both pre- and in-service, have been documented to find content courses ineffective with respect to instructional practices for high school teaching for two reasons: (1) the content seems irrelevant, and (2) the norms and skills for mathematical communication seem inapplicable (Deng, 2007; Moreira & David, 2008; Ticknor, 2012; Wasserman et al., 2015). Even if content courses are in fact designed to address content, norms, and skills that are useful for teaching, teachers are unlikely to draw on resources they view as irrelevant. Content course ineffectiveness may be rooted in a traditional view of knowledge transfer (Perkins & Salomon, 2012). Transfer occurs when knowledge learned in one context (e.g., a content course) leads to improved performance in another context (e.g., high school teaching). Transfer is difficult, and when one context makes little attempt to bring in the other, transfer is even less likely (Barnett & Ceci, 2002). These results point to the need for content courses to cultivate mathematical knowledge in the context of instructional practices, so that transfer is more likely. We propose teacher education should engage PSMTs in using mathematical knowledge for teaching in the context of simulations of instructional practices that most benefit high school teaching.
This project investigated a College Geometry course with 16 students that was required of PSMTs in a secondary mathematics certification program but was open to all mathematics majors. All 16 students agreed to participate in this case study designed to answer the question: How do the modules help PSMTs develop MKT? In order to measure whether or not an increase in MKT occurred during the semester, we utilized a nationally validated Geometry Assessment for Secondary Teachers (GAST) (Mohr-Schroeder, Ronau, Peters, Lee, & Bush, 2017) measure. Each PSMT took the GAST at the beginning and end of the course, and the research team scored responses after being trained by GAST staff. In order to gain insight into how the PSMTs’ MKT changed, we analyzed pre- and post- simulations of teaching practice assignments according to the Silverman and Thompson MKT framework.

In this rapid talk, we present the MODULE(S\(^2\)) project work and a discussion of PSMTs’ development of MKT. In particular, after learning in a College Geometry course with MODULE(S\(^2\)) curricular materials, we observed the development of PSMTs’ KDUs of mathematical ideas and the ability to more fully understand student thinking. In addition, PSMTs significantly decreased their use of general discourse moves. We attribute this advancement of MKT to the PSMTs completing activities that are grounded in the work of teaching.

References:


Biology education is currently undergoing reform efforts to increase student retention and appreciation of biological sciences (AAAS, 2011). Both *Vision and Change in Undergraduate Biology Education* call for the increased use of evidence-based pedagogical strategies to support learning in biology learning environments (AAAS, 2011). However, integration of evidence-based instructional strategies relies on biology instructors’ knowledge of student pre-conceptions and misconceptions (Magnusson, Krajcik, & Borko, 1999). Furthermore, without proper assessments for student conceptual understanding, instructors are unable to gauge the effectiveness of instructional strategies. A concept inventory is an assessment tool with the purpose of identifying students’ pre-conceptions and misconceptions about a specific topic. This work is part of a larger study to develop concept inventories for multiple genetics concepts.

Genetics represents a critical area of biology education that presents many problems for student learning due to its abstract nature, need to think through different scales, and heavy reliance on technical language (Bahar, 1999; Cimer, 2012; Fisher, 1985). Genetics is also a field in biology that has seen tremendous advances in the last two decades. Pedigrees represent a convergence of topics in genetics and, therefore, has the potential to identify multiple student learning difficulties. Pedigrees require an understanding of modes of inheritance, which requires a knowledge of the nature of both dominance and recessiveness of traits, as well as understanding of the connections between genotype and phenotype and the ability to connect microcosm and mesocosm scales. This project sought to gain an understanding of students’ misconceptions of pedigrees in order to promote the development of an assessment tool for students’ conceptions and misconceptions. Our guiding research question for this inquiry was: What misconceptions about pedigrees do undergraduate biology students hold?

Qualitative methods were used to answer the above research question. The research team developed targeted questions focused on specific learning objectives, which were reviewed by genetics faculty. These questionnaires were designed using current standards documents from the Genetics Society of America (GSA), textbooks used in undergraduate genetics courses, and current literature in genetics research. Researchers collected student written responses to these
open-ended questions. The questions were then also used as prompts in selected student interviews, which were audio recorded and transcribed. The questionnaires were also transcribed. Both sets of transcriptions (questionnaires and interviews) were then reviewed and coded by the research team to elicit misconceptions regarding pedigrees.

This presentation will discuss the current progress on developing a pedigree concept inventory. Particular attention will be placed on dissemination of the misconceptions elicited from student responses.

References


Rapid Talk: Using NOS Cards and Plickers to Increase Pre-service Teachers Interest and Engagement in Science

Velta Napoleon-Fanis
Grant E. Gardner
Middle Tennessee State University

Learning, particularly science learning, involves the integration of cognitive and affective processes (Bransford, Brown, & Cocking, 1999). These cognitive and affective processes can be influenced by the nature of classroom activities and experiences that are afforded as a result of engaging in these activities (Bransford et al., 1999). Therefore, learning is impacted by how much feeling-related interests that students have towards a class activity. Furthermore, Bransford et al. elucidated that students’ development of more sophisticated understandings of science concepts and practices involve conceptual changes that are significantly mediated by affects such as learners’ interest in the topic and their motivation to engage in the learning environment.

The Nature of Science (NOS) has been stipulated as a significant factor that influences the overall goal of science education and recently has been an important outcome of many science reform documents (Lederman, 2007). Consequently, there is much emphasis on NOS with a focus on students’ views and efforts to increase students’ understanding of NOS. Researchers posit that an understanding of NOS can facilitate an increase in students’ interest in science (e.g., Lederman & Lederman, 2014; McComas, Clough, & Almazroa, 1998).

The participants of this project were pre-service teachers (PST) enrolled in a Life Science for Elementary Teachers course. Recognizing the unique opportunity to positively influence and shape the perspective of PST, we sought to develop an activity that could make learning more meaningful, long-lasting, interesting, and developed through the labor of PST who are enticed to participate in a ‘continuous cycle of studying, producing, correcting mistakes, and starting over again’ (Lamborn, Newmann, & Wehlage, 1992, p. 3). With that in mind, the following research questions were posed:

1. Do Plicker activities increase pre-service teachers’ interest and engagement in science, if at all?
2. Do Nature of Science (NOS) cards increase pre-service teachers’ interest and engagement in science, if at all?
One way instructors can reach students is by increasing class interest and engagement through active student participation (Prince, 2004). There is not much literature that describes science lessons with the aim of focusing on NOS as well as encouraging or increasing students’ interest and engagement in science. With this limitation in mind, this project was designed to include the use of a new type of interactive emergent technology, known as a Plickers, which can be used to increase students’ interest and engagement in the classroom if used effectively. This low tech tool was paired with NOS cards to provide a unique opportunity to engage with each other and get instantaneous feedback.

Based on findings from data collected via survey and PST’ reflections, it was found that PST felt that they benefited from a situation that was conducive to encouraging all students to participate. Also, results indicated that the NOS cards and Plicker questions made ‘lessons more interesting by keeping students focused in an attempt to be able to determine the answers to Plicker questions’ or more engaging because PST had to ‘justify their claims based on comments made on their NOS cards.’

References:


Rapid Talk: The 2018 Tennessee STEAM Festival

John Hawkins
Discovery Center, Murfreesboro

The Tennessee STEAM Festival aspires to build interest and excitement in STEAM, and cultivate the next generation of citizen and professional science advocates and practitioners by leveraging local partnerships from across the region. The STEAM Festival is actively seeking locations to plan and host events during the 10-day window of October 12-21, 2018. This is a great opportunity for researchers to reach new audiences and disseminate information.

Rapid Talk: MTeach & Discovery Center: A Collaborative Model Supporting STEM Teaching & Learning

Dale McCreedy
Discovery Center, Murfreesboro

MTSU's secondary math and science teacher certification program, called MTeach, provides opportunities for undergraduate STEM majors to "try out teaching" as an add-on to their existing STEM major. Although field placements for MTeach students have historically been school-based, Discovery Center and MTeach began a unique partnership in the summer of 2016 that have shaped the pre-service teachers' experiences and practices in new ways, and influenced the ways in which the museum and MTSU collaborate in meaningful and impactful ways in support of enhanced and diversified STEM teaching and learning experiences.
Rapid Talk: New Biotechnology Laboratory Enhances Student Learning Opportunities at Lebanon High School

Melissa M. Bunch  
Lebanon High School, Lebanon

Lebanon High School has partnered with Volunteer State Community College to develop a new STEM Biotechnology Program. First, biotechnology classes were offered as a part of the school’s Career Technical Education (CTE) program. Starting in the fall 2017, new biotech laboratory equipment was added, which greatly enhances the learning experiences for the students. While other states have been offering biotechnology classes for a number of years, the class that is being offered at Lebanon High School is the first of its kind in Tennessee.

Rapid Talk: ASCE Bridge Competition for High School Students

Janey Camp  
Vanderbilt University

Each year, the Nashville Branch of the American Society of Civil Engineers (ASCE) hosts a bridge competition for high school students in Middle TN. We would love to expand this competition to include more students from across the state. The competition is aimed at high school students due to the national competition regulations, but middle school students can participate in the experience as well. Students build basswood bridges according to set guidelines which change each year and then test (i.e., break) them at the competition. The goal is to create a highly efficient bridge which minimizes the amount of material used in comparison to the amount of weight that the bridge will support. This presentation will include information about the upcoming competition in Nashville on March 3rd and showcase photos of past bridges.
This professional development research project embraced the interdisciplinary nature of statistical investigation. Middle school mathematics teachers (N=19) engaged in a lesson designed to blend both scientific and statistical investigation of soil pH levels in order to highlight diverse ways in which to embrace the authentic uncertainties of statistical analyses. According to the National Council of Teachers of Mathematics (2000), “school mathematics experiences at all levels should include opportunities to learn about mathematics by working on problems arising in contexts outside of mathematics. These connections can be to other subject areas and disciplines as well as to students’ daily lives” (p.65). With this initiative, blending science and statistics lends itself to more real-world context, therefore increasing opportunities for a deeper, conceptual understanding of statistics (Heaton, R. & Mickelson, 2002).

This integrated 6th and 7th grade lesson provided an exemplary opportunity to utilize statistical tools to determine where students could optimally plant a garden on their school grounds. Within this lesson, students dig up their own soil samples, measure the pH values of that soil, and then use this data to answer their original question while simultaneously creating additional questions. This lesson combines both scientific and statistical investigation. The statistical and scientific investigation cycles have both been studied in isolation but rarely in a complementary manner that emphasizes their interdisciplinary characteristics. Both the GASIE report (Guidelines for Assessment and Instruction in Statistics Education Report: A Pre-K-12 Curriculum Framework) (Franklin et al. 2005) and the eight scientific practices outlined by the Next Generation Science Standards (NGSS, 2013) highlight investigative processes which begin with posing a context relevant question that influences data collection, analyses, and interpretation.

During this professional development, the 19 middle school mathematics teachers participated in the above mentioned lesson. The teachers, dug up soil samples, tested each samples pH value, and analyzed the data utilizing an exploratory data analysis and modeling software called Tinkerplots. This software enabled the teachers to analyze, interpret, and display their data in a
unique fashion. This software also encouraged the development of additional authentic scientific and statistical questions. Engagement with this authentic and relevant investigative process provided these teachers with both the content knowledge and pedagogy necessary to support students to learn about statistical inquiry.

Given this opportunity to engage Middle School mathematics teacher in an interdisciplinary lesson, the following research questions were posed.

1. How do the GAISE levels of statistical investigation and the NGSS eight scientific practices relate to the interdisciplinary lesson on soil pH?
2. In what ways do middle school mathematics teachers explore scientific data using Tinkerplots?
3. How can this interdisciplinary lesson be incorporated into the middle mathematics curriculum as reported by teachers?

Teachers were video and audio recorded throughout entire lesson. An analysis of these recordings and each teachers’ Tinkerplots displays and discussions provided a wealth of insight as to how these middle mathematics teachers grappled with an interdisciplinary lesson. These findings and more will be discussed during this breakout session.

References:


Integrating Face-to-Face Professional Development and a MOOC-Ed to Develop Teachers’ Statistical Knowledge for Teaching

Ryan S. Jones
Jennifer Lovett
Angela Google
Middle Tennessee State University

We will report on our effort to support middle grades teachers to develop the content knowledge, pedagogy, and self-efficacy necessary to support students to learn about statistical inquiry through authentic data investigations. There is a growing consensus that “every high school graduate should be able to use sound statistical reasoning to intelligently cope with the requirements of citizenship, employment, and family and to be prepared for a healthy, happy, and productive life” (Franklin et al., 2007, p. 1). This acknowledgement is represented in various content standards for mathematics at the K-12 level (CCSSM, 2010; NCTM, 2000). However, many practicing teachers have not experienced sufficient preparation to facilitate students' development of statistical literacy, and research has shown that most teachers do not have a deep understanding of the foundational concepts related to statistical inference (Franklin et al., 2015).

Thus, we have designed an innovative approach to supporting teachers through the integration of 1) a summer institute, 2) professional learning communities (PLCs), and 3) a Massive Open Online Course for Educators (MOOC-Ed). During the summer institute, teachers will meet together for a week-long professional development. The summer institute will focus on developing deep understandings of statistical concepts and exploring the ways students might engage with these ideas. We will use tasks from the research-based Data Modeling curriculum during the institute (Lehrer, Kim, & Schauble, 2007) to expose teachers to the need for statistical inference by exploring questions in the midst of widespread variability in data and explore different sources of variability and will discuss the conceptual principles of scale, interval, grouping, and order in visual displays of data. The MOOC-Ed, Teaching Statistics Through Data Investigations (Friday.institute/tsdi), was designed by Hollylynne Lee to develop teachers’ knowledge of teaching statistics through the statistical investigative cycle (Franklin et al., 2007).

Twenty 6th and 7th grade teachers participated in this project for one year. These teachers worked in high needs schools, and served a diverse student population. We administered pre and post measures of content knowledge and self-efficacy to teach statistics. We also video recorded summer institute sessions and PLC meetings. We conducted qualitative analyses of two key summer sessions, one focused on using probability to make inferences and another focused on
inventing new and innovative statistics. These analyses showed that teachers engaged in statistical habits of mind in different ways depending on the context. Although both tasks fall under a general umbrella of “statistical thinking”, teachers used different practices and concepts that inform our understanding of how teachers statistical thinking develops, and what additional supports they need to learn. In addition to these different ways of thinking, we learned that teachers shifted from their own inquiry to consider how their students might think about similar problems.

We will report on the design framework for integrating Data Modeling resources and the MOOC-Ed to support sustained teacher support and to build collaborative communities and will elaborate on our findings from the qualitative analyses described above.

References:


The Impact of a Drawing Intervention on the Spatial Visualization Skills of Sixth-Grade Students

Teresa A. Schmidt
Middle Tennessee State University

Background and Research Question

The concept of spatial intelligence has changed over time from being thought of as an innate ability to skills that can be developed (NRC, 2006; Sarama & Clements, 2009; Sorby, 1999). Studies of spatial ability and skills have grown from simply identifying mechanical ability to being a predictor of success in such academic fields as science, technology, engineering, and mathematics (Hegarty & Waller, 2005; Sorby, 1999). The power of spatial intelligence and its many subcomponents are an underappreciated and underutilized cognitive ability within many classrooms (NCTM, 2000; NRC, 2006; Sorby, 1999).

This presentation focuses on a qualitative piece of a quasi-experimental mixed methods design study, which investigated the usefulness of a particular drawing intervention, Quick Draw, to better understand how sixth-grade students of varying abilities approach and interact with spatial visualization tasks. In this paper the term spatial visualization will refer to one’s capacity to perform mental manipulation on two- or three-dimensional objects (e.g., rotating, twisting, folding or unfolding of flat patterns, the relative changes of position of objects in space) using non-verbal multistep manipulation (Jones, Gardner, Taylor, Wiebe, & Forrester, 2011; Linn & Peterson, 1985; McGee, 1979; Sorby, 1999).

Method and Results

The participants for the larger quasi-experimental study were a convenience sample of 77 sixth grade students (43 experimental, 34 control) enrolled in one teacher’s mathematics classes during the fall of 2014. Through pre-testing, four case study participants (two high and two low spatial ability students) were identified. A multiple holistic case study approach provided information concerning the differences amongst subgroups (high or low spatial ability) regarding their approach and interaction with spatial visualization tasks. The testing instrument for both pre- and post- testing consisted of a combination of five modified spatial visualization tests (modified Purdue Spatial Visualization Test, modified Mental Cutting Test, modified Differential Aptitude Test, modified Lappen Test, and the unmodified Wheately Spatial Ability Test). Students participated in six weeks of Quick Draw interventions as five-minute warm-up
activities to track their progress and to determine how their spatial abilities improved. Students briefly viewed a *Quick Draw* figure and were asked to draw what they saw, and follow-up discussions ensued. In a review of all of the data sources (quantitative and qualitative) three distinct differences were identified between the groups. One was how groups viewed the intervention activities’ impact on other academic areas; two, the use of correct geometric terminology. However, the most distinctive difference was how groups appeared to view the figures. Students with high spatial visualization skills appeared to view images holistically, whereas students with low spatial visualization skills appeared to view images as components.

The cross-case comparison provided evidence to suggest that by helping students to make mental connections between the image and a real-world object, their spatial visualization skills may be enhanced. Additionally, it appears that by enhancing their ability to see images as a whole, rather than its parts, their spatial visualization skills may be enhanced. Future research in this area is needed. In addition, recognizing that these results surfaced through an analysis of participants’ *Quick Draw* written response booklets and interviews, future research might also include the development of a metric that could be used to analyze written responses in determining evidence of students’ spatial visualization ability and growth. In addition, further study is needed in this area to determine if educational experiences such as *Quick Draw* can help all students not only improve their spatial visualization skills but also benefit in other academic areas, such as science.
Math Success for STEM Majors: Active Learning Strategies and Engineering Contexts

Holly Garrett Anthony
Stephen J. Robinson
Christopher D. Wilson
Tennessee Technological University

The Math Success for STEM Majors (MSSM) (2010–16) project (NSF STEP) was designed to increase the number of STEM graduates at Tennessee Technological University (TTU) by pursuing six main strategies based in education research (Twigg, 2005). This paper describes the active learning strategies/modules that were designed and implemented by interdisciplinary teams of engineers, educators, mathematicians, and physics researchers and the results of these efforts.

MSSM employed six strategies to increase the number of TTU STEM graduates:
(1) incorporating active learning in the redesign of precalculus;
(2) implementing just-in-time academic support for students enrolled in all introductory STEM mathematics courses;
(3) integrating the STEM disciplines through context-driven math applications within an introduction to university life course for entering STEM freshmen;
(4) articulating mathematics skill-level expectations with selected high schools;
(5) implementing a uniform TTU mathematics course placement policy; and
(6) developing and implementing a data system that tracked individual student performance across STEM disciplines.

The two strategies discussed here are: (1) incorporating active learning in the redesign of precalculus courses (Hensel, Sigler, & Lowery, 2008; Klingbeil et al., 2009) and (3) integrating the STEM disciplines through context-driven mathematics applications within an “introduction to university life” course for entering STEM freshmen (Cordray, Harris, & Harris, 2009).

Precalculus Redesign and Active Learning Strategies
MATH 1730 (Precalculus) was redesigned to include active learning strategies intended to improve student engagement and retention in the calculus sequence. Learning Assistants (LAs) were also used to facilitate student learning outside of scheduled class sessions. Each section of MATH 1730 was staffed with a LA to attend all class sessions along with the students and to
hold 5 office hours per week during which students could come to them for tutoring/mentoring and assistance.

Data show that the pass rate in the redesigned course is higher than the historical rates in the traditional version of the course. Moreover, the pass rate of the “graduates” of the redesigned course in the subsequent Calculus I class has shown no decrease. Over the duration of the project, the average grade point average in MATH 1730 improved from 1.6 to 2.2.

**Introduction to University Life Course Design**

All entering freshmen at TTU are required to enroll in a one-credit “Introduction to University Life” course intended to orient them to various aspects of campus life. MSSM developed a STEM-flavored version of this course with two goals: (1) to improve student attitudes towards mathematics through context-driven math applications, and (2) to appreciate the importance of multidisciplinary approaches in addressing STEM-focused problems. To these ends, several active-learning modules loosely based on the legacy cycle approach (Klein & Harris, 2007) were embedded in special sections of this course.

Student attitudes about STEM were captured with pre/post surveys in the course. Results showed that all students’ attitudes generally worsen over the course of their first collegiate term. However, those taking our course generally had better attitudes about their math courses than those who did not participate in any active-learning projects. Additional data will be shared in the presentation.

**References:**


Undergraduate Biology Students Misconceptions about Mutations

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Zachary Grimes, Middle Tennessee State University  
Rebecca Seipelt-Thiemann, Middle Tennessee State University  
Nancy Boury, Iowa State University

Biology education is currently undergoing reform efforts to increase student retention and appreciation of biological sciences (AAAS, 2011). Vision and Change in Undergraduate Biology Education calls for the increased use of pedagogical strategies that are backed by evidence to support learning in biology education learning environments (AAAS, 2011). Integration of evidence based instructional strategies requires biology instructor’s familiarity with misconceptions and conceptions students may have regarding biology concepts (Magnusson, Krajcik, & Borko, 1999). Furthermore, without proper tools to assess student understanding, instructors face a difficulty in gauging whether a strategy is effective. Concept inventories are a particular type of assessment tool aimed at illuminating student’s conceptions and misconceptions about a particular topic (Knight, 2010). This work is part of a larger study to develop concept inventories for genetics concepts.

Genetics represents a critical area of biology education that presents many problems for student learning, including its abstract nature, multiple scales, and technical language (Bahar, 1999; Cimer, 2012; Fisher, 1985). Within the last two decades, biology has made tremendous progress, particularly in the field of genetics. The nature of mutation, as well as it causes and effects, represents a large conceptual area in genetics education with multiple challenges to student learning. The concepts involving mutations are an important framework for understanding other biological concepts including evolution, organismal disorders, and diversity of life. This project sought to gain an understanding of student’s misconceptions of mutations while also aiding in development of an assessment tool to evaluate student’s conceptions and misconceptions of mutations. Our guiding research question for this inquiry was: What misconceptions about mutations do undergraduate biology majors hold?

Qualitative methodology was used to answer the above research question. The research team developed targeted questions focused on specific learning objectives, which were reviewed by genetics faculty. These questionnaires were designed using current standards documents from the Genetics Society of America (GSA), textbooks used in undergraduate genetics courses, and current literature in genetics research. Researchers collected student written responses to these open-ended questions. The questions were then also as prompts in selected student interviews,
which were audio recorded and transcribed. The questionnaires were also transcribed. Both sets of transcriptions (questionnaires and interviews) were then reviewed by the research team to elicit misconceptions regarding mutations.

This presentation will discuss the current progress on developing a mutations concept inventory. Particular attention will be placed on dissemination of the misconceptions elicited from student responses.

References:


Exploring Science with Students Outdoors through the GLOBE Program
Janey Camp  
Vanderbilt University  

Using basic handheld global positioning units (GPS) and other basic tools to conduct scientific measurements, students can learn about the world around them and contribute to climatological science databases through the Global Learning and Observations to Benefit the Environment (GLOBE) Program. GLOBE is a program developed by NASA to connect scientists and global climate models with localized data collected by students to validate and improve modeling efforts. The GLOBE Program provides online training and data collection protocols for teachers as well as access to a massive database of measurements worldwide that can be utilized for classroom exploration and analysis.

Activities range from simple cloud observations and understanding of cloud types to managing small weather stations on the school grounds. Teachers and students develop an understanding and appreciation for field data collection techniques as well as data management.

In this presentation, we will explore the resources available for teachers through the GLOBE Program and discuss some practical classroom applications to integrate GLOBE into earth science and other STEM-related lessons.

References:

Leveraging GLOBE Resources to Implement Middle Grades Science and Mathematics Standards

Deborah A. McAllister
University of Tennessee at Chattanooga

This program focused on improving science and mathematics content and pedagogy for grade 6 science and mathematics teachers, as they prepare to implement the Tennessee Science Standards. Atmosphere and Biosphere protocols and activities of the Global Learning and Observations to Benefit the Environment (GLOBE, n.d.) program were studied as models of real-world problems and solutions.

The new science standards demand that students develop “knowledge and skills needed for post-secondary and career pursuits, and be well-positioned to become curious, lifelong learners” (TNDoEd, 2016b, ¶ 2). Project protocols and activities align with the current TNReady grade 6, science assessment blueprint (TNDoEd, 2016c). Protocol structure supports the ACT success practices of setting goals that are specific, measurable, attainable, relevant, and time-bound (TNDoEd, 2016a). Protocols provide a framework for collecting real-world data, and modeling and solving real-world problems. Student-collected data is used by scientists, providing Earth-level measurements to accompany satellite mapping data, as well as by other students, conducting research projects.

This program was supported through a Tennessee Higher Education Improving Teacher Quality grant. All activities were correlated to the Tennessee Standards for Science (TNDoEd, 2009, 2016b) and Mathematics (TNDoEd, 2010). There were 21 teacher participants. Sessions included one April meeting, a 5-day summer academy, and two fall meetings. Project staff members included university education, biology, and geography faculty, and two licensed mathematics teachers, who led activities.

The goal was to provide high-quality, teacher professional development to Tennessee teachers to increase content knowledge and instructional skills aligned with the Tennessee Standards. The measurable objectives included the following:

1. There will be a statistically significant increase in teachers’ scores on a 40-item science quiz, between pre-test and post-test assessments (items correlated to Tennessee standards).
2. There will be a statistically significant increase in teacher Environmental Education Efficacy Belief (EEEBI), as the program progresses (Sia, 1992; qualitative instrument, two scales).

The pre-test/post-test and EEEBI were administered in April, June, and September, allowing time for initial learning, classroom implementation, and reflection. The EEEBI was administered in April, June, and September, to determine if an attitude change had occurred over the course of the program. Results indicated significant gains in content knowledge and efficacy belief. Teachers reported use of professional development materials in the classroom and sharing of materials with colleagues.

References:


Tablet computers such as iPads have flooded the aviation industry and are now used as Electronic Flight Bags (EFBs) for both professional pilots and pilots in training. The collegiate flight training industry has a unique educational structure in that professors teach conventional classroom courses and flight instructors also teach pilots at a much more personal individual level. With the influx of flight software applications over the past several years, new challenges have arisen for professors and flight instructors. Ideally, pilots in training receive the same education using iPads as they received in the past using paper charts. This research used established EFB policies for air carriers as a standard to assess the quality of EFB policies and practices at collegiate flight programs.

The Federal Aviation Administration provides guidance for EFB use, suggesting that the EFB provides the functional equivalent of the paper reference material, that charts are current, and that chart legends should be made available (FAA, 2007). Air carriers such as airlines must establish policies and training for EFBs, but researchers have found that even professional pilots have reported having trouble with their EFBs due to a lack of training or insufficient training (Chase & Hiltunen, 2014). Also, a recent study found that only half of the current field of active airline pilots believed that their initial EFB training was adequate (Lytle, 2015). This data suggests that aviation educators need to emphasize the importance of EFB training and policies.

ForeFlight Mobile is a popular software application for flight training, and users generally praise the application (Weihs, 2013). The application provides immediate access to charts, airport information, and weather data. However, in their pilot training manual, the company states that the software is not necessarily an educational tool, and assumes that users have a basic level of understanding iPads and flight navigation (ForeFlight, 2015). This creates a challenge for aviation educators as they must teach foundational knowledge and skills to new pilots with software that is intended for experienced pilots.

This research gathered both qualitative and quantitative data from aviation educators at twenty different collegiate aviation programs throughout the United States. The data was categorized
into two categories: participants from programs with an established EFB policy and participants from programs with no EFB policy. The primary research questions were as follows:

1. Does the presence of an EFB policy have any relation to the quality of the EFB program?
2. How do EFB practices and policies at collegiate programs compare to the established policies and practices at commercial air carriers?
3. Do aviation educators provide the minimum EFB instruction as suggested by the FAA?
4. How well do aviation educators know the software?

Results indicated widespread use of iPads and ForeFlight Mobile, and that most collegiate educators taught to the standards recommended by the FAA. Most programs (60%) had an EFB policy, but in many cases, the programs without a policy more effectively taught EFB practices, such as downloading charts legends. Surprisingly, several participants thought that the chart legends were downloaded automatically with the application, indicating a lack of understand of the software. Data also revealed that most educators believed that students should initially use conventional flight planning methods (i.e. paper charts, etc.) prior to using iPads in the cockpit. The data has implications for both educators and for software developers. Applications such as ForeFlight Mobile certainly have advantages, but pilots in training must understand the limitations of the software.

References:


STEM outreach programs and public services are designed to extend STEM learning, increase students’ interests in STEM academic areas and careers, and supplement school curriculum (Lam, Srivatsan, Doverpike, Vesalo & Mawasha, 2005; Wilkerson & Haden, 2014.) The Oakley STEM Center, established in 2010, has a vision of becoming a leader in rural STEM education with the mission of providing distinctive outreach programs and services to various learning environments. The purpose of the current project was to evaluate the effectiveness of the Center’s outreach programs, including community outreach events and school E(x)pedition field trips, as well as the Lending Library services to support STEM learning and teaching in the Upper Cumberland region. The following research questions were posed:

1. In what ways do the outreach programs lead to increased STEM knowledge and positive attitudes toward STEM content and careers among served students and improved support for STEM educators?
2. What is the impact of the Lending Library service on supporting and enhancing STEM education?

During Spring 2017, three programs were evaluated: community outreach events, school E(x)pedition field trips, and the STEM Lending Library. Each term, the Center offers 4 community outreach events, including two FAB Fridays, which engage children (grades 5th-12th), and two Safari Saturdays, which are geared toward children (pre-K to grade 3). A mixed-methods approach was used to evaluate the effectiveness of the outreach events. The evaluation measures included surveying seventy-four of the guardians who attended the events as well as conducting a focus group interview with three parents. The project also assessed school E(x)pedition field trips, which provide an engaging and standard-aligned lesson led by a member of the Center. Paired pre-post surveys were used to ask students about their content knowledge before and after their lesson experience. Teachers were surveyed about their opinions of the lesson as well. The third evaluated program was the STEM Lending Library. Evaluation data was collected by surveying the registered users of the library. 100 users responded to the survey, representing an 11% response rate. The survey
questions were retrieved from Southwest Indiana STEM Resource Center (University of Southern Indiana, n.d.); some additional edits were made for use by the Oakley STEM Center.

The findings revealed positive responses and feedback from the guardians who brought their children to the community events. Expedition analysis showed an increase in number of the correct answers in the post-test taken by elementary and 6th grade students. However, the sample test indicated no significant change related to 7th and 8th grade students. A majority of the teachers strongly agreed regarding the positive impact of the lesson and that their valuable classroom time was well spent at the STEM Center. Most of the Lending Library’s users who responded rated the reservation, pick-up, and return process as excellent. Users’ comments reflected positive feedback and high satisfaction with the service.

References:


The STEM Academy at Bartlett in Savannah, GA has been recognized as the number one STEM school in the country (WTOC, 2016) and won multiple awards for their innovations and success in education (Moore, 2017). A case study conducted in the fall of 2017 regarding the operations and characteristics of the school sheds light on the best practices of a nationally recognized school. These characteristics are discussed in a proposed framework developed from observations, artifacts, and interviews that were conducted over a week of fieldwork by two researchers, and include the key elements of success in three major categories: students, teachers, and administration. These categories were developed from using a variation of constant comparative coding and analysis methods. This framework that centers around the three major categories will be discussed with and compared to findings from other research that indicate how students learn best, including the book *How People Learn* (National Research Council, 2000), and others (Bybee, 2013).

**References:**


An Overview of the LMU Summer STEM Academy and Participant Attitudes toward Mathematics and Science

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Lincoln Memorial University

Lincoln Memorial University in conjunction with the Clinch-Powell Educational Cooperative (CPEC) has held a three to four day intensive on-campus learning experience, (STEM Academy), for rising high school seniors in the CPEC service area for the past three summers. The activities included aspects of a traditional laboratory experiment as well as those involving modeling approaches with the goal of carrying out best learning practices in STEM through active learning experiences (Freeman, et. al., 2014) in each case. Activities range across disciplines including physics, chemistry, and biology with each facilitated by a University faculty member in the respective field. A separate pure mathematics activity was included in the first year of the Academy, and in subsequent years mathematics and computational modeling was purposefully embedded within the learning experiences.

Students were selected to participate from each of the secondary schools in the CPEC through a process that involved teacher recommendation and written student application. The counties from which these students reside are rural and classified as high need economically with a sizeable poverty rate. It is known that many factors are tied to the attitudes of students towards science and mathematics, as well as STEM careers. It has been reported that social activities have an influence on the identity of students and subsequently may influence their choices to pursue STEM careers (Aschbacher, 2010). It is of interest to establish a baseline of students’ attitudes towards math and science for this rural population and to determine if there is a measurable influence on these attitudes through participation in a short term, intensive, positive social experience regarding math and science as exemplified by the STEM Academy.

The research questions discussed in this talk involves the following aspects regarding the participants’ attitudes towards mathematics and science.

1. What are the initial attitudes regarding interest, utility, cost, attainment, and expectancy for success in mathematics and in science?
2. Does participation in the STEM Academy have an impact on these attitudes?
3. Do these attitudes differ in regards to the fields of mathematics and science?
In order to measure these factors an attitudinal survey was implemented prior to participation in the STEM Academy and a follow-up survey was administered at the completion of the Academy. The survey was partitioned into math and science categories with subsections related to the previously mentioned attitudinal descriptors. The implemented survey was a modified form of the RM-MSMSP Evaluation instrument used by Weinberg (2011) in a motivational study on the impact of participation in an experiential learning program regarding mathematics and science for middle school level students.

The small sample size limits the ability to draw statistically significant conclusions, but the results are informative as to the students’ high self-perceptions of ability and expectancy of success with extremely low cost value as to science and mathematics performance. These results may serve as a formative guide to the development of future STEM Academy learning experiences that might be best attained with activities that extend beyond the laboratory setting.

References:


Moskal and Skokan (2004) indicate that STEM workshops for K-12 educators have a positive impact on teachers’ knowledge and understanding of mathematics and science. During these programs, they can learn strategies to engage students with ideas and help them to understand concepts that will be useful in STEM careers (Kesidou & Koppal 2004). Not only do teachers learn new educational content, but they are also given access to new teaching methods and meaningful opportunities for partnerships (Laursen 2006).

We employed a three-pronged approach to design our annual conference for educators, Big Orange STEM Saturday for Educators (EduBOSS). K-12 teachers from local schools visited the University of Tennessee, Knoxville, to listen to a keynote speaker from the university’s educational department. Participants also attended two 30-minute break out sessions led by university educators. Five unique sessions were offered, and participants chose two interesting and relevant sessions to attend. Exhibitors from around the community and college also attended the conference to provide participants with information about their organization. Throughout the day, the participants engaged with multiple facets of STEM concepts and teaching strategies to carry into their classrooms.

Surveys were distributed to participants and completed at the end of the day. The instrument aimed to solicit participants’ current roles, what they gained from EduBOSS, and general feedback about the program. Examples of qualitative survey questions are below:

1. What are 3 insights you gained today about STEM education at the collegiate level?
2. How might you share these insights with your students and/or school community?

In order to thoroughly assess EduBOSS, we looked at two years of survey responses. The responses were recorded anonymously and analyzed by researchers to determine the program’s role in teachers’ methods as well as identify areas of improvement.

Our findings indicate that the conference introduced attendees to many STEM tools and resources for themselves and their students. We also found that teachers were inspired by the conference speakers and planned to bring experts from the community into their own classrooms to talk with students. Rich feedback from participants was also gathered and will be used to
make improvements to the program. The teachers stated that they wanted more hands-on activities to keep them engaged as well as longer sessions to include more content. More research findings and future program plans based on the findings will be shared during the session.

References:


Most professional development (PD) programs in the US mainly focus on improving teachers’ knowledge through extensive workshops; less attention is given to the implementation of what participating teachers have learned from extensive workshops during PD programs. Based on the best practice of effective professional development programs (Archibald, Coggshall, Croft, & Goe, 2011; Desimone & Garet, 2015), we designed a hybrid PD model that includes extensive workshops, demonstration lessons, and lesson study (Huang & Han, 2015; Lewis & Perry, 2017). The workshop component includes entire group workshops led by university faculty, focusing on deepening teacher’s knowledge regarding the connections and progression of knowledge, and breakout grade level workshops led by expert teachers focusing upon grade-specific activities supporting the teaching of this content. The demonstration lessons taught by experts aim to demonstrate how reform-oriented notions can be implemented in the daily classroom teaching of mathematics. Lesson study originating in Asia, a teacher-oriented, job-embedded, student-focused teacher professional approach, has been adopted globally (Lewis & Lee, 2017). The lesson study facilitated by university faculty and expert teachers focuses on teaching difficult content using innovative ideas in practicing teachers’ classrooms and developing teacher practical knowledge and wisdom. We have completed this PD approach with three cohorts of K-6 teachers from the Murfreesboro City school system (approximately 150 teachers), and the PD program with two new cohorts is ongoing. The study is designed to address the following two research questions: (1) Does the PD project improve participating teachers’ knowledge for teaching? (2) Does lesson study help teachers implement reform-oriented instruction and develop their instructional expertise?

To address the first research question, the instrument of mathematics teachers’ knowledge for teaching developed by University of Michigan (Hill, Ball, & Schilling, 2008) was used as pre-tests and post-tests, which were administrated through an online system. To address the second research question, the lesson plans, videotaped research lessons and debriefing meetings, and post-lesson study reflections were collected from each lesson study group (eight lesson study groups in total). Regarding the first research question, paired T-tests of pre-, post-tests for all
three cohorts showed the significant improvement of teachers’ knowledge for teaching. Regarding lesson study, a specific case was analysed by examining videotaped lessons and teacher’s reflection reports. The case study revealed that the teaching of research lessons was improved across lessons toward more reformed-oriented and research-based approaches. Meanwhile, the practicing teachers not only appreciated the process and product of lesson study, but also perceived their growth in understanding the content and students’ learning, mastering various teaching strategies. Finally, we will discuss the effects and challenges of implementing this hybrid model of PD at scale.

References:


Math Counts is a multi-year Math and Science Partnership (MSP) project designed to support teachers’ content knowledge and instructional practices in K-8 mathematics. The first three years of the project included multi-day summer institutes and Saturday/after-school professional learning sessions. The institutes and sessions focused on content, pedagogy, student misconceptions, mathematical literacy, and cross-curricular integration. Registration for the summer institutes was open to all K-8 math teachers in the district in which the institutes occurred. While the rosters fluctuated, a core group of participants attended all two or more years. This core group of 41 teachers is the focus of the current phase of the project.

Studies point to the need for professional learning to go beyond individual sessions or institutes (Ball & Cohen, 1999; Bell, Wilson, Higgins, & McCoach, 2010; Stein, Smith, & Silver, 1999). To be most effective, traditional professional development needs to be paired with more intensive, embedded follow-up support (Ball & Cohen, 1999; Bell, Wilson, Higgins, & McCoach, 2010; Stein, Smith, & Silver, 1999). During the 2017-2018 school year, the core group of participants are experiencing that layer of support. Each teacher receives individual observation visits followed by coaching conversations and feedback from a member of the project team. The observations are focused on classroom instruction and content knowledge, but flexible enough to allow teachers to ask questions and receive feedback on areas of interest to them. The guiding question for this phase of the project is: In what ways do teacher practices reflect learning from the first three years of the Math Counts project?

Data sources for this phase of the project include observation notes, feedback conversations, and historical Math Counts records. Initial findings indicate that the majority of Math Counts core teachers incorporate aspects of summer learning into the regular classroom routine. Examples of observed practices include: use of multiple computation strategies, mental math via Number Talks (Humphreys & Parker, 2015; Parrish, 2010), high-yield routines (McCoy, Barnett, & Combs, 2013), and literacy integration. Additionally, the core group reports the feedback observation and follow-up support as a positive influence on teaching practices. Many
commented that without the personal visits, they would not feel as confident attempting some of the practices they learned; however, with support, they readily incorporate Math Counts learning into their classrooms.

References:


In recent years, there has been an increased focus on Science, Technology, Engineering, and Mathematics (STEM) education from a national perspective (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012). In 2012 the President’s Council of Advisors on Science and Technology developed a report emphasizing the importance of increasing the number of graduates in the STEM areas. One recommendation highlighted in this report was to improve the first two years of STEM education in colleges and universities (President’s Council of Advisors on Science and Technology, 2012). Calculus is a fundamental course for most STEM areas of study. However, college calculus has the potential either to provide students with a strong foundation for more advanced classes and prepare them with the confidence and skills needed to persist and excel in STEM or to deter students from continuing in STEM undergraduate programs.

Research has shown that when diagnostic tests are accompanied by effective teaching and learning strategies, the mathematical competence of students can be improved (Batchelor, 2004). In fact, developing strategies and tools to improve the mathematical skills of students at the collegiate level has been the focus of research in STEM education for several decades. However, the mathematical readiness of first-year students pursuing STEM degrees has been on a decline (Yang, Fu, Hwang, & Yang, 2017). Diagnostic testing is one tool that can be used to improve instruction because these tests help to identify the level of mathematical skills students have attained. Further, the data collected from diagnostic tests give a more reliable representation of student knowledge than the grades students may have earned by varying standards from different high schools.

Our implementation of diagnostic testing is one component of an ongoing broader study that includes effective teaching and learning strategies and course design. The significance of this portion of our study is its relevance to both secondary education and post-secondary education. Calculus is an advanced course for many high school mathematics programs and a foundational course for most collegiate STEM programs.

To address the matter of diverse skillsets and educational backgrounds, we designed a twenty question, multiple choice diagnostic test to determine our students’ readiness to acquire the new
knowledge and skills of a first semester college calculus curriculum. This diagnostic testing tool spanned the basic algebraic and trigonometric skills we considered necessary for success in a college calculus course. The students were given sixty minutes to complete the assessment. We sought to answer the following question: What are the strengths and weaknesses of our students in the prerequisite content for college calculus?

This presentation will include a brief description of our study, an overview of the diagnostic test implemented, an analysis of the data collected, and a discussion of the next steps in this research study.

References:


In text reference: (President’s Council of Advisors on Science and Technology, 2012)

In our state, the Tennessee Higher Education Commission and the University of Tennessee, Knoxville, Center for Business and Economic Research completed a study (THEC, 2011) addressing computing literacy in the state. They estimated that supply of computer programming and software development will fall short by 400 graduates per year, during 2008-2018. They anticipated a significant deficit between the number of graduates produced and the number of anticipated job openings. Thus, with computer science as a discipline in decline (Goode, 2008; Lee, 2015) but need for “computing” at an all-time high (see Brown et al., 2013 for information from Global Industry Analysis), we see this as the right time to engage students in computing without the weight of a formal computer science course. Some exciting research has shown (Grover et al., 2015) potential gains in computing with middle school students. Our planned research seeks to expand the effects of learning computing into high-school level courses.

In upper level courses, lab-enhanced teaching methods will be used as done in standard college courses. In these labs, students will be introduced to the statistical software package R and will learn how to program and write scripts in R. An Algebra 2 course typically contains parts of probability, statistics, trigonometry, and algebraic functions, topics that are easily computed in R. Our goal is that our diverse research team and secondary teachers for our project will be able to create these labs that are accessible to all students, with the objective of increasing mathematical performance and interest.

Research questions we expect to answer are as follows:
1. How do treatment effects vary across:
   a. student gender?
   b. courses (e.g., Algebra 2, Statistics, Integrated Math 3)?
   c. setting (e.g., public high school vs. STEM school vs. non-traditional high school)?
2. How do teachers experience the curriculum?
3. What are the most successfully ways to keep students on task during the computing exercises?
4. What are the barriers to successful implementation of this model?
5. Does exposure to treatment result in increased interest in STEM careers or majors?
We will fit multilevel models to the data. Multilevel modeling is required to account for the nested structure of the data, with students clustered within classrooms (Raudenbush & Bryk, 2001). This model is a variant of the analysis of covariance model that produces unbiased estimates of treatment effects under random assignment while achieving optimal efficiency (Egbewale, Lewis, & Sim, 2014).

We plan to submit an expanded version of this plan for funding this spring. In the session, we will report on efforts up to this point that we have made to train the teachers in the upper east Tennessee region. Sample lesson plans will be shared that have been developed by the teachers in our projects previously funded by Battelle and the THEC ITQ grant-funding agencies. Participants will be asked to offer suggestions on improving the research plan.

References:


There is growing recognition that the development of science proficiency can extend into the undergraduate experience, as undergraduates, regardless of major or previous science achievement, are generally required to complete one science laboratory course (AAAS, 2011). However, supporting undergraduate students to develop science proficiency is challenging, especially for the undergraduate and graduate teaching assistants instructing the labs at many research universities with minimal preparation for this instructional assignment (Sundberg, Armstrong, & Wischusen, 2005). To address this challenge, novice instructors need a foundation of core practices to draw from and build upon. One suite of practices has been described specifically for beginning K-12 teachers, which may also be fruitful for beginning postsecondary science instructors. Windschitl and colleagues (Thompson, Windschitl, & Braaten, 2013; Windschitl et al., 2012) described a collection of essential teaching practices that are referred to as “ambitious science teaching” and emphasize student ideas as a basis of instruction and the use of authentic investigations as a way to shape those ideas through discourse rich practices, placing a premium on classroom talk as an essential mechanism of science learning.

Teaching practices that allow students to participate in scientifically rigorous discourse are not prevalent in the science classrooms of experienced teachers (Banilower et al., 2013) and are certainly difficult for beginning teachers (Thompson, Windschitl, & Braaten, 2013). Teacher preparation programs and professional development opportunities for elementary and secondary teachers have incorporated ideas of ambitious instruction and some research examines how novice middle and high school teachers appropriate and implement moves associated with ambitious instruction (Stroupe, 2016; Stroupe, 2017; Thompson, Windschitl, & Braaten, 2013). However, if the postsecondary setting is to be drawn upon as another site to support the development of students’ science proficiency, there is a need for research describing how novice post-secondary instructors implement ambitious instruction. In an effort to describe how rich learning opportunities might unfold in a general biology laboratory course for nonscience majors, we examined the following research questions:

1. What patterns of student discourse emerged across multiple iterations of the same planned conversation, designed to elicit student ideas, in a biology laboratory course?
(2) What TA discursive moves were related to high levels of explanatory rigor in student talk during this planned conversation designed to elicit student ideas?

Using conversation analysis, four distinct patterns of student discourse emerged, representing various levels of explanatory rigor. Through regression analysis, we found that the type of question the TA used to initiate classroom talk was not significantly related to the explanatory rigor of student discourse. Rather, the most important aspect of TA talk for elevating the explanatory rigor of student discourse was how the TA responded to the student contributions elicited by the initiating question. These findings have implications for professional development of TAs to orchestrate science classroom conversations with explanatory rigor.

References:


Because laws of physics serve as an accessible vehicle for math teachers to facilitate inquiry-based learning and mathematical modeling, professional development should support physics-based and inquiry-based mathematics teaching. Before and after a professional development workshop, data was collected from 20 in-service teachers to inform the following research questions:

1. Based on pre-post data, does inquiry-based professional development influence (a) content knowledge about physics-based mathematics, or (b) self-efficacy (Bandura, 1997) for teaching math through physics, or components thereof?
2. How do the pre-post differences in these content knowledge and self-efficacy variables correlate?

These results have practically significant implications for cross-curricular STEM PD design and implementation, while revealing theoretically significant nuances in the development of teacher knowledge.

While some studies have linked teachers' self-efficacy to students' achievement and motivation (Caprera et al, 2006), longitudinal studies have revealed that correlations between teaching self-efficacy and ratings of instructional quality are not purely causal or consequential (Holzburger et al, 2013). Unsurprisingly, self-efficacy in teaching practice has been shown to correlate with teachers’ content knowledge (Swackhamer, 2009), but how might this correlation differ if the content knowledge is in an area other than a teacher’s specialization? Mobley's (2015) analysis of self-efficacy for teaching science in an integrated STEM framework resulted in a 3-factor model - social, personal, and material. In this study, these factors serve as an analytic framework for instrument development.

The workshop Let’s Get Physical! Teaching Mathematics through the Lens of Physics, funded by Tennessee Higher Education Commission Improving Teacher Quality grant, provided 20 teachers with physics lab equipment and corresponding curricular resources. This study used a paired t-test to determine if any of the pre-to-post differences were statistically significantly non-zero, and we used regression analysis to determine statistically significant correlations between
those differences. The teachers showed significant improvement in self-efficacy for teaching math using physics, in each of the three self-efficacy sub-scales, and in content knowledge. However, we also examined how these differences might correlate with one another. Although self-efficacy and its subscales were significantly correlated with each other, none of these self-efficacy improvements were correlated with content knowledge improvement.

References:


With the increasing globalization, and the increasing need for a scientifically literate population, it is essential that elementary and secondary school students not only receive meaningful science and literacy instruction, but also see the seamless nature of how each informs the other. According to Yager (2004), “science content must be related to the real world—the world the students know and operate in” (p. 103). In students’ world, they use reading and writing as tools to inquire deeply about science topics. However, students need support to comprehend, compose, understand, and apply what they read in science texts (Goldman, 1997; Ivey, 1999; Lee & Fradd, 1999; Nicholson, 1985). This integration can lead to greater interest and confidence in literacy and scientific endeavors as students move through school and determine future education and career paths (Nichols, 2015).

To that end, the Tennessee Department of Education (TNDOE) Mathematics and Science Partnerships (MSP) Program promotes innovative practices in K-12 Science-Technology-Engineering-Mathematics (STEM) classrooms by bringing together staff from local educational agents (LEA) and faculty from institutes of higher education (IHE) and STEM businesses to provide professional development (PD) to 4-12 teachers. The project described in this presentation, Science Literacy in Education through Project-Based Learning (SLICE-PBL), sought to enable grades 4-12 STEM and English Language Arts (ELA) teachers to reach for excellence in elementary and secondary school STEM and ELA through Hands-on, Standards-based, Project-based and Technology-based (HSPT-based) learning.

The project represents a partnership among 117 Grades 4-12 STEM and ELA teachers from ten LEAs, six business partners and ETSU Colleges of Arts and Sciences, Education and Graduate Studies and Northeast Tennessee Innovation STEM Hub. This opportunity provides a chance for teachers from surrounding districts to join with STEM and Literacy faculty and professionals to form a strong professional learning community focused on the integration of STEM-ELA. Specifically, teachers developed lessons that integrated STEM and literacy, reading and writing about HSPT learning. During this project, a Project Management Team (PMT) used feedback from teachers, as well as literature about effective PD and effective science and literacy
integration to design meaningful experiences for teachers. The purposes of this presentation are: 1.) to describe PD that paired STEM and ELA teachers for the purposes of developing integrated lessons; 2.) to report findings about this PD; 3) and outcomes of student academic performance.

References:


Science, Technology, Engineering, and Mathematics (STEM) education has two primary purposes in the 21st century: to produce a STEM literate society and to increase college students majoring in STEM (AAAS, 2017; Bressoud, 2015; Curtis, 2014; Hossain, & Robinson, 2012; U.S. Department of the Interior STEM Education and Employment Pathways, 2013). In 2012, the President’s Council of Advisors on Science and Technology (PCAST) report projected a deficit of one million STEM graduates over the next decade. Furthermore, undergraduate STEM programs have a less than 40% retention rate (PCAST, 2012). To assist with the goals of STEM education, stakeholders in STEM need to have a common language to communicate with and literature suggests that the STEM acronym has multiple meanings to different stakeholders (Breiner, Harkness, Johnson, and Koehler, 2012; Honey, Pearson, & Schweingreber, 2014).

When considering educating the future STEM workforce, there is debate between integrating the disciplines and keeping the disciplines separate with distinct learning goals (Czerniak & Johnson, 2014; Lederman & Niess, 1998). Honey et al. (2014) promoted an integrated STEM curriculum and discussed the goals, outcomes, nature, and implementation of a potential STEM education framework for K-12 education. The overarching goals of this framework focused on STEM literacy, which includes understanding the Nature of Science, Nature of Technology, Nature of Engineering, and the Nature of Mathematics (AAAS, 2017; Chamberlin, 2013; Goldman, 2004; Koen, 2009; Lederman & Lederman, 2014). However, literature presents these epistemologies as separate silos and not as an integrated unit, even within integrated curricula (i.e., the Nature of STEM).

When considering the general STEM education needs and characteristics of effective teaching for STEM education, we began to ask certain questions: do learning progressions reflect the nature of the STEM disciplines, what would a learning progression look like for STEM curriculum, and what is the integrated nature of the disciplines of STEM? Therefore, our goal for this project aims to understand the alignment between pedagogical theories for STEM education and the knowledge and skills that are needed for the future STEM workforce. To do this, first we will focus on the nature of each independent STEM discipline in the workforce. Our research questions that guided our inquiry are as follows:
1. What are the shared characteristics of the epistemologies of STEM disciplines?

2. How do different professionals (i.e., scientists, technologists, engineers, and mathematicians) in STEM view the epistemologies of the STEM fields?

To begin to answer these questions, a literature review was conducted, the authors and research articles, book chapters, and theoretical papers were analyzed for conceptions of the Nature of Science, Technology, Engineering, and Mathematics. Currently, we have collected and analyzed n=35 data sources. To answer the second research question, we are developing a survey and interview protocol to distribute to professional currently in the STEM workforce. This presentation will be used to disseminate our current findings for research question one and to propose and receive feedback from the audience for research question two. We will provide sample questions from our interview and survey protocols.

References:


Science, Technology, Engineering, and Mathematics (STEM) education is currently experiencing a plethora of calls for reform (AAAS, 2011; Common Core State Standards, 2010; ISTE, 2008; NGSS Lead States, 2013). To address the quickly evolving landscape of STEM education and the related workforce, universities are turning to more effective pedagogical strategies that promote student-centered learning with the goal of increasing persistence in these fields. Technology has been shown to be an effective mediator for implementing student-centered learning (Linn, 2003). One technological strategy that can promote student-centered learning in STEM fields is the use of student response systems (colloquially referred to as “clickers”).

The use of clickers in STEM learning environments have revealed a multitude of benefits for student learning. They have been used to increase student-centered pedagogy in large undergraduate classrooms which can then enhance affective learning outcomes (i.e., motivation, interest, attitudes), as well as promoting social interactions (Bruff, 2009; Caldwell, 2007; Feis & Marshall, 2006; Hansen, 2007; Preszler et al., 2007).

There are many benefits to the use of clickers to promote student-centered learning, yet adoption and implementation varies by faculty and by discipline (Freeman et al., 2007). Therefore, understanding the factors that relate to faculty adoption of clickers is critical to exploring how to increase the use of this technology in undergraduate STEM education. This study sought to explore the factors related to STEM faculty use of clickers. The research questions that guided our inquiry were:

1. What personal and professional characteristics predict undergraduate STEM faculty use of clickers?
2. What learning environment characteristics (class size, rank, department) predict undergraduate STEM faculty use of clickers?

A cross-sectional survey was distributed to university faculty in this study (n = 1,166; response rate = 17.24). The instrument asked faculty if and how they use clickers to engage students, their satisfaction levels with the technology, supports and frustrations associated with the technology,
as well as other professional and personal information. Analysis included descriptive statistics, Pearson correlations, and logistic regression to explain the variation in clicker use. The survey was completed by n=32 STEM faculty. Point biserial correlations revealed class size (n = 32, R = .55, p = 0.001) to be the only statistically significant variable correlated (positively) with use of clickers.

A logistic regression was performed to determine the effects of class size on the likelihood that STEM faculty use clickers. The logistic regression model was statistically significant, χ²(1) = 10.85, p = 0.001. The model explained 38.3% (Nagelkerke R²) of the variance in clicker use and correctly classified 71.9% of cases. This model revealed that class size was a statistically significant predictor for clicker use. For every one standard deviation increase in class size, clicker use increases by 1.17 standard deviations. Implications of this work will be discussed in light of faculty professional development in STEM fields.

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