11th Annual TN STEM Education Research Conference
February 2-3, 2017
DoubleTree Hotel
Murfreesboro, TN
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Welcome from Director
Tom Cheatham

Eleventh Annual Tennessee STEM Education Research Conference
DoubleTree Hotel, Murfreesboro, TN
February 2-3, 2017

We are pleased you have chosen to join us for the 11th Annual Tennessee STEM Education Research Conference hosted by the Tennessee STEM Education Center at Middle Tennessee State University (MTSU). STEM education continues to be an area of great need in our country, but of too little interest among students. The courses are tough, but the rewards are great. Your attendance indicates that you have made the decision to invest in STEM education. Thank you for what you do and for being interested in research about teaching and learning—this is how we improve STEM education. We have a great program for you to enjoy, free food, and an opportunity to renew acquaintances and meet new friends and collaborators.

Keynote speakers include Dr. Rick Moog, Professor of Chemistry at Franklin & Marshall College, Pennsylvania. Dr. Moog is the Director of the National POGIL (process oriented guided inquiry learning) Project and one of the inventors of the POGIL pedagogy. Dr. Eric Knuth is a mathematics education professor in Curriculum and Instruction at the University of Wisconsin-Madison who studies, among other things, the impact of early algebra experiences on student success. Dr. Janey Camp is a research associate professor of civil and environmental engineering at Vanderbilt University. Dr. Camp studies the interaction of nature with man-made systems using geospatial technologies and engages K12 teachers and students in the use of geospatial technologies to increase interest in STEM. Their enthusiasm is contagious and their research experiences are varied and interesting. I hope you will make a point to hear all three during our sessions on Thursday, February 2, 2017 along with Assistant Commissioner of Education Dr. Danielle Mezera.

We also have something for everyone in our 20+ breakout talks on Friday morning, ranging from “scaffolding for problem solving” to “understanding proofs;” from “college readiness through science and literacy” to “active learning in high school biology;” from “journal rankings in mathematics” to “an analysis of CBE-Life Science articles;” from an “MSP Grant” to an “NSF STEP Grant;” and more.

We have never charged a registration fee for the conference and we have been able to provide participants snacks and meals because of generous support from the Tennessee Space Grant Consortium and the MTSU Office of Research. We have been informed that significant cuts in support are certain for next year. This will likely result in us charging a registration fee to pay for at least part of the food cost. We will keep the cost as low as possible and only charge for food costs as necessary based on our level of funding. I hope this anticipated change will not impact your participation in the conference.

Special thanks 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.
Conference Agenda
11th Annual Tennessee STEM Education Research Conference
February 2-3, 2017
DoubleTree Hotel
Murfreesboro, TN 37129

{There is a pre-conference meeting of the STEM Education Leadership Council, 8:30 AM - 10:30 AM}

Thursday, February 2, 2017

10:30 – Registration

11:30-12:15 Light Lunch

12:15 – 12:45 Welcome and Announcements (Ballroom) (Facilitator: Tom Cheatham)
Dr. David Butler, Vice Provost for Research & Dean Graduate College, MTSU
Dr. Robert Fischer, Dean, College of Basic & Applied Sciences, MTSU
Dr. Henrique Momm, MTSU PI NASA Space Grant & Professor Geoscience, MTSU

12:45 – 1:45 Mathematics Education Keynote (Facilitator: Seth Jones, Middle Tennessee State University)
The Impact of Early Algebra on Students’ Algebra-Readiness
Dr. Eric Knuth, Professor, Department of Curriculum and Instruction, University of Wisconsin-Madison, Madison, WI.

1:50 – 2:50 Science Education Keynote (Facilitator: Amy Phelps, Middle Tennessee State University)
Process Oriented Guided Inquiry Learning (POGIL): A Student-Centered Approach to STEM Instruction
Dr. Rick Moog, Professor of Chemistry & Director National POGIL Project, Franklin & Marshall College, Lancaster, PA

2:50 – 3:00 Break/Discussion

3:00 – 4:00 Tennessee K-12 Education Update (Facilitator: Elaine Martin, Tennessee State University)
Dr. Danielle Mezera, TN Assistant Commissioner of Education, Division of College, Career and Technical Education, Tennessee Department of Education, Nashville, Tennessee

4:00 – 4:45 Rapid Talks
1. Mathematics Content Praxis Data in TN, Holly Anthony (Tennessee Technological University) and Jackie Vogel (Austin Peay State University)
2. Plickers: A ‘New’ Technology to Benefit Students and Instructors, Joshua Reid, Cindi Smith-Walters, and Jennifer Parrish, Middle Tennessee State University
3. Inclusion of Special Education Students in STEM Education, Claire Williams-McGee (Metro Nashville Public Schools)
6. Building Home-School Partnerships in High School: Lessons Learned from Family Math Night, Michael Lawson and Lynn Hodge, University of Tennessee, Knoxville
8. The Biology Teaching Assistant Project 2.0: Advancing Research, Synthesizing Evidence, Grant Gardner (MTSU), Elisabeth Schussler (University of Tennessee, Knoxville), Gili Marbach-Ad (University of Maryland), Kristen Miller (University of Georgia), Judith Ridgway (Ohio State University)
9. Reinforcing and Assessing Preservice Teachers Science Content Knowledge using Alphabet Books, Velta Napoleon-Fanis & Cindi Smith-Walters, Middle Tennessee State University

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

6:00 – 8:00 Banquet and Keynote (Introduced by Heather Brown, Professor & Director MTSU)
Integrating Geospatial Technologies into K12 STEM Education – A SWOT Analysis
Dr. Janey Camp, Research Associate Professor of Civil and Environmental Engineering, Vanderbilt University, Nashville, TN
Friday, February 3, 2017

7:30 – 8:15  Full Breakfast
8:15 – 10:15  Concurrent Breakout Session 1 (talks are 20 minutes plus 10 minutes for questions)

**Mathematics Education Research 1 (Ballroom A)** (*Facilitator: Scott Eddins, TN Tech*)
- Meeting Teachers’ Expressed Needs: Adaptations of the Traditional Model for Demonstration Lessons, Angela Barlow, Alyson Lischka, Chris Stephens, Jeremy Strayer, Kristin Hartland, and Lucy Watson (Middle Tennessee State University)
- Leveraging the Local Community in Math Class: A Teacher’s Tale, Ashley Walther and Lynn Hodge (University of Tennessee, Knoxville)
- Equations, Functions, and Modeling with Real-world Problems in Algebra I, Deborah McAllister (University of Tennessee at Chattanooga)
- How Undergraduate Students Understand the Roles of Proof in Mathematics: Implications for Explicit and Reflective Teaching, Jeffrey Pair and Sarah Bleiler-Baxter (Middle Tennessee State University)

**Science Education Research 1 (Ballroom B)** (*Facilitator: Velta Napoleon-Fanis, MTSU*)
- STEM Summer Institute – A Five Year Review, Stacy Klein-Gardner (Harpeth Hall School and Vanderbilt University)
- Digging Deep into Science Literacy MSP Grant, Leslie Suters, Kristen Trent, Kelly Moore, Queen Ogbomo, and Stephanie Wendt (Tennessee Technological University), and Gale Stanley (Campbell County Schools)
- Mathematics as a FirstSTEP to Success in STEM: An NSF STEP Project, Tom Cheatham, Ginger Rowell, Chris Stevens, Don Nelson, and Brad Rudnik (Middle Tennessee State University)
- Preparing College/Career Readiness through Integrating Science Learning with Literacy in Secondary Education, Chih-Che Tai and Karin Keith (East Tennessee State University)

**STEM Education Research 1 (Ballroom C)** (*Facilitator: Sheila Webster, UTK*)
- Journal Rankings and Representation in Mathematics Education, Ryan Nivens (East Tennessee State University) and Samuel Otten (University of Missouri-Columbia)
- Creating a Collaborative Environment with Four-Year Institutions and Community College Faculty to Engage Students in Learning Statistics, Michael Darrell, Lori Giles, Marilee Gorta, and James Smith (Columbia State Community College), Lisa Green, Scott McDaniel, Nancy McCormick, Jeremy Strayer, and Ginger Rowell (Middle Tennessee State University)
- Examining Teacher Learning and Critical Resources in the Context of Mathematics Professional Development, Gale Stanley (Campbell County Schools), Michael Lawson, Ashley Walther, Lynn Hodge (University of Tennessee, Knoxville)
- POGIL to Success in Chemistry, Nancy Caukin and Tom Cheatham (Middle Tennessee State University)

10:15 – 10:30  Break/Discussions

10:30 – 12:00  Concurrent Breakout Session 2 (talks are 20 minutes plus 10 minutes for questions)

**Mathematics Education Research 2 (Ballroom A)** (*Facilitator: Kevin Cooper, LMU*)
- Supporting Students’ Inferential Reasoning Through Building, Testing, and Revising Models, Seth Jones and Jacob Jia (Middle Tennessee State University)
- Building Mathematical Content Knowledge for Teaching in a Geometry Content Course for Secondary Teachers, Lucy Watson, Candice Quinn, Alyson Lischka and Jeremy Strayer (Middle Tennessee State University)
- Technology Tools Scaffold Students’ Sense-Making in Problem Solving Task, Amdeberhan Tessema (Middle Tennessee State University)

**Science Education Research 2 (Ballroom B)** (*Facilitator: Amiel Jarstfer, LMU*)
- A Comparison of the Instructional Impacts of Peer Instruction (PI) and Process-Oriented Guided Inquiry Learning (POGIL) in High School Biology, Grant E. Gardner, Jennifer Parrish, Tom Cheatham (Middle Tennessee State University) and Leigh McNeil (US Naval Academy)
- Non-majors Biology Students’ Environmental Knowledge and Perceptions about Conservation after Participating in Invasive Pest Plant Removal Projects, Kim Sadler, Angelique Troelstrup, and Penny Carroll (Middle Tennessee State University)
• Trees, Ecology, and Technology: Examining the Effects of a Campus Arboretum Curriculum on the Ecological Literacy of Undergraduate Biology Students, Patrick Phoebus, Michael Rutledge, and Kim Sadler (Middle Tennessee State University)

**STEM Education Research 2 (Ballroom C) (Facilitator: Tasha Frick, Middle TN State University)**

• Recent Efforts to Build Arctic and Marine Topics into the High School Curriculum at the School for Science and Math at Vanderbilt, Jordan Grigor and Angela Eeds (Vanderbilt University)

• Methodological Trends in Biology Education Research: An Analysis of *CBE-Life Science Education* Journal Articles from 2002-2015, Joshua Reid, Grant Gardner, Penny Carroll, Velta Napoleon-Fanis, and Emily Smith (Middle Tennessee State University)

• Using a Computer Science-based Board Game to Develop Preschoolers' Mathematics Understanding, Ryan Nivens and Rosemary Geiken (East Tennessee State University)

12:00 - Lunch/Depart
Teaching and learning algebra has undergone a critical transformation over the last several decades. Prompted largely by the failure of historical paths to prepare students for success in school algebra and in conjunction with algebra’s gatekeeper role, mathematics education researchers have worked to examine traditional algebra education and formulate new recommendations for teaching and learning algebra. A central argument in re-conceptualizing algebra has been that the “arithmetic-then-algebra” approach, where an arithmetic curriculum in the elementary grades is followed by a formal treatment of algebra in the secondary grades, has not allowed the time and space necessary for developing depth in students’ algebraic thinking and, instead, has led to a widespread marginalization of students in school and society. As a result, it is now widely accepted that algebra should be treated as a longitudinal, grades K–12 strand of thinking whereby students have long-term, sustained algebra experiences in school mathematics, beginning in the elementary grades that build their natural, informal intuitions about patterns and relationships into formalized ways of mathematical thinking.

In this presentation, I will address the following question: What is the impact of a long-term, sustained early algebra education on children’s understanding of algebraic concepts and their readiness for algebra in secondary school? I will present an overview of three interrelated projects that address the question of whether students who experience early algebra in the elementary grades are better prepared for algebra in the middle grades than students who experience a more traditional arithmetic curriculum in the elementary grades. I will also discuss the implications of the research.
Science Education Keynote

Dr. Rick Moog, Professor

Department of Chemistry
Franklin & Marshall College

Process Oriented Guided Inquiry Learning (POGIL): A Student-Centered Approach to STEM Instruction

Process Oriented Guided Inquiry Learning (POGIL) is a student-centered, team learning approach to instruction that is based on research on how students learn best (Spencer, 1999). In a POGIL classroom environment, students work cooperatively in small teams of three or four using specially-designed materials that guide them to develop key course concepts and to deepen and refine their understanding of those ideas. In addition to enhancing content mastery, the POGIL approach also emphasizes the development of important process skills such as critical thinking, problem solving, teamwork, and oral and written communication (Farrell, Moog, & Spencer, 1999).

POGIL classroom materials are carefully designed, typically following a learning cycle that begins with exploration of data or other information for the students to interpret or analyze. A series of guiding questions helps students make sense of this information and leads them to the development of the intended concept. This concept is then reinforced through an application to a new situation or context. Frequently, this "application phase" then leads into a new exploration, and the cycle begins again.

In this interactive presentation, attendees will have an opportunity to experience (briefly) a POGIL classroom environment. We will use this experience as a basis for further discussion of the overall philosophy and research basis of the POGIL pedagogic approach and the evidence of its effectiveness in promoting student learning and retention of information.

References:


Tennessee K-12 Education Update

Dr. Danielle Mezera

Assistant Commissioner of Education
Division of College, Career and Technical Education
Tennessee Department of Education

In 2012, Dr. Danielle Mezera assumed the position of Assistant Commissioner of Career and Technical Education for the Tennessee Department of Education. She serves as the state director for CTE and directs the vision and curriculum of CTE across the state. Dr. Mezera previously held positions with Metro Nashville Government and Vanderbilt University. In 2015 the word “College” was added to the name of her division and with it an expanded focus to include the Governor “Drive to 55” program and other college initiatives. Dr. Mezera will update conference attendees on activities in the Tennessee Department of Education.
Keynote Banquet Speaker

Dr. Janey Camp, Research Associate Professor
Department of Civil and Environmental Engineering
Vanderbilt University

Integrating Geospatial Technologies in K12 STEM Education—
A SWOT Analysis

Geospatial technologies (GT) play a role in many daily functions including locating restaurants, finding directions, Facebook, Twitter, and even Lyft and Uber. At the core of geospatial technology is electronic mapping and spatial analysis. Today, Tennessee students and teachers have new opportunities, with regards to geospatial technologies (McWilliams & Rooney, 1997; Wanner & Kerski, 1999) that have never existed before. These include access to ArcGIS Online Organizational accounts through Obama’s ConnectEd Initiative and a hefty gift from ESRI, the world leader in GIS software, as well as a new course for high school students developed by the Tennessee Department of Education released in 2014. Additionally, the geospatial technology job market is growing in industries such as business, environmental science, engineering, and mobile application development. In this presentation, we will explore the strengths, weaknesses, opportunities and threats (SWOT) associated with integrating geospatial technologies into Tennessee K-12 classrooms. Specifically, we will look at ongoing efforts, overcoming some of the challenges, and prospects for a path forward to enhance STEM education through use of GT in the K-12 classroom.

References:


This rapid talk will showcase data concerning the pass rates of preservice high school mathematics teachers before and after the change in the cut score for the Mathematics Content Praxis test (5161) in Tennessee. The intent is to begin a conversation with colleagues across the State on how we can best address this dilemma.
Rapid Talk: Plickers: A 'New' Technology to Benefit Students and Instructors

Joshua W. Reid  
Cindi Smith-Walters  
Jennifer Parrish  
Middle Tennessee State University

Teachers have been using student response systems in science classrooms as a means of formative assessment and to promote active learning for a number of years (Allen & Tanner, 2005). One example of a student response system is the 'clicker'. However, this technology requires students to purchase their own device or for teachers to purchase a class set. A free alternative with the same benefits of clickers are Plickers (www.plickers.com). Plickers can be used in various contexts including science lectures and laboratory courses to promote peer instruction (Mazur, 1997), argumentative discourse in the science classroom, and used for formative assessment and instant feedback.

Plickers work using QR codes printed on cardstock. Each code is associated with a unique number, which is registered to one student per class. Once the teacher poses a question to the class, the students will orient their card to the correct position matching their answer choice. The instructor uses a mobile device or tablet to scan the cards from the front of room and can immediately display the results in a variety of formats for their own use or to share with students. This technology also provides teachers with an instant and formative feedback by allowing the teachers to connect faces with the answers selected.

This session will give an overview of the technology and participants will have the opportunity to experience Plickers as students would.

References:


Rapid Talk: Inclusion of Special Education Students in STEM Education

Claire Williams McGee
Metro Nashville Public Schools

Students with special needs are being included with their non-disabled peers, for academic instruction in the areas of reading and math more often than in previous years. However, with the advent of the STEM philosophy, it has become imperative that these special needs students, be included fully and without interruption during their grade level appropriate STEM education. The STEM philosophy allows students to create and learn in a non-traditional manner which can be generalized across multiple subject areas increasing their academic comprehension as a whole, and resulting in an increase in self-worth and confidence.
Imagine a partnership in which cultivating curiosity is the priority, and engaging family is one of the critical strategies employed. Research suggests that informal learning experiences in STEM are essential to engagement and identity development in STEM. By creating ecosystems for STEM learning, Discovery Center at Murfree Spring and MTSU are building cross-sector collaborations, with the goal of improving access to high-quality STEM learning for all students.
Rapid Talk: Building Capacity for Tennessee Science Education (BCTSE)  
“Inside the Science Teacher’s Studio” Professional Learning Series

Linda Jordan  
Tennessee Science Teachers Association

BCTSE is a statewide initiative to improve science education in Tennessee and is patterned after a national initiative developed by the Council of State Science Supervisors entitled Building Capacity in State Science Education (BCSSE). The BCSSE project was designed to provide sustained professional development for state science supervisors to gain fluency and utility with the National Resource Council’s (NRC) A Framework for K-12 Science Education.

BCTSE is partnering with Tennessee Science Teachers Association (TSTA) to provide thoughtful and timely professional development/learning for science teachers that is anchored in effective instructional practices that support the implementation of the NRC Framework and the new state science standards.

The BCTSE professional learning goals include:
1. To enable TN science teachers to implement the principles and practices of the NRC K-12 Science Framework.
2. To engage TN science teachers in research-based instructional strategies that support student science learning.

Tennessee’s BCTSE “Inside the Teacher’s Studio” program is designed around two major constructs: an interview, followed by a Pop-Up Conference.

The Interview format is adapted from the television series, Inside the Actor’s Studio and showcases talented TN teachers and their efforts to ensure student learning through the consistent application of a particular instructional strategy. The interview process is as follows:
• An informal conversation occurs between a TN teacher who has demonstrated success with students and an educator interviewer.
During the live broadcast the teacher describes the strategy and may reference video clips where students are actually engaged in science.

The taped version of the interview is then archived with an online resource file on the Oakley STEM Center website, located at Tennessee Tech University.

Because the format is designed to pique interest rather than provide an in-depth exploration of a topic, pop-up conferences are offered for further elaboration of the instructional approach.

The Pop-Up Conference follows the interview segment and provides opportunities for teachers to explore an instructional topic of interest through a model lesson conducted by the interview teacher.

**BCTSE: Inside the Teacher’s Studio Program Timeline 2015-2016**

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<th>Event Description</th>
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<td>May, 2015</td>
<td>Second webcast taped at Winfree Bryant MS, Lebanon TN, featuring Margie Hawkins describing how she initiates and maintains student discourse.</td>
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<td>August, 2015</td>
<td>Conducted Pop-Up Conference at Pope John Paul II HS, Hendersonville TN, featuring Jennifer Dye and Margie Hawkins</td>
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<td>September, 2015</td>
<td>Third webcast filmed at Clinton Elementary School, featuring Kimberly O’Dell demonstrating student modeling.</td>
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<td>April, 2016</td>
<td>Fourth video filmed at Scales Elementary School, Brentwood, TN, featuring Stephanie Novin discussing improving designs and the engineering process.</td>
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<td>Spring 2016</td>
<td>Recruit and film three more presenters for continuing the series.</td>
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<tr>
<td>August 27, 2016</td>
<td>Conducted PopUp Conference featuring all four Inside the Science Teacher’s Studio presenters.</td>
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All *Inside the Science Teacher’s Studio* videos can be accessed at the TSTA website [http://tsta.wildapricot.org/page-1696732](http://tsta.wildapricot.org/page-1696732). Check the [TSTA website](http://tsta.wildapricot.org) for updates on BCTSE professional learning events.
Research surrounding home-school (and home-school-community) partnerships has grown in both breadth and depth over the year, as work surrounding these partnerships has indicated parent involvement (e.g., Epstein’s Six Types of Involvement) as an important factor in the academic success of students (Sheldon & Epstein, 2005). However, one of the many challenges facing the construction of effective partnerships is research describing “schools rather than parents [being] ‘hard to reach’”, where social and economic factors play a role and they cite a difference between involving parents in schooling and engaging parents in learning (Harris & Goodall, 2008). Additionally, these partnerships encounter many barriers such as parents’ perceived lack of content knowledge (DePlanty et al., 2007), parents not knowing how to be involved (Walker et al., 2004), and secondary teachers using less parent involvement strategies than their elementary counterparts (Becker & Epstein, 1982), each of which hinder effective home-school relations throughout students’ schooling.

As a secondary math educator in an urban high school and a mathematics teacher educator at a local university, we saw many of the previously mentioned barriers, among others, play out first hand. Thus, finding a strategy to overcome these barriers and build effective home-school relations in a high school setting provided the purpose for this study that began as an action research project. This project took place initially in the context of a graduate degree program in education, but then extended into an opportunity to learn more about realistically supporting students and their parents.

In reviewing parent/family engagement strategies Family Math Night (FMN) emerged as a fit to building these relationships and to engage with families on a school-wide scale. Studies indicate that FMN provides a non-threatening environment where families and schools can demystify mathematical concepts and share in new challenges (Schussheim, 2004); in addition to providing a setting to address curriculum needs, make school resources available, and celebrate mathematics (Szemcsak & West, 1996). With FMN as the selected engagement strategy, the following questions were asked:
(1) What is the response to FMN in a high school setting?
(2) What do families experience and gain from participating in FMN?

In addressing these questions FMN was implemented in an urban high school once a year for four consecutive years. Data collected from the events came in the form of an exit survey completed by families and their student. The survey consisted of Likert scale and open-ended questions. The data were analyzed using open-coding and descriptive statistics to gain a holistic understanding of the family and student responses.

Analyses indicated that there was a shift in how families and students viewed mathematics to a subject that is useful, approachable, and fun. Parents and students also both indicated that FMN was welcomed, beneficial, interesting, challenging, and informative. Based on the implementation of FMN over four years lessons learned relating to communication, design, and implementation will be shared, in addition to implications for future work in building home-school partnerships.

References:

Bringing Science of Mind to [Science] Educators: Mindfulness in the Science Classroom

Aimee Govett
East Tennessee State University

Based on 30-plus years of research in brain-based learning, Social and Emotional Learning (SEL), prosocial competencies, 21st Century Skills, and mindfulness practices in psychiatry and psychology, we explore the application of mindfulness practices in secondary science methods classrooms. Mindfulness emphasizes inquiry, which is reflective of the nature of science, lending itself well to this educational setting. We will review the science behind the process and outcomes of mindfulness practices. Brain processes underlying mindfulness practices may resonate with biology, chemistry, physics and engineering majors, as they study neurotransmitters and the regions of the brain where stress, problem solving, and decision-making occur. We examine the effects of stress on learning and how to counteract those effects through regulating emotions and responses to stress and impulses. Our teacher candidates learn to implement and master these practices first so that they can create a safe, harmonious, classroom community for their students.
The Biology Teaching Assistant Project 2.0: Advancing Research, Synthesizing Evidence

Grant Gardner (Middle Tennessee State University)
Elisabeth Schussler (University of Tennessee, Knoxville)
Gili Marbach-Ad (University of Maryland)
Kristen Miller (University of Georgia)
Judith Ridgway (Ohio State University)

Improving instructional quality is essential to retention and success of biology students at postsecondary institutions. Although many education reform efforts target faculty as instructors, fewer are focused on graduate teaching assistants (GTAs). As the primary instructors of small sections associated with gateway biology courses, GTAs often have the most direct interaction with undergraduates. Thus, improving teaching professional development (TPD) for these future faculty should be an important component of their education. Unfortunately, delivery of TPD to biology GTAs is limited in scope and length at most universities. This may be due to resistance to devoting time to these programs, GTA TPD practitioners working in isolation, and/or a lack of community TPD standards because of limited research on GTA TPD program outcomes.

To address these barriers, the Biology Teaching Assistant Project (BioTAP) was funded as a NSF RCN-UBE incubator which took the critical steps toward gathering TPD practitioners and identifying current biology GTA TPD practices, but identification of community TPD standards requires a new approach. This Rapid Talk will share the background of BioTAP 2.0 that is building a sustainable collaborative network to support, synthesize, and disseminate biology GTA TPD research and advocate for community TPD standards with the potential to increase the effectiveness of GTA TPD nationwide. Specific project objectives include: 1) Expanding and supporting collaborations with all biology GTA TPD stakeholders through face-to-face and virtual learning community platforms, 2) Supporting virtual learning communities through Virtual Learning presentations (VLCasts) that promote GTA TPD research projects, 3) Recruitment and identification of institutional participants in formal Research Development Sessions to encourage and support rigorous collaborative research in GTA TPD, and 4) Synthesis, dissemination and advocacy for research to identify empirically-based best practices in GTA TPD.
Alphabet books have a long history of being used as a teaching tool to facilitate the development of alphabet knowledge and reading skills in young children. However, alphabet books were used in BIOL 3000 to assess the science content knowledge of pre-service teachers and to evaluate their ability to transfer complex scientific information into organized yet simplified contexts for a K-8 audience. Qualitative analysis of alphabet books revealed that pre-service teachers’ understanding of scientific concepts were both enhanced and reinforced as a result of engaging in this exercise. Additionally, this activity reported that pre-service teachers had positive attitudes towards doing alphabet books and ascribed great value regarding the use of the books as a source of information. A major theme that emerged was a consensus among the pre-service teachers that alphabet books could serve as a means of educating, engaging, and entertaining K-8 students while making the delivery and relevance of science content more ‘interesting’, ‘enjoyable’, ‘fun,’ and ‘easy to understand.’ Since the use of alphabet books is a tool that has neither been used at the undergraduate level or with pre-service teachers, we intend to further explore their use in promoting scientific literacy and the learning and reinforcement of science vocabulary.
With increased expectations regarding mathematics learning, there is a strong need to support teachers in “envision[ing] and implement[ing] classrooms in which students are effectively engaged in learning mathematics and understand[ing] the instructional decisions that they need to make in order to create this environment” (National Council of Supervisors of Mathematics [NCSM], 2014, p. 1). This type of mathematics teaching is complex (National Council of Teachers of Mathematics, 2014) and requires that mathematics education leaders “model effective instructional strategies” (NCSM, 2014, p. 16) as a way to encourage teachers to professionally reflect on instruction (NCSM, 2014). One way to provide teachers with the opportunity for such reflection is through the use of demonstration lessons (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010).

Demonstration lessons include: a briefing that focuses observing teachers’ attention on selected features of the upcoming lesson; the observation of the demonstration lesson where teachers attend to the features of interest; and a debriefing in which the teachers’ observations are discussed (Loucks-Horsley et al., 2010). In the literature, two types of demonstration lessons are described. First, exemplar demonstration lessons provide teachers with a vision for what mathematics instruction that supports student thinking can look like. Clark and colleagues (2013) demonstrated the effectiveness of this type of demonstration lesson for facilitating teachers’ greater emphasis on student thinking and use of hands-on materials. The second type of demonstration lesson is referred to as a replication demonstration lesson, which includes the enactment of the demonstration lesson in observing teachers’ classrooms in addition to the traditional brief-teach-debrief cycle. Hebert and colleagues (2015) reported that this model provided the teachers with multiple vantage points from which to notice students’ mathematical thinking. Although there are different recommendations regarding how to conduct demonstration
lessons in the literature (e.g., Casey, 2011), in our professional development project, the purpose and design of demonstration lessons have emerged as a result of participating teachers’ needs.

In this presentation, we will introduce two new models for demonstration lessons (i.e., day two demonstration lessons and double demonstration lessons) and highlight how the design of these models emerged in response to the expressed needs of the project’s teachers. We will give particular attention to the participating teachers’ levels of appropriation, using a framework provided by Farmer, Garretson, and Lassak (2003).

References:


Leveraging the Local Community in Math Class: A Teacher’s Tale

Ashley Walther
Lynn L. Hodge
University of Tennessee, Knoxville

All too often in today’s world sighs are emitted when speaking about the topic of mathematics. Parents, students, many adults, and even some teachers think of math as a boring subject that they were forced to endure while in school. Math teachers across the world cringe when they hear a colleague say to a student, “It’s okay, I don’t like math either.” Despite the best efforts of math teachers to convey the purpose and usefulness of mathematics, we, as a field, still miss the mark on many occasions. This study was designed to investigate two teachers’ first experiences of leveraging community issues in math class in an effort to motivate students and show them the true power of mathematics.

Teaching mathematics for social justice is often cited as one way to bring relevance to the math classroom (Gutstein, 2003; 2006; Turner & Strawhun, 2007). Unfortunately, most mathematics teachers are never given the opportunity to explore the integration of social issues and mathematics. More recent research demonstrates the need to support teachers as they navigate that process (Bartell, 2013). Teachers tend to feel anxious when the idea of leveraging potentially controversial social issues in the classroom is discussed. For the purposes of this study, both teachers worked with their students to generate a list of community issues that were meaningful to them, rather than tackling a general social issue that could get lost in conversation about faceless others.

The study aimed to answer three questions: (1) How do teachers view the role of math and context in social justice-themed activities? (2) What are the challenges teachers experience as they implement social justice-themed activities? (3) What are the supports they find helpful as they implement these activities? To address these, the authors designed a multiple-case study. The authors co-planned lessons with each teacher. All planning sessions were recorded (5 for the first case; 2 for the second case). Each teacher implemented the lessons within her own classroom. The authors were present, taking field notes, and video recording (10 for the first case; 1 for the second case). The participants were interviewed pre- and post-lesson(s). All interview data and planning session data were transcribed and coded in order to identify relevant themes both within and across cases.
Findings indicate that teachers experience significant tension between mathematical goals and social justice goals during a lesson. On the one hand, they are expected to adhere to the standards and curriculum set forth by the administration; on the other, they find great value in teaching students to use mathematics as a tool to interrogate and, perhaps, change current social situations. In both cases, mathematical goals took precedence over the social goals whenever the teachers made a decision to highlight one over another. Individual teacher backgrounds also play a large role in how they view and implement this approach. Both cases indicated that planning with someone during the early stages of implementation is recommended and preferred.

References:


Equations, Functions, and Modeling with Real-world Problems in Algebra I

Deborah McAllister
University of Tennessee Chattanooga

This program focused on improving mathematics content and pedagogy for Algebra I teachers, as they continue to implement the Tennessee Mathematics Standards. Concentrating work on a few topics allows for tightening breadth while increasing depth of content, as well as devoting study to the mathematics required for career choices. A major focus of Algebra I content is work with equations, functions, and modeling of real-world problems.

Noh and Webb (2015) investigated teacher knowledge of rate of change, and found the context of the problem to be a factor in teacher ability to explore complex problems in algebraic functions. More experienced teachers were more successful in solving the problems, and in recognizing similar and contrasting characteristics of types of problems. This suggests a need for improvement for less experienced teachers. Dubinsky and Wilson (2013) stressed that, with appropriate pedagogy, algebra students from underrepresented groups were able to achieve a level of understanding of functions similar to that of beginning college students. Rust (2011) found that, in a community college pre-algebra course, stronger implementation of reading strategies positively impacted student achievement, and suggested that organized professional development is required for new strategies to be effective.

This program was supported through a Tennessee Higher Education Improving Teacher Quality grant. All activities were correlated to the Tennessee Standards for Algebra I and English language arts, and the eight Mathematical Practices. There were 27 teacher participants. Sessions included one April meeting, a 5-day summer academy, and two fall meetings. Project staff members included university education and mathematics faculty, and two licensed mathematics teachers, who led activities, including integration of graphing calculators. Literacy strategies were incorporated into daily sessions.

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 mathematics quiz, between pre-test and post-test assessments (items correlated to Tennessee Standards).

2. There will be a statistically significant increase in teacher attitude toward mathematics, as the program progresses (Remmers, 1960).

3. Teacher reporting of perception of student learning will be greater than 50% on all measures (University of Minnesota, Morris, 2000).

The pre-test/post-test was administered in April, June, and September, allowing time for initial learning, classroom implementation, and reflection. The mathematics attitude survey was administered in April, June, and September, to determine if an attitude change had occurred over the course of the program. Prior to the September session, each teacher completed a survey regarding perception of student learning (University of Minnesota, Morris, 2000). Results indicated significant gains in content knowledge from the pre-test to each administration of the post-test. There were no significant differences in attitude toward mathematics. There was an average greater than 50% on 7 of the 10 measures of teacher perception of student learning. Teachers reported use of professional development materials in the classroom and sharing of materials with colleagues.

References:


How Undergraduate Students Understand the Roles of Proof in Mathematics: Implications for Explicit and Reflective Teaching

Jeffrey Pair
Sarah Bleiler-Baxter
Middle Tennessee State University

Researchers in mathematics education have made efforts to understand the disciplinary practices of mathematicians (Burton, 1999; Nardi, 2008; Weber, 2008; Weber & Mejia-Ramos, 2011). Understanding the work of experts in a field is an important aspect of instructor knowledge, allowing instructors to design learning environments that engage students in authentic disciplinary practices and thus aid in their learning of mathematics. Thus, for prospective mathematics teachers, developing such knowledge of disciplinary practice is critical. Explicit knowledge of the nature of a discipline is also increasingly recognized, especially by scholars in science education, as important student knowledge in general (Bell, Blair, Crawford, & Lederman, 2003; Lederman & Lederman, 2014).

We believe there may be an implicit assumption possessed by some mathematics education scholars that if students participate in inquiry-oriented classrooms and engage in authentic mathematical practices, then the students may come away from such classes with informed conceptions of what it means to know and do mathematics in the discipline. The authors of this paper admit to being guilty of this assumption in the past. We believed that undergraduates’ understanding of the nature of proof in the discipline could be developed implicitly by engaging students in the five roles of proof described by de Villiers (1990): verification, explanation, systematization, discovery, and communication. In a previous study, we identified the (classroom) activities that engaged students in those five roles of proof. We assumed that by engaging in the five roles of proof, students would gain a sophisticated understanding of those roles in the discipline. However, we found that even when students engaged in a role of proof, this did not always lead to their understanding of the role in the broader discipline. This leads us to the hypothesis, based on the findings in science education (Bell et al., 2003; Lederman & Lederman, 2014), that an explicit and reflective (ER) approach to instruction may be important if we want students to learn about the nature of mathematics (in general) and the nature of proof (more specifically).
We explore the following questions:

- What do undergraduate students in a transition-to-proof course understand about the nature of proof in the discipline? What do they not understand?
- Which roles of proof are in need of further ER instruction?

Data were taken from an undergraduate transition-to-proof course at a southeastern university in the United States. There were thirteen students in the course: nine mathematics majors (seven of whom were prospective secondary mathematics teachers), and four mathematics minors. The researchers used open process coding (Saldaña, 2009) to analyze written descriptions of 65 student recollections (five roles of proof × thirteen students) of the instances in which they recalled being engaged in the roles of proof during the course. During subsequent analysis the researchers discussed how student perceptions aligned with the role of proof as articulated by de Villiers. We present results for each of de Villiers’ (1990) five roles of proof, and offer implications for both research and practice, with respect to ER instruction on roles of proof.

References:


The need for more females in the STEM disciplines has been well documented. To accomplish this goal, it is imperative that programs designed for females take into account what the literature has to offer about what females both need and desire in a STEM classroom or program. Women are attracted to STEM programs that include civic engagement (Knight, Mappen, & Knight, 2011). The use of problems that contextualize a topic to girls’ interests is important (Halperm, et al., 2007) and that may include instances where altruism and science overlap (Carlone & Johnson, 2007).

The STEM Summer Institute (SSI) is a ten-day summer camp held by the national Center for STEM Education for Girls. The SSI originally engaged rising 9th through 12th grade underrepresented girls in STEM in years one through four, and then expanded to included rising 7th and 8th grade girls. Each year the STEM Summer Institute tackles engineering problems selected and sponsored by the Lwala Community Alliance, a non-profit health and development agency in a rural village in western Kenya. Participants used the engineering design process, scientific inquiry, statistical analyses, CAD drawings, and prototypes to solve the problems.

The effectiveness of the SSI in its first five years was evaluated through answering four research questions:

- **Question 1.** How does participation in the STEM Summer Institute increase or change participants’ understanding of the nature of engineering?
- **Question 2.** How does participation in the STEM Summer Institute increase participants’ self-efficacy?
- **Question 3.** How does first-year participation in the STEM Summer Institute increase parental knowledge of and attitude towards engineering?
- **Question 4.** How does participation in the STEM Summer Institute affect a participant’s plans to enroll in college in a STEM major?

The participants from the first three years who gave assent and whose parents gave consent were given the assessment Draw an Engineer Test (Knight & Cunningham, 2004) and the Pre-College Annual Self-Efficacy Survey (AWE, 2008) at the start and completion of the STEM Summer Institute. The Parents’ Engineering Awareness Survey (PEAS) (Yun, et al., 2010) was
administered to all consented parents in years two through five prior to and following the student’s first year of participation in SSI. As SSI participants have graduated from high school, they were surveyed to attain information about college choices and plans for their major. Post-SSI, the girls developed a more accurate conception of engineering. The SSI was effective in increasing the girl’s self-efficacy; after attending the SSI, the girls had a greater belief in their success within STEM courses. The students also had a greater feeling of inclusion both inside and outside the classroom after attending the SSI. Parental knowledge of and attitudes towards engineering increased statistically significantly. Of the 35 former SSI participants who have graduated from high school in 2014 to 2016, 22 of 31 girls responding confirmed they are planning to pursue a STEM major in college, and 30 of 31 girls reported that the SSI influenced their choice of a college major.

References:


This session shares observations and preliminary findings from the first year (2016) of a two-year MSP grant for K-8 teachers, which has recently been extended another year with the inclusion of secondary teachers. **Digging Deep into Science Literacy K-8 (DDiSL)** aims to promote change in teacher understanding of science content and pedagogy through the use of critical reading and technical writing. **DDiSL** has planned for effective modeling, demonstration, guided practice, and coaching with follow-up (Guskey & Sparks, 1991; Learning First Alliance, 2000) as science teachers investigate research-based strategies for incorporating critical reading and technical writing for science with 72 hours of face-to-face contact. More scaffolding is provided through local and online PLCs as well as classroom visits for peer coaching, modeling, observations, interviews, and focus groups. The grant extension allows for 78 additional hours of PD through July 2018.

During year one, teachers from Campbell, Union, Scott and Oneida schools were divided into grade level bands, K-3 (n=33), 4-5 (n=34), and 6-8 (n=17). Year two and three will integrate 20 secondary with the 6-8 group. The three grade bands attend four sessions throughout each workshop day including: **Content** with scientists from Biology, Geology, Chemistry, and Physics; **Disciplinary Literacy** with a focus on close reading and technical writing; **Science Pedagogy** with a focus on the 5E Inquiry Model and Engineering Design; and **Literacy and STEM Integration**.

*A Framework for K-12 Science Education* (National Research Council, 2012) calls for teachers to actively engage students in scientific practices that would allow them to cultivate deep conceptual learning. It asks for learning opportunities for students to develop sophisticated
explanations and models undergirded by critical reading strategies and technical writing skills of CCSS (NRC, 2012). While The Framework (NRC, 2012) does not specify particular pedagogy for each area, it does require that teachers encourage students to inquire, investigate, analyze, deduct, read, write, share, and apply information, all of which are pedagogical concepts of TEAM (Tennessee Department of Education, 2010). “Teachers are the linchpin in any effort to change K-12 science education…. In order to support implementation of the new standards and the curricula designed to achieve them, the initial preparation and professional development of teachers of science will need to change” (NRC, 2012, p. 256).

The following research questions are posed. How does participation in Digging Deep Into Science Literacy impact participants’:
1. self-rating of their knowledge and use of State Standards for Science and ELA, & A Framework for K-12 Science Education?
2. use of effective pedagogical practices included within the TEAM model.
3. knowledge and use of pedagogically sound strategies for critical reading and technical writing in science.
4. efficacy beliefs toward teaching both science and ELA.
5. ability to create and implement lesson plans based upon the DDiSL ideology.
6. science content knowledge.

A variety of quantitative and qualitative measures are used to evaluate changes including the Modified Pennycuff-Reed PD survey; the Science Teaching Efficacy Beliefs Instrument; Modified ELA Efficacy Beliefs Instrument; Teacher Survey/Questionnaire: and a Content Test. We will share results of teacher-pre-assessments and formative measures that we have collected during the 1st year of the grant.

References:


Mathematics as a FirstSTEP to Success in STEM: An NSF STEP Project

Tom Cheatham
Ginger Rowell
Chris Stevens
Don Nelson
Brad Rudnik
Middle Tennessee State University

Seventy percent (70%) of Tennessee high school graduates do not meet the ACT benchmark in mathematics. Ninety-one percent (91%) of African-American graduates and 81% of Hispanic graduates fail to meet the ACT benchmark for college readiness in mathematics (Sutherland, 2016). Roughly three of four Tennessee high school graduates are not prepared to succeed in college algebra and will likely be significantly behind in their STEM major by the end of their freshman year. These underprepared students constitute more than half of the MTSU freshman class (56%) and succeed in freshman STEM courses at a much lower rate than prepared students. In some cases, students may not have focused on school and certainly bear some responsibility for their poor preparation in mathematics. However, we prefer to think of these underprepared students like Brier (1978), “not as students who have failed, but rather students who could succeed,” if we help them. This was the goal of the 5-year MTSU-NSF STEP project (DUE #0969571). This talk reviews the proposed interventions and provides 6 years of data to demonstrate the success/failure of the project.

References:


Preparing College/Career Readiness through Integrating Science Learning with Literacy in Secondary Education

Chih-Che Tai
Karin Keith
East Tennessee State University

With the increasing globalization, and the increasing need for a scientifically literate population, it is essential that secondary school (Grades 6-12) 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 the 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) to provide professional development (PD) to K-12 teachers. The project described in this presentation, Science Literacy in Education (SLICE), sought to enable grades 6-12 Science and English Language Arts (ELA) teachers to reach for excellence in middle and high school Science and ELA through Hands-on, Standards-based, Project-based and Technology-based (HSPT-based) learning.

The project represents a partnership among 90 grades 6-12 science and ELA teachers from ten LEAs, five 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 Science and Literacy faculty and professionals to form a strong professional learning community focused on the integration of Science-ELA. Specifically, teachers developed lessons that integrated science 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 middle school and high school science and ELA teachers for the purposes of developing integrated lessons; and 2) to report findings about this PD.

References:


One can assess the impact of a publication on the scholarly literature by looking at citation counts – that is, how many times a publication has been cited by other peer-reviewed publications (Garfield, 1963). In the modern age of technology and big data, however, new ways to measure scholarly output and impact have led to the creation of large databases.

Toerner and Arzarello (2012) presented the results of a survey completed by 75 experts in mathematics education concerning various journals with an international scope, yielding rankings for only 17 journals. Additionally, Williams and Leatham (unpublished manuscript) conducted a similar survey, resulting in a set of top-tier, mid-tier, and low-tier journals in mathematics education. Both surveys found Educational Studies in Mathematics and the Journal for Research in Mathematics Education to be more highly regarded by mathematics education scholars than the other journals. However, these survey studies provide data from only a subset of the researchers in the field.

New Internet databases keep a current list of journals for scholars to see the reputation of journals in their field. Additionally, these databases are updated yearly. We present our research study in analyzing the status of journal rankings in mathematics education, focused on the following research question:

To what extent do journal rankings and representation change over time, in particular the years 2010 – 2013?

While there are several journal ranking systems available, we focus exclusively on Scopus for this study because it is freely available and quite large. Looking through the Scopus database, we used the Social Science subject area, Education sub-category, and downloaded each dataset for years 2010 to 2013. To focus our study, we searched for journals that specifically target mathematics education, but we did not include general education research journals.
Using these databases, we identified the mathematics education journals found in the two above-mentioned surveys, as well as another study (see Nivens & Otten, in press). Here we present the four resultant datasets.

The presence of journals indexed in Scopus in the field of mathematics education has grown over the years, as has the representation by country. Specific results will be shared, including 3 tables and 1 appendix listing journal titles found in this study. A twelve-page paper will be available for download and the link shared during the presentation.

References:


Creating a Collaborative Environment with Four-Year Institutions and Community College Faculty to Engage Students in Learning Statistics

Michael Darrell, Lori Giles, Marilee Gorta, and James Smith
Columbia State Community College

Lisa Green, Scott McDaniel, Nancy McCormick, Jeremy Strayer, and Ginger Rowell
Middle Tennessee State University

The Modules for Teaching Statistics with Pedagogy using Active Learning (MTStatPAL) research group designed learning modules for an introductory statistics course to improve student success by disseminating best teaching practices across the many sections of this course. During the class-testing by faculty outside the MTStatPAL project, we observed that faculty new to active learning have a hard time implementing the modules without support. Many faculty members do not have formal statistical training in their undergraduate or graduate coursework. Further, many do not have training in using active learning. Last year at this conference, the MTStatPAL project team reported on the Introductory Statistics Course Community that was created at Middle Tennessee State University (MTSU) to provide a professional development model to support faculty in effectively integrating active learning in introductory statistics.

Starting in May 2016, the MTSU MTStatPAL project team developed a collaboration with faculty teaching introductory statistics at Columbia State Community College (CSCC) in which we class tested the MTStatPAL student and instructor materials with community college students during the Fall 2016 semester. We also tested a model for professional development when faculty are teaching at different institutions. Questions of interest included when the faculty’s institutions are over an hour apart, what are the most effective ways to incorporate components of successful professional development programs such as a substantial time investment, systemic support for the instructors, opportunities for collaborative and varied learning experiences that result in acquisition of skills and knowledge, and evaluations of both student achievement and the immediate and ongoing impact on professional practice (Ohio Department of Education).

The collaborative model for transitioning to using active learning or for incorporating additional active learning materials included a few timely face-to-face meetings, emails, designated mentor/mentee partners, and a designated leader at each institution. Other support materials for this teaching transition included a student booklet with ten full-class active learning modules and five minute daily warmups to continue student-to-student conversations; a corresponding teacher
manual with solutions to the student workbook, but also with helpful hints for each module and suggestions for things to teach each class period; videos of experienced instructions teaching the active learning modules; and instructions for accessing videos for students to watch and corresponding quizzes for the students to ensure they are prepared to effectively complete the in-class activities or to extend concepts from class.

This presentation will report on the experiences of the faculty members involved in collaboration and the strengths and weaknesses of this remote access professional development model for making a large scale transition in teaching pedagogy. We will also include results from the student pre and post tests and ease of use surveys which allow comparisons between community college and university students using these teaching materials and this instructional approach.

References:

Examining Teacher Learning and Critical Resources in the Context of Mathematics Professional Development

Gale Stanley
Campbell County Schools

Michael Lawson
Ashley Walther
Lynn Liao Hodge
University of Tennessee, Knoxville

The overarching goal of the Math Counts project is to support teachers’ instructional practices and content understanding in order to substantially impact student learning in K-8 mathematics. For this reason, the project focuses on developing a community of teachers who have a repertoire of instructional practices and tools available to them and a common language to discuss issues of teaching and learning. In our first year the ideas of high-leverage practices and high-leverage content informed our work. With this foundation in place, the second iteration of Math Counts drew on the ideas of learning progressions (Confrey, Maloney, & Nguyen, 2011; Ginsburg, 1983) and building discourse communities (Ball, 1993; Lampert, 2009). The idea of learning progressions offers a map, showing multiple routes of learning, for teachers to understand how understanding builds toward key math concepts and skills—providing deeper understanding for how students learn about particular concepts and competencies. In order to maximize an understanding of learning progressions, teachers will participate in discourse communities and extend these strategies to create discourse communities in their classrooms. Discourse communities are classes or groups that unpack ideas and share thinking in order to improve understanding for all individuals.

The purpose of this study is twofold. The first aspect is to examine teacher learning and initial impact of the second year of Math Counts. The central question guiding this aspect of the study was: What do teachers learn and gain from participating in the second year of Math Counts? The second aspect of this study is to understand the critical resources that supported teachers’ learning.

Participants of the Math Counts project were 50 elementary and middle school teachers and instructional coaches who completed a 5-day summer institute and two additional follow-up
professional development sessions. While being informed by research around learning progressions and discourse communities, the content and pedagogical focus of the professional development sessions addressed common misconceptions in mathematics and developing strategies to respond to student misconceptions. During the institute and follow up sessions participants completed pre/post-measures of mathematics content and pedagogy and on their experiences. The data were analyzed using dependent t-tests and in vivo coding to produce a thematic analysis.

Preliminary analysis revealed that there were significant differences between the participants’ knowledge about both the content and pedagogical attributes towards mathematical misconceptions before and after the institute. Additionally, teachers suggested gaining specific strategies and larger practices they can utilize to address misconceptions. The level of confidence teachers displayed in terms of their newfound awareness and readiness to observe and address misconceptions in the classroom was not only apparent in their takeaways but also in the clarity of their answers during the post-assessment and in discussions during the follow-up sessions.

Based on a preliminary retrospective analysis, critical resources included the community building that took place during both Summer Institutes. This involved the participants and the project team. The norms of participation during sessions with teachers and the nature of the tasks also contributed to teachers’ learning and positive views of the professional development.

References:


POGIL to Success in Chemistry

Nancy Caukin
Tom Cheatham
Middle Tennessee State University

With the goal of improving teacher content knowledge and PCK, professors from the Colleges of Education, Basic and Applied Sciences, and the MTSU STEM Center collaborated to provide high-school chemistry teachers a 5-day workshop engaging them in the teaching strategy called process oriented guided inquiry learning (POGIL; Farrell, Moog, & Spencer, 1999; Spencer, 1999). Funded by a Tennessee Improving Teacher Quality (ITQ) grant, 30 teachers from four high needs districts and from the surrounding area participated in this professional development experience. They completed a pre- and post-content knowledge test, as well as the Instructors’ Attitudes towards Active Learning survey (Kinneret & Herscovitz, 2009) and other assessments. Results from the project will be shared.

References:


Supporting Students’ Inferential Reasoning Through Building, Testing, and Revising Models

Seth Jones
Jacob Jia
Middle Tennessee State University

Model based, statistical inferences are becoming increasingly important in a world where we have to make sense of variable data to inform decisions. However, this practice requires a sophisticated integration of ideas about sample, sampling variability, probability, and modeling (Makar & Rubin, 2009). Currently, too few students have opportunities to grapple with these conceptual underpinnings of statistical inference, and those that do often encounter them hidden beneath an intricate system of formal probability models. This can create learning environments where probability seems unrelated to statistics, foundational issues related to variability and random chance go undiscussed, and students do not have opportunities to build the models that support their inferences (Franklin et al., 2007).

With this in mind, we designed learning opportunities for 7th grade students to engage with these ideas through explorations in modeling simple chance events, such as the probability of a new born baby being a girl. We designed a three-week trajectory through probability that, in contrast to common approaches, did not focus on enumerating increasingly challenging outcome spaces, but instead on more deeply understanding the relationship between theoretical probability and the distribution of empirical outcomes from repeated samples. We created a variety of contexts for students to explore sampling variability, modeling, the relationship between sample size and sampling variability, and model-based inference using dynamic data analysis software (Tinkerplots). These tasks drew on previous research on student thinking about data and inference (Lehrer, Kim, Wilson, & Ayers, 2015).

We conducted a 3-week design research study (Cobb, Confrey, Disessa, Lehrer, & Schauble, 2003) with two teachers and 40 students in a 7th grade class. We explored the ways students interacted with our learning environment and the ways their thinking changed by pursuing the following research questions:

1) How does student thinking about the relationship between theoretical probability and empirical probability change?
2) How does student thinking about sampling distributions and the relationship between sample size and sampling variability change?

3) How do students use probability models to construct inference claims? How does this change?

We video recorded one lesson each week during the three-week unit. These video recordings included a camera at the rear of the classroom, and on one group of students during small group activities. We also collected student work products. In addition to these data, we interviewed a purposeful sample of 7 students from across two classes. Teachers selected the students to represent a range of mathematical proficiency. We analyzed these data to explore qualitative themes about student thinking during the classroom activities, and how students’ ideas changed. We found that students were able to develop sophisticated ideas about sampling, sampling distributions, and sampling variability. However, students had less developed ideas about the relationship between theoretical probability and empirical probability. We will discuss the nature of the changing ideas, as well as present the diverse and creative ways these students approached modeling activities. We will also discuss the implications for our next design iterations, and more general implications for teaching sampling, probability, modeling, and inference.

References:


Building Mathematical Content Knowledge for Teaching in a Geometry Content Course for Secondary Teachers

Lucy A. Watson
Candice M. Quinn
Alyson E. Lischka
Jeremy F. Strayer
Middle Tennessee State University

Mathematics teachers rely on mathematical knowledge for teaching (MKT), which requires not only knowledge of the content but also specialized content knowledge usually needed for only teachers (Ball, Thames, & Phelps, 2008). Ball and colleagues (2008) described specialized content knowledge for teachers as knowing mathematics in “ways useful for, among other things, making mathematical sense of student work and choosing powerful ways of representing the subject so that it is understandable to students” (p. 404). Unfortunately, prospective secondary mathematics teachers (PSMTs) often learn advanced content knowledge and pedagogical knowledge in separate courses. Grossman, Hammerness, and McDonald (2009) argued this separation of foundation and methods is problematic for PSMTs because it contributes to the PSMTs disconnect between theoretical knowledge and work in the classroom. Furthermore, they argued the separation does not allow PSMTs to focus on concrete practices, but instead leads to focus on conceptual foundations of teaching.

As part of a national initiative, the project in this presentation included developing, piloting, and studying the effectiveness of modules for use in a College Geometry course that interweaves common and specialized content knowledge elements into a rigorous content course for secondary teachers. PSMTs engage in mathematical practices while developing a deep understanding of advanced content through three modules. Additionally, the modules provide opportunities for PSMTs to develop their pedagogical content knowledge and to better understand the nature of the field of mathematics and its practice.

The researchers posed three questions to guide the study: How do the Geometry modules help PSMTs develop MKT? How do PSMTs connect the more advanced mathematics they are learning with content they will be expected to teach at the 7-12 level? How does learning with the Geometry modules impact PSMTs perception of MKT? The collected qualitative data included a pre and post assessment on each module in the course that required PSMTs to respond.
to student thinking using a representation of teaching practice. The researchers posed questions following the teaching of an advanced topic that asked PSMTs to draw on their own understanding of the topic, and collected pre and post assessment of the geometric knowledge PSMTs believe is necessary for teaching at the secondary level. PSMTs also took the nationally validated Mathematical Knowledge for Teaching Geometry Assessment (Mohr-Schroeder, M. J., Ronau, R. N., Peters, S., Lee, C. W., & Bush, W., under review) as a pre and post assessment of the course. Researchers scored this test and ran quantitative analysis of overall improvements in the PSMTs’ MKT. Preliminary findings indicate that PSMTs moved away from generic teacher moves and questions toward content specific teacher moves in response of an effort to understand the mathematics-learning statements. This presentation will include an overview of the project and how it began, a brief description of the modules and how they help develop PSMTs’ MKT, a description of data collected, and a review of initial findings and next steps.

References:


Technology Tool Scaffold Students’ Sense-Making in Problem Solving Task

Amdeberhan Tessema
Middle Tennessee State University

According to Schoenfeld (1992), the main focus of mathematics education should be to have students become competent problem solvers. He argued that the goals and focuses of mathematics education should be on the students’ meaning making, thinking, and conceptual understanding, which are learned through engaging students in problem-solving tasks. Similarly, Lobato (2010) indicated that the role of problem solving is to develop students’ understanding of mathematics. She further argued that students who confront problematic situations can construct new knowledge and new understanding. In another study, Kim and Hannafin (2011) identified that problem-solving activity is a situated, student-centered, active engagement with a goal to attempt and solve the problem by employing different strategies through multiple interactions among students, cognitive tools, and other resources. In addition, Kim and Hannafin (2011) reported that technology tools not only foster problem-solving learning but also scaffold students’ work through “tailored” assistance, which involves collaboration and discussion among students, immediate feedback, and work as semiotic mediation. Technology tools also provide multiple, authentic, situated perspectives, through graphing, tables, simulations, visualization, and dragging effects. Unfortunately, in most cases students in mathematics classroom do not have the opportunity to learn through problem-solving instruction with support of technology tools.

In this research study, students engaged in problem-solving instruction with the support of a technology tool. The technology tool, GeoGebra applet, was used as a means for learning or as an intervention for learning. The GeoGebra applet was designed to scaffold students’ problem-solving learning by allowing for mathematical experimentation and interactive explorations. The purpose of this research study specifically was to examine how technology scaffolded or supported students’ meaning making during problem-solving instruction. To this end, I posed the following research question: How does dynamic mathematics software (GeoGebra) scaffold students meaning making when solving a two co-varying modeled function problem?

This study was an experimental design based qualitative research study. Thirty-two freshmen pre-calculus students participated. The data were collected through video recordings and
students’ worksheets. The recorded data were categorized or grouped based on relevant events that showed when students were struggling to solve the problem. These events in which students struggled during problem solving were selected for analysis because they highlighted students’ interactions with the applet and with their group. Moreover, these events highlighted students’ thinking when they were trying to solve the problem. Results showed that the GeoGebra applet supported students’ mathematical meaning making during their struggle to solve non-routine mathematics problems. Moreover, the applet scaffolded students’ thinking by generating or creating connections among different mathematics concepts. Additionally, the cognitive tool scaffolded students’ thinking by triggering sense making through visualizing the main concept of the problem-solving task.

References:


A Comparison of the Instructional Impacts of Peer Instruction (PI) and Process-Oriented Guided Inquiry Learning (POGIL) in High School Biology

Grant E. Gardner
Jennifer Parrish
Tom Cheatham
Middle Tennessee State University

Leigh McNeil
US Naval Academy

The need to develop Research-Based Instructional Strategies (RBIS) in K-16 classrooms to promote student learning is a priority in STEM fields (PCAST, 2012). Peer Instruction (PI) and Process-Oriented Guided Inquiry Learning (POGIL) are RBIS with evidence supporting positive impacts on students’ conceptual understanding of science (Mazur, 1997; Ferrell, Spencer & Moog, 2008). PI was developed for undergraduate physics classrooms and POGIL was developed for undergraduate chemistry. PI and POGIL have been adopted horizontally to other postsecondary disciplines but educational researchers have rarely examined if these RBIS can be adopted vertically to K-12 classrooms (Fagen et al., 2002). Contextual differences may make vertical transfer difficult and require instructors to make adaptations to balance implementation fidelity (Gess-Newsome et al., 2003; Henderson & Dancy, 2007).

This NSF-funded DRK-12 project, Promoting Active Learning in Science (PALS), sought to facilitate the vertical transfer of PI and POGIL to secondary school classrooms, evaluate the RBISs’ impact on student learning, and support teacher implementation of the strategies. This presentation focuses on the following research questions:

1. What changes occurred in participating high school students’ and teachers’ knowledge of biology following instruction utilizing PI and POGIL?
2. What changes occurred in participating high school students’ and teachers’ expert-like thinking related to biology following instruction utilizing PI and POGIL?
3. Are there any significant differences between student and teacher knowledge acquisition and expert-like thinking related to biology in the PI and POGIL instructional conditions?

Participants were high school biology teachers from 16 school districts in middle Tennessee, representing 32 area high school. Of the sample teachers $n = 22$ were randomly assigned to the PI condition; $n = 24$ to the POGIL condition; and $n = 3$ served as controls. Complete data was
obtained from \( n = 513 \) students participants. Knowledge of the Cells and Heredity strand of the Tennessee state standards was evaluated by a 24-item concept assessment. Expert-like thinking was measured with the CLASS-Bio (Semsar et al., 2011).

There was an initial difference in teacher knowledge scores between groups with the PI group being significantly lower [\( F(2,49) = 3.39, p = 0.027 \)]. Although there were no statistically significant differences between PI, POGIL, and control teacher post scores (when controlling for pre-scores), there were some items for which many teachers maintained persistent misconceptions. Overall teachers showed a statistical reduction in expert-like thinking [\( t(24) = 2.37, p = 0.026 \)]. This is not uncommon in studies utilizing the Class-Bio. These changes were not significantly different between PI and POGIL groups [\( t(23) = 0.043, p = 0.966 \)].

Results revealed learning gains across all students [Pre-mean = 5.09 (SD = 1.56); Post-mean = 7.01 (SD = 1.95); \( t(160) = 10.63; p < 0.0001 \)], and there were no statistically significant differences in student learning gains between the conditions [PI mean = 1.88 (SD = 2.07); POGIL mean = 1.92 (SD = 2.42); \( t(159) = -1.30; p = 0.897 \)]. No differences were discovered between student post-knowledge scores [\( F(2,247) = 0.76; p = 0.47 \)] or post-expert-like thinking scores [\( F(2,244) = 0.98; p = 0.91 \)].

References:


President’s Council of Advisors on Science and Technology (PCAST). (2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics.


Non-majors Biology Students’ Environmental Knowledge and Perceptions about Conservation after Participating in Invasive Pest Plant Removal Projects

Kim Cleary Sadler
Angelique Troelstrup
Penny Carroll
Middle Tennessee State University

This study explored student knowledge and perceptions about the environment while enrolled in a non-majors biology experiential learning (EXL) course. The two goals that guided the biology EXL course were students will: (1) engage in systematic reflection and demonstrate the ability to critically examine their experiences and to create connections between those experiences and disciplinary knowledge; and, (2) make contributions to their communities and learn the value of making these contributions (good citizenship). To extend learning about conservation issues beyond the classroom walls, students participated in invasive pest plant removal projects on public lands.

The expression, “the more things change, the more they stay the same” can appropriately be applied to a silent biological threat to our natural heritage, which is the loss of native plant species through displacement by introduced invasive pest plants (Simberloff, 2013). Physical removal of invasive pest plants is one management strategy that produces sustained, immediately observable, and positive results. The student’s restoration efforts were in locations that students can return to year after year to see the impact of their work. Project work sites were located on historically relevant civil war sites and partnering agencies included the National Park Service (Stones River National Battlefield) and the Murfreesboro parks department. Students worked in small randomly assigned collaborative teams for four to six hours based upon the dates and work site. Training was provided in class and on site by park staff. Explanations included the significance of the work and the value, environmentally and fiscally.

To learn more about the impact of the ecological restoration component of the course the following research question was posed: What are student perceptions of the importance of civic engagement as it relates to the environment and more specifically, the conservation work in which they were involved?
Data was collected and analyzed from 353 students that completed a pre and post 12-item knowledge survey about the environment, reflective journals, and a baseline survey that gathered information about previous outside experiences and level of civic engagement. Results from the basic knowledge survey indicated there was a significant difference between pre-survey and post survey scores, \( t(352) = 17.10, p < 0.001 \). Results indicated that scores increased from pre-survey (\( M = 36.33, SD = 18.06, n = 353 \)) prior to instruction and EXL experiences to post-survey (\( M = 51.42, SD = 20.90, n = 353 \)). Fifteen pre and post journal entries were randomly selected for analysis. Journal entries were open coded using Atlas.ti to find themes and patterns. Students were initially unsure of the restoration work associated with experiential learning project and had different expectations but most reported they ultimately valued it. One student stated this project gave them their first experience using a shovel and another said they had very little experience being outside. The most impressive aspect reported by students was seeing the physical progress of their work. A high percentage indicated the project had value as a conservation effort and should be continued as a requirement of the course.

References:

Trees, Ecology, and Technology: Examining the Effects of a Campus Arboretum Curriculum on the Ecological Literacy of Undergraduate Biology Students

Patrick E. Phoebus
Michael Rutledge
Kim Cleary Sadler
Middle Tennessee State University

Despite the need for an ecologically literate citizenry to make informed decisions about environmental issues confronting society, individual knowledge of our natural surroundings is decreasing (Atran, Medin, & Ross, 2004). Although factors such as resource dependency and urbanization have been shown to affect ecological literacy levels, the primary reason for the decline can be attributed to the diminishing amount of time people spend in natural environments (Pilgrim, Smith, & Pretty, 2007).

Urban green spaces provide opportunities to interact with local natural areas (Noss, 2004; Shwartz et al., 2014; Standish, Hobbs, & Miller, 2013), which has been shown to increase individual levels of ecological literacy (Cooper, 2008; Lindemann-Matthies, 2005; Parker, 2009; Pilgrim et al., 2008). However, studies evaluating the ability of green spaces to increase ecological literacy are not widespread (Lin et al., 2014; Standish et al., 2013). Additionally, although studies evaluating the use of mobile technology to enhance non-specific domain learning are numerous (Martin & Ertzberger, 2013; Wu et al., 2012), studies investigating the combined use of direct experience with nature and mobile technologies to enhance ecological literacy are less prevalent (e.g., Liu, Peng, Wu, & Lin, 2009; Ruchter, Klar, & Geiger, 2010; Zimmerman & Land, 2014).

Subsequently, the purpose of the study was to explore the ecological literacy of undergraduate biology students and pre-service k-8 teachers through formal instruction incorporating the use of an urban green space and mobile technology. Using a convergent parallel mixed methods design (Creswell & Plano Clark, 2011), undergraduate students enrolled in two different biology courses participated in a series of ecological activities incorporating an interactive online campus arboretum guide designed for the study. Students in a third undergraduate biology class served as a comparison group and did not participate in the activities. Pre- and post-treatment data was collected on individual student ecological knowledge, environmental attitudes and beliefs, and environmental behaviors using three survey instruments. In addition, qualitative data was collected using written reflections, interviews with participants, and observations. The following research questions were asked:
1. Are there significant differences between the pre- and post-scores for ecological knowledge, environmental beliefs and attitudes, and environmental behaviors?

2. Are there significant differences among the three groups for ecological knowledge, environmental beliefs and attitudes, and environmental behaviors?

3. How does participation in the arboretum curriculum influence the environmental attitudes and beliefs of undergraduate students, if at all?

Quantitative data was analyzed using three separate 3 (within-groups) x 2 (within-subjects) mixed design ANOVAS. Although significant differences between pre- and post-scores on ecological knowledge were found for all 3 groups, no significant differences were found between the treatment and comparison groups. Additionally, no significant differences were found for environmental attitudes and beliefs or for environmental behaviors. Initial themes emerging from preliminary analysis of qualitative data include the importance of learning about nature, student engagement with the curriculum, the application of learning outside of class, and an awareness of human impacts on the environment. These findings will be used to support an enhanced understanding of the impact of the arboretum curriculum.

References:


Noss, R. F. (2004). Can urban areas have ecological integrity. In W. Shaw, L. Harris, and L. VanDruff (Eds.), *Proceedings, 4th International Wildlife Symposium* (pp. 3-8).


Although high school students in Nashville may be interested in the Earth’s marine and polar environments and the important issues affecting them, there is relatively little attention given to such topics in the public high school curriculum. The School for Science and Math at Vanderbilt is a joint venture between Vanderbilt University and Metropolitan Nashville Public Schools (MNPS) that each week, provides four separate cohorts of high school students (grades 9-12) with a research-based experience that includes environmental topics [1]. The SSMV prioritizes refining a curriculum to encompass a wide breath of science and engineering topics. SSMV has recently invested some of its resources into improving the presence of marine and polar topics in its curriculum, recruiting a new PhD instructor who has worked in the fields of Oceanography and Arctic marine ecology for several years. New lessons have been added to the SSMV curriculum on relevant topics such as the United Nations Convention on the Law of the Sea, climate change causes and impacts, as well as mitigation and adaptation strategies, and components of Arctic marine food chains. While students are excited to learn these topics, lessons have revealed fundamental knowledge gaps amongst Nashville public school students, which could be improved. Furthermore, to fulfill the requirements of semester projects, 4 sophomore students are currently engaged in original Arctic research projects, investigating the phenology of Arctic shorebirds from new data on bird numbers obtained from colleagues in Norway [2]. Another 3 students are developing a unique smart phone application to help other students identify small Arctic marine animals. In this presentation, I will outline some early observations and challenges that we have identified when introducing these topics into the curriculum, and suggest ways in which Arctic topics could be more widely incorporated into the curricula of other high schools in the USA.

References:


Joshua W. Reid
Grant E. Gardner
Penny Carroll
Velta Napoleon-Fanis
Emily Smith
Middle Tennessee State University

Biology Education Research (BER) has become a critical emergent area of scholarship over the last two decades and there is a need for a review of the common methodologies used in this field. Much BER has sought to understand how students learn biology, what methods are best for teaching biology, and students’ attitudes and beliefs about learning biology (Dirks, 2011). Other studies have reviewed the development of BER historically and described theoretical frameworks of BER (DeHaan, 2011; Dirks, 2011) or have used descriptive content analysis to review the emerging field of BER (Gul & Sozbilir, 2016). However, no reviews have looked at the methodological trends of BER as a whole to understand how BER has evolved or indicated the major gaps in the current literature to inform the future of the field.

CBE Life Sciences Education has become the foremost journal for BER as indicated by the Scimago H index journal rankings. The purpose of this study is to describe the trends in BER methodology over the last one and a half decades as indicated by CBE research articles. A comprehensive review of trends in BER methods from all articles (n = 377) in CBE resulted in a sample that was reviewed by the research team. Relevant research trends were extracted and data collected was input into an online tool to record all pertinent information. The researchers analyzed the data through synthesis, comparison, and gap analysis to identify methodological trends in BER research. Specifically, the researchers have characterized the various research designs, sample descriptions, and methodologies used in BER over the last fifteen years, as indicated by its premier journal.

Our study adds to the current literature on the development of BER as a research field by revealing trends in methodologies. This study was guided by the following research questions:
1. What are the methodological trends in BER as indicated by *CBE Life Science Education* journal?
2. What are the current methodological strengths and weaknesses of BER?
3. Are there gaps in the literature that may provide foundations for future research and if so, what are they?

Preliminary results have revealed trends in the methodologies used in BER over the previous thirteen years. Notable trends include an increase in mixed methods and quasi-experimental research designs, increases in the reporting of gender and race and no difference in reporting of socio-economic status as critical study variables. The results also present trends that the journal primarily conducts studies in the United States and in the college and university context. When looking at the common data sources and measurement instruments used in studies published in CBE, we found that most were researcher designed. However, aligning with this, we also find that there is a longitudinal trend of more studies reporting validity and reliability data for their measurement instruments. Implications of these results for the future of BER will be discussed.

**References:**


Using a Computer Science-based Board Game to Develop Preschoolers' Mathematics Understanding

Ryan Nivens
Rosemary Geiken
East Tennessee State University

The objectives for this project are: Identify mathematical concepts children develop when playing Robot Turtles, and explore how playing Robot Turtles influences children’s interest in computer programming type games. The activities consist of a pre-assessment to measure mathematical concepts and preference in types of games to play when given free choice. After this assessment children will play a game (either the computer science based game or an alternative) once a week for four weeks. This will be followed by a post-assessment to measure any changes from the pre-project assessment. We report on the mid-progress of this ongoing research project.

Forty children, age 4, at the Child Study Center and Little Bucs will be randomly assigned to one of two groups. The treatment group will play Robot Turtles, a game meant to help children learn. The control group will play Candy Land, a game that is only for fun and that prior research has shown to have no measurable effect in mathematical learning. Following the methods of Siegler and Ramani (2009), children will play our games during five 15-20 minute session within a four-week period.

Measures include number sequencing; right/left recognition; counting spaces in a square grid; and, solving a maze.

The work is significant because of the need for computer science professionals and the potential to impact young children toward computing. Computer science is foundational knowledge that all students need. Nearly 75% of U.S. schools don’t even offer computer science and only 8% of STEM graduates study it. In order to improve access for all students, including groups who have traditionally been underrepresented, we can work within the social structure of what is valued: mathematics. And since computer science is heavily based in mathematics, our research can make a difference. We believe that by starting with the youngest children we can light a fire of inspiration
and desire to pursue computer science-related studies while also improving their knowledge of mathematics.

**References:**


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### List of Facilitators

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STEM Resources in Tennessee

Tennessee STEM Innovation Network
Wes Hall, hallj@battelle.org

STEM Hubs
West TN STEM Hub, ssalyers@memphis.edu
Northwest TN STEM Hub, ckunkel@utm.edu
Middle TN STEM Hub, tom.cheatham@mtsu.edu
Upper Cumberland Rural, seddins@tnstate.edu
Southeast TN STEM Hub, mstone@pefchattanooga.org
STEMspark East TN Hub, haley.holt@knoxschools.org
ETSU NE TN STEM Hub, godbolea@etsu.edu

Platform Schools
Southwind STEM Academy
Hattie Cotton STEM Magnet Elementary
Stratford STEM Magnet High School
Prescott South Elementary
Prescott South Middle School
STEM School Chattanooga
L&N STEM Academy
Innovation Academy

STEM Centers in Tennessee
Center of Excellence in Math & Science, ETSU
Center for Enhancing Education in Mathematics & Sciences, UTK
Oakley STEM Center, TTU
TN STEM Education Center, MTSU
Jack Hunt STEM Center, APSU
STEM Center for Teaching & Learning, UTM
Center for Research and Innovation in STEM Teaching and Learning, UofM
Challenger STEM Learning Center, UTC

Professional STEM Organizations in Tennessee
TN Mathematics Teachers Association
TN Science Teachers Association
American Chemical Society Local Chapters
TN Science Education Leadership Association
TN Academy of Science
TN Society of Professional Engineers
TN Section of American Society of Civil Engineers
TN Association of Mathematics Teacher Educators
TN Educational Technology Association

Other STEM Resources
Oak Ridge National Laboratory
Oak Ridge Associated Universities
TN Valley Authority
US Army Corps of Engineers
Arnold Engineering Development Center
Colleges and Universities
preK-12 Schools
Museums and Science Centers