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SOUTHEASTERN STEM EDUCATION RESEARCH CONFERENCE

2022

DATE

JANUARY 13-14, 2022

HOSTED BY

MIDDLE TENNESSEE STATE UNIVERSITY

MURFREESBORO, TENNESSEE

16th Annual Tennessee STEM Education Research Conference
January 13-14, 2022

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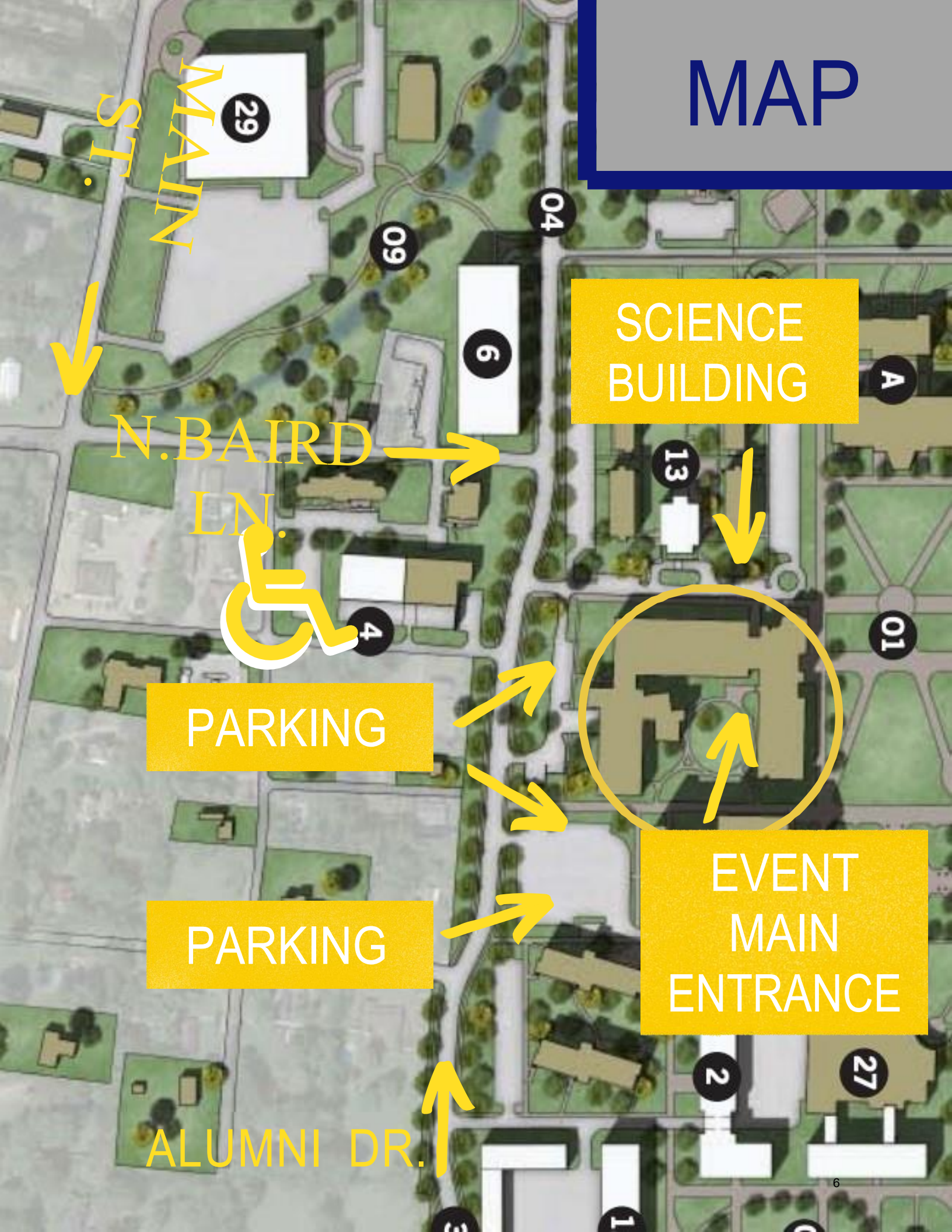
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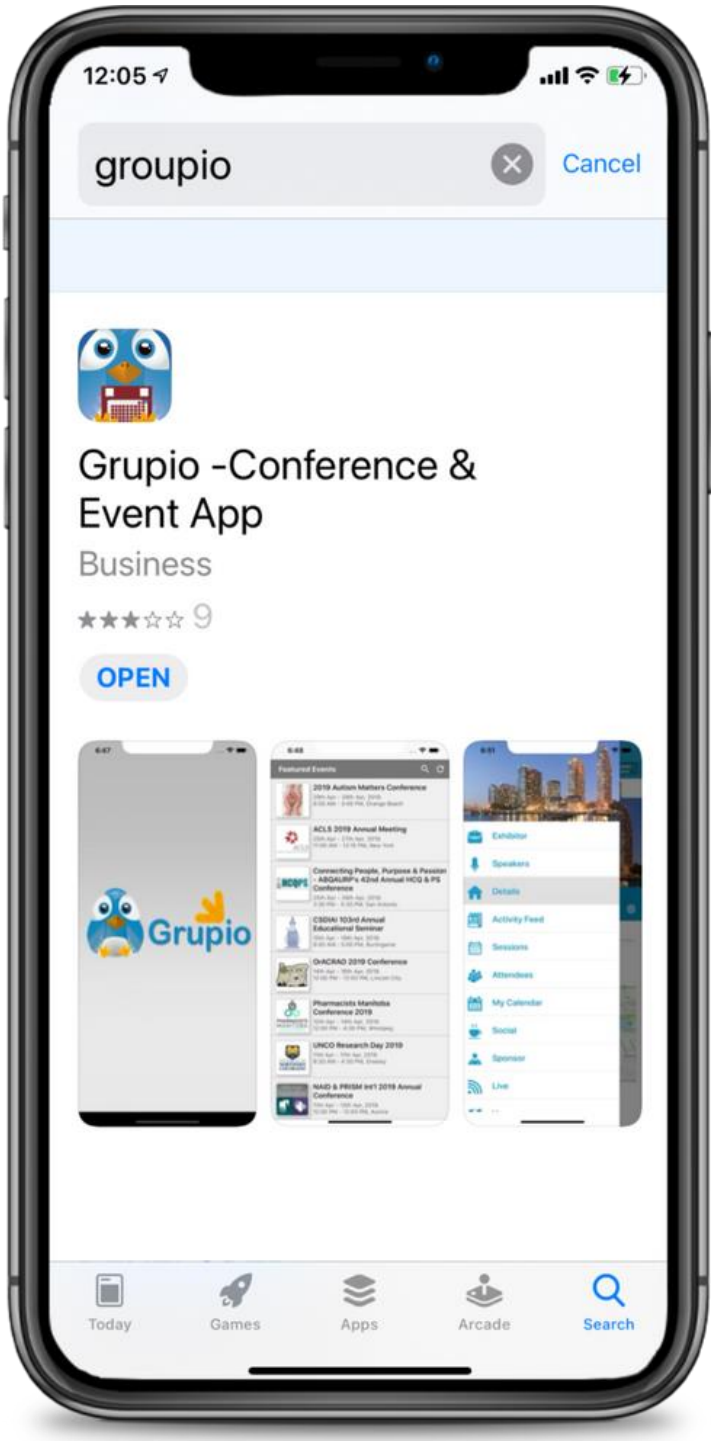

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EVENT SCHEDULE

THE SESSIONS ARE SPONSORED BY

COLLEGE OF BASIC AND APPLIED SCIENCES

MIDDLE TENNESSEE STATE UNIVERSITY

16th Annual Tennessee STEM Education Research Conference

January 13-14, 2022

Thursday-Friday, January 13-14, 2022

Thursday, January 13, 2022

12:00pm Registration Opens

- Register at Downstairs Atrium Info Desk

12:000pm– 4:30pm Poster Session Setup

- Presenter Setup in Upstairs Atrium

1:30pm– 3:30pm Refreshments

- Served Upstairs Atrium

1:00pm– 2:30pm Early Career Panel

- Located in SCI 1006

2:00pm– 3:00pm Session 1

Room 2 SCI 1190

- Computational Thinking: Engaging Students in STEM During the Age of COVID-19
- The Impact of Parental Involvement in STEM Activities for Children from Low Socio-Economic Backgrounds

3:00–3:15pm Break

3:15–4:15pm Session 2

Room 1 SCI 1191

- Trailblaizing the Way to Campus Climate Change
- Leveraging Mathematics Identity in Pursuit of Computing Identity: Results of a Literature Review

Room 2 SCI 1190

- A Phenomenological Exploration of the Role of Identity in a Data Analysis Task
- Group Reflection on Mathematical Creativity in Proving

4:15–4:30pm Break 4:30–

6:00pm Poster Session

- Located in Upstairs Atrium

6:00–8:00pm Dinner

- Served in Downstairs Atrium

8:00pm– 9:00pm Keynote Presentation

SCI 1006

- The Impacts of a Foregrounding Equity Research Agenda

Friday, January 14, 2022

7:30am Registration Opens

- Available at Downstairs Atrium Info Desk

8:00am– 9:00am Breakfast

- Served in Upstairs Atrium

9:00am–10:30am Session 3

Room 1 SCI 1190

- Biology Graduate Student Experiences with COVID-19 and Social Unrest
- Undergraduate Anatomy & Physiology Student Definitions of Learning, Understanding, Studying, & Memorizing
- Evaluating open-note examinations: student perceptions and preparation methods in an undergraduate biology course

Room 2 SCI 1003

- The Tale of Brody and the Jamie's Colleague Task
- Examining the Perceived Helpfulness of Instructional Practices and Assessment for International Students and English Language Learners in Undergraduate Mathematics Courses
- Parsing Meaning from Symbols in Undergraduate Mathematics

Room 3 SCI 1191

- Intersections: Reading STEM in Tennessee Elementary Schools
- Reflections on the co-development and initial implementation of a preschool robotics program: Listening to teacher and caregiver voices
- Faculty Awareness of Inclusivity and Diversity Needs within STEM Classrooms

10:30am–10:45am Break

10:45am– 12:15pm Session Four

Room 1 SCI 1190

- Impact of Small Group Structure on Discussion About Socioscientific Issues in an Introductory Biology Course
- Engaging Female High School Students in New Frontiers of Computing
- ELL students' discursive moves that lead to knowledge construction in a POGIL-based chemistry class

Room 2 SCI 1003

- Revising the Assessment Structure in a Mathematics Methods Course: A Means to Move Authority
- Student Voices and Reflections on their Mathematics Teacher Preparation Programs
- Preservice Secondary Teachers' Reasoning about Static and Dynamic Representations of Function

Room 3 SCI 1191

- Design of evidence based training in STEM online pedagogies
- Expanding Future Faculty's Repertoires to Incorporate an Entrepreneurial Mindset
- COVID-19 and the incoming STEM student: The effect of the pandemic on student self-efficacy and identity

12:15pm–1:30pm Lunch

1:30pm– 3:00pm Session Five

Room 2 SCI 1190

- Sources of authority for mathematics students in an introduction to proof course
- Exploring the Potential for Integrating Place-Based Education and Modeling Pedagogies in 6th Grade Science Classes

Room 3 SCI 1191

- Classroom Manufacturing Project to Support Work-Based Learning
- Precision Mentoring through The Research on Science Education (ROSE) Network Fellowship: A Strategy for Effective Professional Development for Community College Instructors.
- Developing 3D standards-aligned assessment tasks for the Next Gen PET curriculum

EARLY CAREER PANEL

THE EARLY CAREER PANEL IS HELD
THURSDAY, JANUARY 13, 2022 FROM 1:00PM-2:30PM
IN THE SCIENCE BUILDING ROOM 1006

THE EARLY CAREER PANEL IS SPONSORED BY

EAST TENNESSEE STATE UNIVERSITY

Center of Excellence in STEM Education
Department of Mathematics & Statistics

EARLY CAREER PANEL

We are so excited to kick off this year's conference with a brand new event! The Early Career Panel is being sponsored by East Tennessee State University's Center of Excellence in STEM Education. One of the priorities of the conference is to be welcoming and beneficial for graduate students and those who are early in their career. The poster session is a part of the conference that often draws predominately from this category or at least is easily accessible to it. Now, this Early Career Panel will be an additional event that we hope will be a great way to kick off the conference. One of the things we hope to encourage through these events is opportunities to network. We want to bring together people at all different levels of their career so regardless of where you are, please plan to come to the panel and the poster session to support and connect with other researchers.

PANEL MEMBERS

Stephen Robinson
Tennessee
Tech University

Sarah Bleiler-Baxter
Middle Tennessee
State University

Joshua Reid
Middle Tennessee
State University

Kehinde Helen Orimaye
East Tennessee
State University

KEYNOTE

SPEAKER

DR. MARILYN STRUTCHENS

THE KEYNOTE ADDRESS IS HELD
THURSDAY, JANUARY 13, 2022 FROM 8:00PM-9:00PM
IN THE SCIENCE BUILDING ROOM 1006

THE KEYNOTE SPEAKER IS SPONSORED BY

Mathematics and Science Education
Doctor of Philosophy Program

Keynote Speaker

Dr. Marilyn Strutchens

Emily R. and Gerald S. Leischuck Endowed Professor and Mildred Cheshire Fraley Distinguished Professor of Mathematics Education

Department of Curriculum and Teaching, Acting Department Head

Auburn University

The Impacts of a Foregrounding Equity Research Agenda

Dr. Strutchens' address will focus on the impacts of conducting equity-based research. She will discuss the underpinning themes and theories related to her research. She will also share the major impacts of her and her colleagues' work on students, teachers, administrators, mathematics teacher educators, mathematicians, parents, and mathematics education as a whole. Furthermore, she will discuss how this work has implications for other STEM fields.

Marilyn Strutchens, Ph.D is the chair of the Advisory Committee for the Directorate for Education and Human Resources or the National Science Foundation. She is a past Advisory Board Member for the AAAS initiative --Stimulating Research and Innovation in STEM Teacher Preservice Education, funded by the NSF Robert Noyce Teacher Scholarships Program. Dr. Strutchens has also served as a Board Member for the National Council of Teachers of Mathematics (NCTM) from 2015 -2018, president of the Association of Mathematics Teacher Educators [AMTE] (2011 –2013) and a member of the Executive Board of Directors for the Conference Board of Mathematical Sciences (2012 – 2014). She received the 2017 Judith Jacobs Lectureship from the AMTE.

Dr. Strutchens has participated in several national initiatives, including the NCTM's Principles to Actions Toolkits (writing team) and AMTE's Standards for Preparing Teachers of Mathematics (writing team). She is the leader for the Clinical Experiences Research Action Cluster for the Mathematics Teacher Education-Partnership, a coalition of 100 universities organized by the Association of Public and Land-grant Universities to transform secondary mathematics teacher preparation.

Dr. Strutchens was the Co-PI and co-director of TEAM-Math (Transforming East Alabama Mathematics). TEAM-Math was a National Science Foundation-funded Math and Science Partnership between Auburn University, Tuskegee University, and 14 school districts in East Alabama. She also directed TEAM-Math's Secondary and Elementary Teacher Leader Academies funded by NSF's Noyce program, and the TEAM-Math and AMSTI-AU Professional Mathematics Learning Communities Partnership.

A major theme of her work is linking research to practice and practice to research. Her goal has been to conduct research that illuminates what happens in the classroom to effect positive and equitable change. Her work shows the importance of hearing the voices of the key constituents involved in the mathematics education of students and the school, societal, and race/ethnicity factors that influence students' achievement.

She served as the editor or co-editor for several books including *Educating Prospective Secondary Mathematics Teachers,* AMTE's Second Monograph Series, the 2012 special equity issue of the *Journal of Mathematics Teacher Education*, the National Council of Teachers of Mathematics' *Focus on High School Mathematics: Fostering Reasoning and Sense Making for All Students,* and *Changing the Faces of Mathematics: Perspectives on African Americans*. She has also authored and co-authored numerous book chapters and journal articles.

She has an undergraduate degree in fashion merchandising and a masters' and Ph.D. in mathematics education from the University of Georgia.

ORAL PRESENTATIONS

AUTHORS AND ABSTRACTS

S²ERC
SOUTHEASTERN STEM EDUCATION RESEARCH CONFERENCE

2022

Oral Presentation: COVID-19 and the incoming STEM student: The effect of the pandemic on student self-efficacy and identity

Josh Forakis

Joe L. March

.Mitzy Erdmann

University of Alabama at Birmingham

As a part of an ongoing investigation into the effect of general chemistry laboratory interventions on student persistence in STEM, we have collected student data on constructs relevant to STEM persistence since the fall of 2019. With the onset of the pandemic, we shifted our focus to understanding the effects of COVID-19 on STEM persistence. Our initial findings suggest that target constructs were not significantly affected by the onset of the pandemic, but long term analyses are needed to understand the pandemic's full impact on STEM students. The present work offers a comparison of three incoming student groups with varying proximities to the onset of COVID-19. At the beginning of the fall 2019, 2020, and 2021 semester, students were asked to complete a 30-item survey with measures of science self-efficacy, science identity, and intention to pursue a career in STEM. The results of each semester's data collection were compared. Results indicate a significantly lower science self-efficacy score among the fall 2021 cohort as compared to the previous year's cohorts, but their intention to pursue STEM increased significantly. The results suggest current STEM freshman are inspired to pursue STEM, but have missed out on some scientific experiences due to the pandemic. STEM educators should consider ways to foster the development of self-efficacy to more effectively prepare students for STEM careers.

Oral Presentation: Student Voices and Reflections on their Mathematics Teacher Preparation Programs

Natasha Gerstenschlager

Dr. Hope Marchionda

Western Kentucky University

Pre-service secondary mathematics teachers take a variety of mathematics, education, and/or mathematics education courses in their programs (Darling-Hammond et al., 2005). The courses and structure of the program are heavily tied to the institutional context. Local institutional contexts are always looking to improve their programs to enhance the recruitment and retention of students, as well as improve the overall teacher education experience. The broader teacher education community has argued that innovation of teacher education programs be focused on the humanization of learning and teaching (Ellis et al., 2019). Student voices and perspectives are an important, yet often overlooked, component in the process of instructional changes related to improving these programs (Allen & Peach, 2007). In this session, we report on our findings from student voices and perspectives on their beliefs about how their program is preparing them or has prepared them to be teachers. To situate this, we will also describe the specifics of our mathematics teacher preparation programs.

Methods

A survey was sent to our current undergraduate middle-grades mathematics education and/or secondary mathematics education students and former graduates from these programs from the last 10 years. In all, we had 69 participants. The survey collected demographic information in addition to open-ended and Likert-scale questions about their experiences in the program. Examples of these open-ended questions follow (note, these were versions written for current students, former students were altered appropriately).

- What about the program do you feel will have the most/least impact on your practice as a teacher?
- What courses have you most/least enjoyed and why?

Additionally, there were more questions specific to only former students, who now have teaching experience.

- If you are currently teaching, please describe your style of teaching and why that is your approach to teaching mathematics.

Finally, participants were asked to use the scale of strongly agree, somewhat agree, neither agree or disagree, somewhat disagree, or strongly disagree to rate the following.

1. Given my teacher preparation at University X, I feel prepared to_____.

    a. Teach mathematics in a student-centered way.

    b. Inquire into my students' mathematical thinking.

    c. Assess students' mathematical knowledge.

    d. Prepare mathematics lessons.

    e. Solve mathematical problems.

    f. Support diverse students and diverse student thinking.

    g. Make connections between mathematics content.

Findings and Participant Engagement

Preliminary findings indicate that students in and from the program experienced disconnects between their mathematics content courses and their mathematics education courses. Further, they identify a disconnect between what they are told is good pedagogy and what they observe in the field. Additionally, most students either strongly agreed or somewhat agreed with

Conclusions and Implications

This work provides initial steps in building program reform that is rooted in students' voices and reflections of their program. Moreover, implications from this work will inform the teacher preparation research community about perspectives on their education which can be used to understanding, from a student point of view, if programs are achieving their goals.

References

1. Allen, J. M. & Peach, D. (2007). Exploring connections between the in-field and on-campus components of a preservice teacher education program: A student perspective. *AsiaPacific Journal of Cooperative Education*, 8(1), 23-36.

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Oral presentation: Revising the Assessment Structure in a Mathematics Methods Course: A Means to Move Authority

Alyson Lischka

Jennifer Webster

Middle Tennessee State University

Dr. Natasha Gerstenschlager

Western Kentucky University

Assessment of learning is a required aspect of pedagogy in any course. Traditional forms of assessment which utilize summative assessments and assign letter or numerical grades to course tasks prevail in higher education (Buhagiar, 2007; Rojstaczer & Healy, 2012) and have historically served the purpose of "selection and certification" (Buhagiar, 2007, p. 39). Traditional assessment is most often used as a tool for control within a system structured around rewards and punishments (Buhagiar, 2007; Kohn, 1999). This traditional system of assessment is contradictory to the ideals of autonomy and model building set forth in constructivist teaching (Buhagiar, 2007; Steffe & D'Ambrosio, 1995) and does not support equitable practice. In this presentation, we share how one instructor disrupted the traditional assessment practices in her mathematics methods course and how this change supported prospective teachers' reflective practice and authority for learning. This presentation focuses on answering the following research question: How does aligning assessment models with constructivist teaching practices promote prospective teachers' authority over their own learning?

The first presenter revised her mathematics methods grading practice to remove all numerical values for activities completed in order to align her constructivist teaching philosophy (Kastberg, 2014; Steffe & D'Ambrosio, 1995) with her assessment system. Instead of assigning traditional percentage or number grades on assignments, prospective teachers received written feedback on their work and were informed of their progress toward expectations for each task through written and verbal feedback. Revision of work was encouraged and assignments involving reflection on their work were interspersed throughout the course. At two points during the course, prospective teachers summarized their progress and defended the letter grade they should be assigned for the overall course, according to a rubric that emphasized growth, reflection, and improvement. To answer the research question, we collected the following data: prospective teacher course journals, audio recordings of class conversations, transcripts of final one-on-one evaluation conferences, an instructor journal, transcript of a whole group interview on grading practices conducted by the third author, and other submitted student work with written instructor feedback.

In our qualitative analysis of this data, we found that the shift from a traditional assessment system to the revised assessment structure provided opportunities for the prospective teachers to take up authority in their own learning. Particularly, the ways in which the instructor

provided rich and regular feedback throughout the semester offered prospective teachers opportunities to revise and resubmit their work, developing prospective teachers' authority over their own learning. Additional findings indicate that rubrics and standards in the field of mathematics teaching (e.g., AMTE, 2017; NCTM, 2014) play an important role in transitioning authority from instructor to prospective teacher. This study is significant in informing the work of STEM teacher preparation about the ways the field can support prospective teachers to develop as professionals who evaluate their own growth as educators.

References

1. Association of Mathematics Teacher Educators. (2017). *Standards for preparing teachers of mathematics*. Available online at http://amte.net/standards

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Oral presentation: Preservice Secondary Teachers' Reasoning about Static and Dynamic Representations of Function

Demet Yalman Ozen

Samantha Fletcher

Jennifer N. Lovett

Middle Tennessee State University

Nina G. Bailey

Allison W. McCulloch

University of North Carolina at Charlotte

Hamid Reza Sanei

North Carolina State University

Dr. Charity Cayton

East Carolina University

The concept of function permeates all levels of mathematics and is a large focus of the high school curriculum. Central to the treatment of functions in high school is attention to characteristics of families of functions given their usefulness for mathematical modeling. This attention means that significant emphasis is placed on graphical representations of functions (i.e., static graphs on a Cartesian plane). Research has shown that when analyzing graphical representations of functions, students and teachers alike often attend to perceptual cues rather than the relationships between the variables the perceptual cues are representing (e.g., Moore & Thompson, 2015; Sinclair et al., 2009). The coordination of two quantities represented in a graph of a function and the ways they change in relation to each other is called covariational reasoning and has been identified as foundational for mathematical modeling as well as many calculus concepts (e.g., Carlson et al., 2002). Given the role that functions play in the high school curriculum, it is essential that preservice secondary mathematics teachers (PSMTs) develop covariational reasoning skills. Carlson et al. pointed to the potential of dynamic technologies to support those learning to apply covariational reasoning. Recent work with a particular dynamic representation of functions in one dimension, the dynagraph (Goldenberg et al., 1992), has pointed to its potential to elicit student reasoning about the ways in which independent and dependent variables vary and covary (e.g., Antonini et al., 2020; Sinclair et al., 2009). To that end, the purpose of this study was to examine the similarities and differences in the ways PSMTs reasoned about different representations of functions—static and dynamic.

This study situated within the context of a larger study investigating how PSMTs reasoned across static and dynamic representations of function specifically focused on two PSMTs' reasonings. Here we used a multiple case study design (Yin, 2017) to explore two cases, where each case was defined by the type of visual mediator (i.e., static and DIM) with which the students interacted. Semi-structured interviews (Goldin, 2000), each posed one of the visual mediators first, served as the main data source. Sfard's (2008) Theory of Commognition guided our analysis. Findings indicate that while static representations restrict attention given to covariation, dynamic representations support PSMTs' reasoning about covariation including making connections to how covariation is represented in static graphs.

References

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Oral Presentation: Developing 3D standards aligned assessment tasks for the Next Gen PET curriculum

Stephen Robinson

Paula Engelhardt

Meghan England

Tennessee Tech University

The intention of the Next Generation Science Standards (NGSS) [1] is to promote the learning of science via the integration of three dimensions; Disciplinary Core Ideas (Content), Science and Engineering Practices, and Crosscutting Concepts. Many states have adopted these standards, or based their own on the same framework. The Next Generation Physical Science and Everyday Thinking (Next Gen PET) curriculum materials [2] are a coherent set of inquiry-based materials explicitly designed to give students learning experiences in the physical sciences that integrate all three of these dimensions. Some combination of these materials is currently used in physics, physical science, or science methods courses for prospective elementary and middle school teachers in over 50 colleges and universities across the country.

In order to confirm the intent of the Next Gen PET materials to facilitate three-dimensional learning, we carried out an analysis of a subset of the materials using the EQUIP rubric [3]. This analysis confirmed a deep integration of all three dimensions and showed the materials themselves to be exemplary in these terms. However, another aspect of the EQUIP rubric examines whether the methods used to assess student learning are also compatible with the intent of NGSS. Therefore, we used the 3D-LAP [4] to analyze all the test bank questions that accompany the Next Gen PET materials. This analysis revealed that most items being used for assessment did not integrate the three dimensions. Indeed, most items were only one dimensional, testing only for content knowledge.

As an alternative assessment strategy we are developing assessment ‘tasks’ that have the same structure as the Next Gen PET activities. Each section of these tasks addresses one or more three-dimensional performance objectives, and is structured to allow students to demonstrate their three-dimensional learning in investigating and explaining new, but related, phenomena. In this presentation, we will describe the path that led us to this point, the process we are using to develop and evaluate these tasks, and preliminary results.

References

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Oral presentation: Evaluating open-note examinations: student perceptions and preparation methods in an undergraduate biology course

Emily Driessen

Abby Beatty

Cissy Ballen

Auburn University

Vision and Change: A Call to Action, outlined six core competencies intended to guide undergraduate biology education, including the application of science and critical thinking (1). However, the common way we evaluate student competencies (i.e., via closed-note multiple-choice testing) rewards and emphasizes the memorization of details rather than the development of critical-thinking abilities (2-4). Open-note testing has the potential to shift this emphasis (5), as other disciplines have demonstrated (6). Proponents of open-note testing applaud the ability to focus students on gathering and critically analyzing material from multiple sources rather than storing information for quick retrieval (7, 8) and its ability to decrease student testing anxiety (9-11). Opponents of open-note testing criticize their inability to increase student performance (12, 13), however, these claims are contested (14, 15). As we know exam performance is highly correlated with exam preparation methods (16-19), we investigated student perceptions and preparation methods in an undergraduate biology course for open-note versus closed-note examinations. Specifically, we investigated the following two research questions: (1a) How do students perceive open-note exams impact their exam scores, anxiety, and amount they studied? (1b) How do these perceptions relate to performance outcomes? (2a) How do students prepare for open-note exams? (2b) How do these responses relate to performance outcomes? We surveyed students directly after each of their three open-note exams. The surveys included Likert-scale questions about student anxiety, time spent studying, and perceived performance on each of these open-note exams. Likert-scale results demonstrate students perceived increased exam scores, decreased anxiety, and claimed to study less for these open-note exams. The students who had greatly reduced anxiety due to open-note tests significantly outperformed those students who had unchanged anxiety, and students who did not change the amount of time they studied for tests outperformed those students who greatly decreased their study time for these open-note tests. To answer our second question, the survey also asked one open-ended question: How do you think you studied differently for this open-note exam compared to how you would study for a closed-note exam? We created nine codes through first- and second-cycle analyses to analyze the open-ended question and then used linear-mixed effects models to assess for a relationship between codes and student performance. Open-ended survey response results suggested many students adapted their study habits by focusing on note preparation and broad conceptual understanding rather than rote memorization. The students who focused on note preparation significantly outperformed those students who did not focus on either of those study habits. Our results provide a solid starting point for understanding how undergraduate STEM students prepare for a scalable, novel type of examination that lends itself to a more genuine experience in science, as compared to memorization.

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Oral Presentation: Impact of Small Group Structure on Discussion About Socioscientic Issues in an Introductory Biology Course

Brock Couch

Grant Gardner

Middle Tennessee State University

Introduction

Socioscientific issues (SSI) are scientific issues that can be perceived as controversial due to differences between individuals' beliefs, culture, and political views related to the science (1,2). Since SSI are situated in the larger society, they are important for individuals, both within and outside of science, to understand and effectively communicate information surrounding them (3,4). For SSI interventions in formal classrooms, a major goal is to help improve students' Vision II scientific literacy, which emphasizes student discourse (5). Because Vision II literacy is focused on discourse, integrating instructional practices, such as small learning groups, that create opportunities for students to discuss SSI are needed. Although small groups provide students the opportunity to discuss SSI, they are complex to conduct successfully due the numerous factors influencing student learning (6). It is vital to gain a greater understanding of how small group learning is impacting the co-construction and negotiation of group responses to SSI. Therefore, the purpose of this study is to gain an understanding of how small-group dynamics within SSI discussion contexts influence group negotiation and response to SSI.

Research Question

How do cooperative small group conversations about SSI develop during a class period?

Collection and Methods

In the Spring of 2021, I collected video and audio data on thirteen cooperative small groups of an introductory biology course for majors in Zoom breakout rooms. I also used a survey to collect demographic data on students. To code the transcripts of small group discussions, I will use Chui's framework (7) that captures group problem-solving processes. Chui's framework utilized three dimensions, which each contain three codes, that capture students' individual actions during group problem-solving: evaluation of previous action, knowledge content, and invitational form.

To help gain an understanding of group dynamics, I will use a combination of social network analysis and epistemic analysis (8). Social network analysis (SNA) looks at the underlying structure of a network by focusing on the interactions between individuals (e.g., students talking to each other) in a network (e.g., cooperative small group). Epistemic network analysis (ENA) is used to understand connections between codes within an epistemic frame (9). An epistemic frame is defined as, "a pattern of associations among knowledge, skills, habits of mind, and other cognitive elements that characterizes communities of practice, or groups of people who share similar ways of framing, investigating, and solving complex problems" (10). By using a combination of SNA and ENA, I will be able to capture the impact group composition has on the flow of information within a small group.

To understand differences in epistemic and social networks for different groups at the same timepoint, I will compare epistemic measures (i.e., density, weighted centrality) and social

measures (i.e., density, reciprocity, weighted centrality) using an Kruskal-Wallis comparison followed by pairwise comparisons, if the Kruskal Wallis is statistically significant. F statistically significantly different ($p < .05$) pairwise comparisons, or those approaching significance, I will provide a qualitative description of the epistemic and social networks.

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Oral Presentation: Undergraduate Anatomy & Physiology Student Definitions of Learning, Understanding, Studying, & Memorizing

Staci Johnson

Southern Wesleyan University

Aradaryn Singleton

Clemson University

Biology education research often utilizes common educational terms without providing specific definitions. As an example, the word "learning" is commonly discussed and used by instructors and education researchers within the life sciences ("A Call to Action Summary of Recommendations," 2009; Bonsaksen, Brown, Lim, & Fong, 2017; Eagleton, 2015; Hattie & Donoghue, 2016; Momsen et al., 2013). Overall, education researchers use the terms learning, understanding, memorizing, and studying within interviews and surveys and may or may not define them in publications. In data collection, definitions for this term are often assumed rather than specifically defined, introducing a significant threat to interpretive validity, or the extent to which researcher interpretation of data reflects the actual meaning intended by the participants (Walther, Sochacka, & Kellam, 2013). Given the broad use of these terms in instructional and research settings, ensuring congruent definitions by researchers and their participants is imperative for effective application of research to practice. A previous study from our lab found students to hold a number of definitions for each of these terms (Johnson & Gallagher, 2021).

To strengthen communicative and interpretive validity and avoid misapplication of research results, it is important to know how students perceive and use these important terms. This qualitative study attempts to answer the following question: "In what ways do undergraduate A&P students define the terms learning, understanding, memorizing, and studying?"

During academic year 2020-21, we collected survey responses from 33 participants from five different institutions while enrolled in an A&P course. The survey asked participants for their definitions of educational terms, including learning, understanding, memorizing, and studying through open-ended items on the Microsoft Forms platform. The research team assigned code categories based on previous work by Johnson & Gallagher (2021) or created new codes, when appropriate. Coding decisions were then discussed to consensus by all coders.

Learning definition groups highlighted processes, outcomes, or a combination of both a process and outcome. Understanding definition groups focused on specific outcomes, but these ranged across multiple Bloom's taxonomy levels. Memorizing definition groups highlighted the outcomes of short-term memory or simple recall while sometimes employing the process of repetition. Studying definitions varied the most as they connected various specific actions to multiple outcomes. These findings continue to highlight the need for communication between students and instructors with regard to term usage. In addition, future research in biology and physiology education should be careful to provide working definitions of these terms to ensure communicative and interpretive validity and to promote transferability and repeatability of findings.

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Oral Presentation: Precision Mentoring through The Research on Science Education (ROSE) Network Fellowship: A Strategy for Effective Professional Development for Community College Instructors.

Penny Carroll

Jeff Morris

Christina Morra

Samiksha Raut

University of Alabama, Birmingham

Trent Sutton

University of Alaska Fairbanks

Jefferey T. Olimpo

University of Texas El Paso

Abstract:

Evidence-based teaching strategies in the STEM classroom increase learning outcome achievement and student retention, broadly improve student course evaluations, and reduce the achievement gap for underrepresented student populations. While the benefits are ubiquitously accepted, significant barriers exist limiting instructors' implementation of evidence-based teaching strategies in their undergraduate STEM classrooms. These barriers are felt disproportionately by community college and other primarily undergraduate institution (PUI) educators. The Research On STEM Education (ROSE) Network Fellowship Program was established to address these barriers by providing training, precision mentoring, funding, and bridges to continuing support. The fellows work with the ROSE Network Fellowship Mentor to build a firm pedagogical foundation, and employ precision mentoring to develop a fellow-driven course redesign plan. The fellow then enacts the change outlined in the redesign plan with resources provided by the Fellowship and, upon reflection on the success of the changes, becomes a change agent to perpetuate and expand evidence-based teaching practices at their home institution. We will explore the foundation on which the ROSE Network Fellowship was built, what we learned from the Pilot cohort, the format for current and future ROSE Network Fellows cohorts and our plans to evaluate the diverse goals of this fellowship program.

Oral Presentation: Intersections: Reading STEM in Tennessee Elementary Schools

Chloe Freeman

Thura Mack

University of Tennessee, Knoxville

Tiffany Collins

Willow Brook Elementary School

Too often, STEM and literature are considered to be entirely different subjects of education; this prevents students from recognizing the interconnectedness between the fields. Wilson-Lopez and Gregory (2015) state that "Engineering—the E in STEM education—has traditionally been paired with science, technology, and mathematics, but reading and writing are also its natural partners" (p. 32). By engaging the intersection of literature and STEM to deepen student understanding, educators can better address all types of learners' academic needs while bridging the pipeline between kindergarten and post-secondary education. Demonstrating the relationship between subject areas allows students to solve everyday problems by building a strong foundation in the Engineering Design Process (EDP) at an early age. The EDP is an interchangeable five-step process for engineers and students to demonstrate effective problem-solving skills. The Reading Design Challenge (RDC) was intentionally built to showcase this cross-curricular connection of subjects and use the EDP at elementary schools. We focused on the following research question:

1. How does reading STEM and implementing the Engineering Design Process affect students' understanding and connection to STEM?

By implementing the RDC program, students became problem solvers, project creators, and entrepreneurs. Student engineers worked in collaborative groups or independently to design creative solutions to problems as they interacted with literature that was read in supportive learning environments. As a result, students were able to fully engage with the material and demonstrate their comprehension of readings by solving challenges based on exposure to various STEAM-related careers, jobs, or entrepreneurship opportunities. The RDC prepared and equipped underrepresented individuals in our school community with 21st-century college and career readiness skills to become the future groundbreaking leaders of tomorrow.

The infusion of STEM instruction as a supplement to the literature curriculum provides an opportunity for educators and valued stakeholders in the community to shift the learning culture and transform the Create, Design, and Invent initiative across various educational settings. The reading STEM model could benefit students across various Tennessee elementary schools and provide more opportunities for students' STEM literacy beyond the classroom.

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Oral Presentation: The Tale of Brody and the Jamie's Colleague Task

Kristen Roland

Appalachian State University

News reporting of data and models reached unprecedented levels in 2020 as the world battled the coronavirus pandemic. Making sense of this information requires global citizens to be knowledgeable consumers of data and results of statistical inference. Understanding the results of statistical inference and in particular, the use of the p-value cutoff, $p < 0.05$, for publication of scientific results, is ubiquitous (Hubbard, 2016, 2019). Both the American Statistical Association and the American Psychological Association have issued statements cautioning against the overreliance of p-values in scientific research (see: Wasserstein & Lazar, 2016; Wilkinson, 1999) and strongly suggest reporting point and interval estimates and/or effect sizes accompanied by a measure of uncertainty (Wasserstein et al., 2019).

Communicating and understanding the uncertainty associated with confidence intervals (CIs) requires a robust understanding of the interpretation of 1) the CI and 2) the confidence level (CLvl). Complicating matters, the idea of CIs is a highly complex set of concepts within statistical inference requiring an individual to understand fine details in the derivation of the confidence interval procedure: the fundamental difference between an estimator and an estimate which are used to estimate an unknown value of a parameter. The authors hypothesize that developing a deep understanding of the difference in the estimator and estimate will help individuals be better consumers and producers of statistics. This presentation presents an interesting case ("Brody"), selected from a larger study (n=11), that provides evidence of the high-level connections among concepts necessary for a robust understanding of CIs.

The theoretical perspective and underlying framework for this case study is based in the development of a concept image for the concept of confidence intervals. Roland and Kaplan (in review) present a detailed hypothesized concept image for the concept of confidence intervals. The concept image was derived from formal statistical definitions and associated curricular concepts. Statistical concept clusters were defined to describe the connections between the curricular concepts in the formal statistical definitions. These clusters are contained within "sub" concept images that compose the entire concept image for the concept of confidence intervals. This presentation will focus on the development of the connection between one of the statistical concept clusters, Estimator/Estimate, and the two "sub" concept images for the interpretation of a CI and C-Lvl.

Brody was the only participant in the larger study who demonstrated robust conceptualizations of the concept of a CI and the concepts of the interpretation of a 1) CI and 2) C-Lvl. These conceptualizations, however, seemed to be isolated: there did not appear to be connections between the concept of a CI and how to interpret the C-Lvl and the CI. Brody was able to make the connections among these conceptualizations through three tasks (including the Jamie's Colleague task), which were designed to explore the Estimator/Estimate concept cluster

and its hypothesized connections to the "sub" concept images of the interpretation of a CI and a C-Lvl. This talk will present evidence of the necessity of this curricular concept cluster and its connections to the "sub" concept images.

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Oral Presentation: Sources of authority for mathematics students in an introduction to proof course

Jordan Kirby

Sarah K Bleiler-Baxter

Middle Tennessee State University

Samuel Reed

Lander University

Authority in a classroom becomes shared when participants of a community beyond a textbook or instructor present valid mathematical ideas that hold authority in their context (Amit & Fried, 2005; Gerson & Bateman, 2010; Langer-Osuna, 2016). Mathematical proof presents an opportunity for shared authority when participants in a community communicate their ideas and develop an argument for the validity of a statement (Burton, 1998; Inglis & Mejia-Ramos, 2009; Weber et al., 2014). When mathematicians participate in mathematical proving activities, they often focus on participating in communities and build upon definitions to validate a statement (Burton, 1998). We are interested in what authority sources students rely on to validate a mathematical claim when authority becomes shared in an introduction to proof classroom. Further, we are interested in comparing the practices of students in this shared setting to how mathematicians practice mathematical proving. To answer this question, we have the following research question. (Author, under review)

1. What are the sources of authority manifested within small-group conversations related to proof construction? (i.e., Upon what do students base their decisions?)

To answer this question we recorded video data of students in small-group settings as they worked together to prove tasks in an introduction to proof course. Students were placed in groups of 3-4 to prove conjectures in 9 different proving episodes. After working collaboratively on their proofs, student groups presented their proofs to their peers for feedback. We then as a research team looked over the 9 episodes holistically to examine themes that emerged for authority sources of students in this shared environment. This was accomplished by looking for times in the episodes when students made decisions as a group to move their proof forward before presenting their group's proof to their peers.

Our results produced four themes of authority attended to by students: (1) The coursedeveloped rubric for proof writing as authority, (2) Peers' confidence (and the need to produce a product) as authority, (3) Form and symbols as authority and (4) Logical structure and mathematical definition as authority.

In our presentation, we will provide excerpts from group-proving discussions that highlight the themes developed from our inductive analysis. Then we will make connections between students' sources of authority and mathematicians' sources of authority, informed by previous empirical work on mathematicians' practice (Burton, 1998).

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Oral Presentation: Parsing Meaning from Symbols in Undergraduate Mathematics

Tony Nguyen

Eliza Gallagher

Clemson University

> "Symbols act as an interface, in two ways: between our own thoughts and those of other people; and between those levels of our mind which are difficult to access, and those easily accessible. Though the power of mathematics lies in its knowledge structures, access to this power is dependent on its symbols." (Skemp, 1989, p. 90)

Since mathematical symbols and the associated syntax represent mathematical concepts and the relationships between them, learning mathematics requires one to perform symbol sense-making, an uncovering of perceived meaning(s) from a symbolic statement. As mathematics is foundational for STEM majors, a better understanding of exactly how learners perform elements of this sense-making can serve as a lever to improve mathematics communication and learning. Not much is known about the symbol sense-making process, especially at the post-secondary level.

We present early results from an in-progress grounded theory study designed to address **"How do STEM undergraduates make sense of mathematical symbols in post-secondary mathematics?"**

Drawing on interview data collected between March and October 2021, we report the emerging understanding of ways that students leverage context in parsing meaning from symbol-heavy mathematical statements. What do students attend to within the statement? How do students extract meaning? What additional information do students desire when facing ambiguous or unfamiliar symbols? Our preliminary and evolving results indicate that specific course contexts influence the meanings students extract from symbols, both supporting and constraining the range of meanings that are inferred.

> "So when you're being taught something and you come across a symbol that you don't know, you have a very easy method of acquiring, you know, knowledge on what it is and what it means and how it operates---the person who's teaching you." - Calculus I Student

However, symbol-heavy courses may still be overwhelming, with students relying on procedural memorization of how symbols function within that specific course context, rather than developing an understanding of the meaning encapsulated by those symbols.

> "The biggest thing is just that, only 5 days into this course, everything is reduced to seemingly meaningless/arbitrary representational letters and symbols that I don't know, and I get the feeling I've been thrown directly into the deep end while missing some extremely foundational key knowledge. While I am capable of completing the homeworks just by identifying the techniques used in the examples and applying them to the problems, I still have absolutely no idea what the math I'm doing actually means. I know I'm changing little numbers in squares with only an inkling of a clue what those numbers and squares represent." - Linear Algebra Student

In the absence of a course context, students look for clues within or surrounding the statement. When those are missing, the interpretation of the symbols is heavily influenced by prior experiences and inferred context. While the model of symbol sense-making is still emerging, these preliminary findings start pointing to the necessity, but not sufficiency, of a well-established context for students to begin to add meaning to new or unfamiliar symbols in undergraduate mathematics.

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Oral Presentation: Faculty Awareness of Inclusivity and Diversity Needs within STEM Classrooms

Grant Gardner

Olena T. James

Sarah K. Bleiler-Baxter

Gregory Rushton

Fonya C. Scott

Amanda Lake Heath

O. Theresa Ayangbola

Middle Tennessee State University

Research Significance: U.S. universities are becoming increasingly demographically diverse (Mather et al., 2019). However, STEM disciplines within these universities often grossly underrepresent this diversity (Estrada et al., 2016) continuing to be white- and male-dominated (Makarova et al., 2019). Arguments have been made that faculty play a large role in perpetuating this inequity due to how they choose to teach STEM subject matter (Margott & Kettler, 2019). This has led to national calls for implementation of inclusive evidence-based teaching methods that can sustain or increase participation of diverse groups (Lo et al., 2020). Before we can make significant progress as a field on the implementation of inclusive pedagogy, we must first understand what faculty bring to the table (i.e., what they are aware of) when it comes to issues of diversity and inclusion in STEM classrooms. Program Description: This work focuses on a descriptive case study of eight STEM faculty (three from Biology, three from Chemistry, and two from Mathematics) who participated in a year-long STEM inclusive pedagogy professional development (PD) program called Teaching TRIOS (Author, 2021). The PD was designed as a faculty learning community with the primary goal of raising faculty awareness of how to meet the needs of diverse student populations and to become responsive to those needs by integrating inclusive pedagogical practices into their teaching. This was done through interdisciplinary whole-group and intradisciplinary small-group discussions about inclusive practices. Research Question: What aspects of diversity and inclusion were STEM faculty most aware of during the year-long PD on the topic of inclusive pedagogy? Data Collection and Analysis: To answer our research question we draw on data from semistructured individual interviews with the eight STEM faculty during three time-stamps of the project (early, mid, late). We analyzed data by highlighting emergent themes as well as coding with an a priori framework, the Conceptions of Diversity Framework (Suarez et al., 2021). Preliminary Findings. Early in the PD, participants were aware of student diversity, particularly racial and ethnic diversity due to the nature of their content and that they attempted to be respectful of this diversity and engage with different

groups. Examples of faculty reflection in this regard include the following two excerpts: “I have talked about racial ethnic and religious and political identities [in my classes] because these are things that intersect with the material quite a bit.” “...effective [inclusive] teaching looks to me like ...An environment in which students with all sorts of different identities are engaged equally.” In this presentation, we will share interview excerpts, such as those above, and classify them according to the Conceptions of Diversity framework (Suarez et al., 2021). This will allow us to provide an in-depth picture of the potential awareness of undergraduate STEM faculty with respect to diverse student needs in their classrooms. This work is significant for the field as it provides depth to our understanding of faculty awareness and conceptions surrounding diversity and inclusion. Moreover, this work will support future professional developers in planning for effective PD.

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Oral Presentation: Reflections on the co-development and initial implementation of a preschool robotics program: Listening to teacher and caregiver voices

Margaret Quinn

Lori A. Caudle

University of Tennessee, Knoxville

Luci Diego

Francia Zelaya

Centro Hispano de East TN

Porscha Settlemeyer

Dana Schumpert

Taja Welch

Kyli Wooten

Darelene Greene

Knox County Schools

The CRRAFT Partnership

Computational thinking (CT), as related to computer science, represents an important 21stcentury skill that is becoming more prevalent in PK-12 classrooms and schools (e.g., Bers, 2021). In early childhood (i.e., preschool) contexts, a growing body of research evaluates the efficacy of instructional programs, curricula, and interventions to support early CT (e.g., Lavigne et al., 2020; Saxena et al., 2020). Nonetheless, looming challenges exist, namely in creating developmentally and contextually appropriate computer science experiences and programs for young children. Additional research is necessary to ensure that educational efforts effectively broaden CT learning opportunities, rather than perpetuate the exclusion of historically and systematically marginalized groups in STEM. We describe a research practice partnership aimed at developing a culturally relevant computing program through meaningful integration of teacher and caregiver contributions.Some research has documented early childhood teachers' CT and broader computer science education practices (e.g., Otterborn et al., 2020; Wang et al, 2021), but less is known about experiences children may have with computer science at home with caregivers. Despite the fact that caregivers represent equally important stakeholders as facilitators of children's learning and development, the voices of parents are often not considered. Further given caregivers' and teachers' positions and knowledge of individual children in their care, teachers and caregivers (and not developers/researchers) are experts in what is possible as it relates to new programsand curricula. The proposed presentation will

demonstrate the ways in which teachers as well as caregivers alongside university partners co-constructed, implemented, and evaluated a culturally relevant robotics program for preschoolers. Specifically, thispresentation will address the following questions:(1) What are the ways in which preschool teachers and caregivers approached constructing a program for preschool robotics for home-based and school-based experiences?(2) How did they experience enactingthe program in its first stage?(3) In what ways did teachers and parent-leaders work together to involve other families, make changes to the program/provide feedback, and work with university partners to enact the program?In a series of meetings and workshops over the course of a summer and first quarter of an academic year, teachers and caregivers (parent-leaders), supported by university faculty/research team, co-constructed a culturally relevant robotics program for preschoolers, including the initial development of stages in which home and school activities, experiences, and instructional foci would be aligned. Following these initial stages, teachers and caregivers provided insights about their experiences with the co-development and the initial implementation of the program.Transcripts and field notes from partnership meetings were analyzed using an open-coding process (e.g., Miles & Huberman, 1994) to identify patterns in teachers' and caregivers' individual and collective experiences. Findings describe the themes in the types of feedback/insights that teachers and caregivers shared (e.g., use of materials) and the modalities that supported the communication of such insights/feedback (e.g., comments on documents; text messages). As presenters andauthors of this presentation, teachers and caregivers will share, directly, how the partnership model supported them as co-developers and co-creators of the culturally relevant robotics program.

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Oral Presentation: Engaging Female High School Students in New Frontiers of Computing

Akos Ledeczi

Brian Broll

Vanderbilt University

Shuchi Grover

Looking Glass Ventures

Tiffany Barnes

NCSU

Building on the foundations set by the AP Computer Science (CS) Principles course, this project seeks to dramatically expand access, especially for high school girls, to the most exciting and emerging frontiers of computing, such as distributed computation, the internet of things (IoT), cybersecurity, and machine learning, as well as other 21st century skills required to productively leverage computational methods and tools in virtually every profession. Creating pathways that stimulate high school learners' interest in advanced topics with the goal of building a diverse, gender-balanced, future-ready workforce is a crucial and impactful imperative addressed in this work. We are designing a new, modular, open-access curriculum called Computer Science Frontiers (CSF) that provides an engaging introduction to these advanced topics in high school that are currently accessible only to CS majors in college. CSF can serve as an alternative for the long running AP CSA course that focuses on object-oriented programming with Java. AP CSA is suited to high school students who want to major in CS in college and is dominated by male students (The College Board 2018). CSF is being designed to engage female students in advanced, yet exciting CS topics through relevant real-world projects and applications. The project leverages NetsBlox (Broll et al. 2017), a powerful but easy-to-use visual programming environment that has been shown to increase engagement and interest in computing (Ledeczi et al 2019). Additionally, NetsBlox supports effective collaboration and as such, is uniquely suited to both in-person teamwork and virtual classrooms. Our research questions focus on if and how advanced computing methods can be introduced in high school; how pedagogies involving project-based activities around real-world, multidisciplinary problems work to increase female students' interests in computing; and which advanced topics work better than others in terms of difficulty level and engagement. Through studying the impact of innovative computing tools and curricular units on learning, attitudes, interests, and collaboration of students (and especially young women), the project seeks to advance discovery and understanding to aid the cause of broadening participation in technology-related careers as well as the future of work at the human-technology frontier. We have piloted the various curricular modules in summer camps. We had secondary education teachers, with experience teaching the AP CSP course, act as camp instructors. To prepare the educators, our team facilitated a week of online synchronous professional development (PD) that leveraged the Teacher-Learner-Observer (TLO) model

(Goode et al. 2014). In the TLO model, participants spend time playing the roles of teacher and learner while the PD facilitators observe and guide a structured reflection after each TLO session (Catete et al. 2020). The goal of this PD was for the educators to co-design and critique our developed curriculum. In turn, pairs of teachers conducted four 2-week long online summer camps to a total of 40 students. Two camps focused on IoT and while the other two covered ML. Student engagement was very high and post survey results indicated an increased interest in both computing and STEM related careers.

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Oral Presentation: Examining the Perceived Helpfulness of Instructional Practices and Assessment for International Students and English Language Learners in Undergraduate Mathematics Courses

Sarah Otterbeck

Matthew Voigt

Clemson University

In order to better support the rising number of International students and English Language Learners in the postsecondary education system, researchers must consider what these students find the most helpful for their learning. Of particular importance are students' perceptions of learning in their mathematics courses, since these courses often serve as gatekeepers rather than gateways to educational excellence (Bryk and Treisman, 2010). Research has shown that having an International student body on campus brings a level of prestige to the college but there is little attention given to their experiences after admittance (Lee, 2010). International students experience a lot of challenges when attending a U.S. university such as adapting to new food, climate, community as well as adjusting to the academic norms for reading and writing which may be different than their past educational experience(Gebhard, 2010; Lee, 2010). English Language Learners (ELLs) also experience challenges both academically and linguistically (Bergery et al., 2018; Mulready-Shick, 2013). It has been shown that for ELLs there is more time and energy expended in their coursework as they are learning coursework at grade level and trying to become proficient in English (Mulready-Shick, 2013). While there has been a lot of research on how International students and ELLs experience college life in the US, the question of what they find helpful for their learning is often left out. Thus our guiding research question is: *What do international students and ELLs report as helpful in undergraduate mathematics classes?*

We draw on data from the Student Post-Secondary Instructional Practices survey (Apkarian, et al., 2019) administered as part of an NSF-funded project examining introductory mathematics courses across 12 universities (n=19,192). For this analysis, we examined a subset of questions regarding how students ranked different forms of assessment and instructional practices as helpful to their learning, see Table 1 for list of questions asked. We used descriptive statistics to examine practices and assessments they reported as most and least helpful to their learning in the mathematics classroom. Of the 19,191 total participants there are 1,003 students who self identified as an ELL and 1,507 students who self identified as an International student.

Our initial analysis found that both International students and ELLs reported that the most helpful form of assessment was exams and that most helpful instructional practices were when instructors guided the students through major topics. Interestingly there are differences in how International students and ELLs ranked the helpfulness of the instructional practices. Generally International students ranked the different instructional methods as more helpful than how the ELLs ranked the helpfulness of those same methods. We see International students overall ranking each item in forms of assessment and instructional practices as more helpful than all of their peers. Students identifying as non-International and non-ELLs generally ranked instructional methods at the same level of helpfulness. Initial findings also showed that all students surveyed ranked the instructional practice of constructively criticizing their peers as least helpful to their learning.

Our findings help inform decisions about course design to better align with the needs of our International students and ELLs. According to the Universal Design for Learning framework, courses should have activities that meet the needs of all students. Suggesting that learning should be individualized (Bergery et al., 2018) and therefore instructional practices and forms of assessment should be thought about as helpful tools of learning for all students. Being mindful of what practices and assessments International and ELLs find helpful will create a more inclusive class.

Table 1:

The subset of questions looked at to determine what is most helpful to International Students and ELLs in mathematics classrooms.

Forms of Assessment		
To what extent are the following course elements helpful to your learning in the course.	*Online Homework*	1: Not applicable 2: Not helpful 3: Somewhat helpful 4: Very helpful
	Written Homework	
	Exams	
	Worksheets	
Instructional Practices		
For each of the following activities, please indicate how much each helps your learning in the course.	*I listen as the instructor guides me through major topics*	1:Not very helpful 2: Somewhat helpful 3: Very Helpful
	The class activities connect course content to my life and future work	
	I receive immediate feedback on my work during class (e.g., student response systems such as clickers or voting systems; short quizzes)	
	I am asked to respond to questions during class time	
	I talk with other students about course topics during class	
	I constructively criticize other student's ideas during class	
	I work on problems individually during class time	
	I work with other students in small groups during class	
	The instructor knows my name	
	Class is structured to encourage peer to peer support among students (e.g., ask peer before you ask instructor,	

	having group roles, developing a group solution to share)	
	I receive feedback from my instructor on homework, exams, quizzes, etc.	
	My instructor uses strategies to encourage participation from a wide range of students	

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Oral Presentation: Trailblazing the Way to Campus Climate Change

Nicole Finch

Karen High

Clemson University

Clemson University conducted a climate survey in 2007 and found that people of minoritized groups rated the climate significantly lower than their counterparts. This climate survey demonstrated a need for change at the university. Tigers ADVANCE was founded to enact a strategy to change the environment of Clemson University. ADVANCE programs are funded by NSF to advance STEM Faculty Women. While the focus and NSF funding at Clemson is on STEM faculty, the provost provided additional money for non-STEM faculty to participate to broaden the scope of impact that the project has on campus climate at Clemson University. Through this program, Trailblazers was founded. Trailblazers is an academic year long program for faculty aimed at mentorship and leadership growth. Faculty attend a series of monthly workshops centered around leadership styles. They also carry out a leadership project with a team. These leadership projects aim to highlight gender and minority gaps at Clemson University to further enact change within the University. Two research questions are focused on when looking at the effect of the Trailblazers program on the Clemson University campus climate:1.How does participation in the program affect participants' confidence in leadership identity?2.Can academic year long research projects promote administrative change at Clemson University? The 2020-2021 finale meeting of Trailblazers shone a light on the transformation of the participants in the Trailblazers program by having them write Leadership Statements incorporating what they had learned through the program. Through these Leadership Statements participants expressed how much they had grown through the program and their aspirations to work toward equality. The 2021-2022 Trailblazers coalition will write these statements at the beginning, middle, and end of their program year to document their growth through the program. Many of the leadership project teams have promoted major administrative change at Clemson University. One highlight of this is a team that focused on gender bias in Teaching Evaluations. They found that statistically, a question on the Teaching Evaluations asking students to rank their professor's overall teaching effectiveness yielded drastically lower scores for female teachers than for their male counterparts, even when the teachers scored similarly on the rest of the Teaching Evaluations. This was a major problem as this particular question was used as an indication of merit for Tenure and Promotion for many departments. This leadership team reported their findings to the Provost's office, resulting in the removal of this question from teaching evaluations. A sub-committee of the Faculty Senate Scholastic Policy committee was also formed to further examine the issues of gender disparity within Teaching Evaluations. The Trailblazers program at Clemson University is helping to promote members of our community in their leadership identity as well as highlighting projects that can promote real administrative change. Programs like this are necessary to continually assess the campus climate to ensure that all members of the campus community are supported equally.

Oral Presentation: The Impact of Parental Involvement in STEM Activities for Children from Low Socio-Economic Backgrounds

Trinetia Respress

Owen Johnson

Sosiak Makonnen

Londee Boyd

Tennessee State University

Parental and family involvement is one of the most important factors to increasing the effectiveness and quality of education. This involvement is important because both the home and school environments affect a child's development(Kuru & Taskin, 2016).Many research studies have reported on the significance and effect of the family in the process of education. In these studies, it was found that parental involvement increased student's learning and academic success (Jeynes 2015; Castro et al. 2015).Despite the many studies that have reported on the positive benefits of parental involvement, this is not always a reality for children who live in lower-social economic environments. Social economic status remains a relevant theme of great interest to those who study child development. This interest is derived from the belief that those from high socio-economic backgrounds have the finances to pay for an array of services and social connections that will benefit the child. Whereas, children from low socio-economic backgrounds lack access to similar resources and experiences, thus putting them at risk of developmental problems. The NASA Funded TSU Minority University Research Education Project (MUREP)works to address this problem by empowering parents/families of children from low socio-economic backgrounds to work effectively with their children in the area of STEM. Family empowerment sessions are provided to parents and other family members with effective strategies, emerging technologies, and access to STEM and NASA resources. These sessions are offered through a series of activities, such as parent café, family workshops, family nights, and family STEM days. The program targets economically disadvantaged communities in the zip code areas of North Nashville within a 10-mile radius of TSU, including 37207, 37208, 37209, and 37218.These zip codes have a high number of children living below the poverty level and include schools where children have low rates of math and science proficiency. The TSU evaluation plan has one research question and two objectives that address parental/family engagement. The research question evaluates the impact of participation in TSU-MUREP program on parent/child engagement in STEM activities at home and school. Data was collected through quantitative procedures and analyzed through the use of descriptive statistics. Project findings suggest that the TSU-MUREP program exceeded its research objectives to engage parents in STEM activities at home and school. Additionally, 93% of the parents and guardians of the TSU MUREP children reported that they felt that they had an impact on their child's engagement in STEM activities.

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Oral Presentation: A Phenomenological Exploration of the Role of Identity in a Data Analysis Task

Jennifer M. Seat

Middle Tennessee State University

Over the past twenty years, Teaching Mathematics for Social Justice (TMSJ) has emerged as a well-documented phenomenon of practice in mathematics education. Thinking about the knowledge and experience of the participant is crucial to the planning of productive experiences in the TMSJ context, with one important consideration being the role of the lived experiences in how participants will interact with social justice tasks. Findings from the literature of statistics education can be helpful in understanding how lived experiences can influence student interaction in a social justice context. Investigations by Wroughton et al. (2013)and Queiroz et al. (2017)demonstrated that statistical content and student experience cannot be separated. Another critical linkage is the dependence of TMSJ on data (Frankenstein, 2012; Skovsmose, 2012). The use of data sets in TMSJ can be fixed, meaning that activities direct attention in a single direction to focus student attention. An interesting finding from early childhood data literacy, however, offered that questions about data can limit the ability of students to fully express ideas(Schwartz & Whitin, 2006). This limitation may also happen when using TMSJ tasks. One teaching strategy from statistics education that could remove the issue of a fixed point in a social justice lesson would be to facilitate a social justice lesson guided as an investigation. MacGillivray and Pereira-Mendoza (2011) indicated that when students design authentic investigations, there are significant positive implications for both the written and verbal communication of statistical ideas. These statistical ideas are interesting when combined with ideas like lived experiences in social justice tasks, which is the focus of this presentation. The question that guides the current research is: In what ways do student identities and lived experiences influence the interpretation of an open statistical task in a TMSJ context? To investigate this question, a task-based interview (Goldin, 1997) was designed to examine the ways in which students interacted with a multivariate social justice data set. The task was centered around the prompt, “Use the data provided to find a noticeable difference or demonstrate there is no noticeable difference between groups represented in the data.” Participants used a from the GSS survey (https://gssdataexplorer.norc.org/variables/vfilter) loaded into CODAP (https://codap.concord.org/). Initial design work showed that participant background was influential in the interpretation of the task by participants. To continue to develop and refine the research task, participants from a mid-sized public university were used. The interviews were initially analyzed based on self-identification data provided by participants to find incidents of participant use of identity in the interpretation of the GSS data. These relevant incidents were combined to generate an aggregate set of data that was analyzed for themes. This presentation discusses the phenomenological analysis of the aggregate set. Themes as well as anonymized samples from the data will be provided for exemplars to demonstrate the process. While final data collection and analysis are still on-going at the time of submission, the researcher has reason to believe the new findings will broaden and deepen the findings from the design phase.

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Oral Presentation: Expanding Future Faculty's Repertoires to Incorporate an Entrepreneurial Mindset

Jennifer Brown

Karen High

Clemson University

Stephanie Cutler

Sarah Zappe

The Pennsylvania State University

Professional development of graduate students as future faculty is challenged by the current model for graduate student mentoring. One major shortfall of the current model is that faculty advisors all too often see the interactions as very transactional, and focus mentoring efforts on the needs of the institution and research agenda, neglecting the reality that graduate students are individuals with diverse needs and challenges. On a national scale, there is a lack of effective graduate student mentoring (Denecke et al., 2017; Gardner and Barnes, 2014), especially for those from traditionally underserved communities in STEM. The report Graduate STEM Education for the 21st Century (2018) from the National Academies of Sciences put forth several avenues for revising mentoring practices as well as a call to move away from the current institution-focused model of mentoring and instead embrace a more individualized, student-centered approach. Additionally, graduate students rarely experience engagement in holistic professional development, though this have been advocated strongly within faculty development (Whittaker & Montgomery, 2014; Sutherland 2018). Traditionally, graduate student professional development activities and mentorships nearly always follow a segmented approach, which faculty development is also known to suffer from (Sutherland, 2018). In a segmented approach, professional development activities typically focus only on technical skills specific to a given lab without highlighting connections to more transferable professional skills such as research management and entrepreneurship. These disjointed experiences disadvantage graduate students, because while they can teach or conduct research effectively, they may not be able to aptly market their strengths to future employers, hindering career advancement. By encouraging an entrepreneurial mindset as a framework to integrate all major components of a successful faculty career, graduate students can gain a competitive edge when launching their early careers. In this study, graduate students from two major R1 institutions were surveyed to answer the following research questions:1) What do graduate students identify as entrepreneurial attributes that are critical to success? 2) How do graduate students currently connect entrepreneurial attributes/practices with the major pillars of faculty life (teaching, research, and leadership/service)? The purpose of this stage of data collection was to establish a baseline understanding of current graduate students' relationship with entrepreneurship and how it may relate to their future careers as faculty members. Nearly all students involved indicated a desire

to pursue a career in academia, which was expected based on the sampling scheme. Survey results indicated that graduate students generally lacked a depth of understanding of entrepreneurial attributes and skills. Few students were able to form connections between some aspects of faculty life and entrepreneurial attributes and articulate how such attributes might benefit their professional development. Perhaps most importantly, several opportunities to revise existing mentoring practices to clarify connections and address these gaps in knowledge were identified through emerging themes in the survey responses. These findings will help guide the re-development of multiple courses for future faculty at both institutions with a focus on holistic professional development using an entrepreneurial mindset framework.

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Oral Presentation: Group Reflection on Mathematical Creativity in Proving

Amanda Lake Heath

Sarah K. Bleiler-Baxter

Jordan Kirby

Middle Tennessee State University

Mathematical creativity is a critical component of the field of mathematics (Karakok et al., 2015; Mann, 2006; Nadjafikhah et al., 2012; Sriraman, 2004; Zazkis & Holton, 2009). In particular, there has been a recent call for undergraduate mathematics programs to encourage more creative thinking in their major courses (Schumacher & Seigel, 2015). Although research on mathematical creativity has grown rapidly in recent years (Heath, 2021; Sriraman, 2017), this research has primarily focused on mathematical creativity as an individual. However, proving, an essential and creative aspect of the work of professional mathematicians (e.g., Karakok et al., 2015; Sriraman, 2004), is often conducted in a social setting (Sriraman, 2004). As proof-based undergraduate mathematics courses incorporate more collaboration, it is critical to support and investigate the creative growth of students in group proving settings. In this study, we investigate the relationship between collaboration, creativity, and reflection in proving through the use of the Creativity-in-Progress Rubric (CPR) on Proving (Savic et al., 2017). Although the CPR was designed for individual student use, we have previously investigated the potential implementation of the CPR in a group setting and have posited three suggestions for adapting the CPR (Heath, 2021). Before we can investigate the impacts of group reflection on creativity in proving, we must determine whether the CPR, with suggested modifications, can be successfully used by students engaged in group proving. Thus, this study seeks to answer the question, how do undergraduate students use the CPR (with modifications) to reflect upon their experiences in collaborative proving? We collected audio and video data of group proving and group reflection using the CPR, completed group and individual CPRs, and survey data from 11 students enrolled in an undergraduate introduction-to-proofs course at a southeastern public university. For the purpose of this study, we thematically analyzed the video data of two of three research groups as they worked to assess their group's creativity using the CPR. We compared the approaches used by these groups as they worked to reach consensus regarding their placements within each of the subcategories of the CPR. Two themes emerged from this process. First, we noted a general difference in approach between group 1 and group 2 with respect to how they reached a consensus on scoring the CPR. Group 1 drew upon specific examples from their proof to collaboratively reach a consensus on their placement on the CPR, while group 2 generally reached consensus without much discussion. Second, both groups had instances wherein one group member doubted the group's engagement with a subcategory (e.g. tools and tricks, posing questions/making suggestions) of the CPR and another group member reminded the group of a moment in the group's proving process when they did engage with that subcategory. In this session, we will provide data excerpts illustrating these two themes, summarize additional observations regarding how students used the CPR as a group reflection tool, and hypothesize how group reflection on collaborative proving experiences may influence student learning.

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Oral Presentation: Computational Thinking: Engaging Students in STEM During the Age of COVID-19

Tisha Gaines

Belmont University

In an age where self-expression is limited to emojis, hashtags and TikTok videos; an instant connection is needed to provoke student interest. However, students' attention levels vary widely based on factors like motivation, emotion, enjoyment and time of day[4]. As the COVID-19 pandemic progressed, the number of Zoom screentime hours was added to this list. As a result, the incredible task of educators over the past 15 months required transitioning to a student-centered learning experience that was simplified, interactive, and adaptable. Using Computational Thinking Techniques(CTT), we implemented instructional strategies which assist students in decomposing STEM course content into manageable concepts to recognize patterns, use abstraction and construct feasible solutions for real-world problems[5]. This model will allow us to build upon the current positive student outcomes seen in grade improvement, student-instructor rapport and content engagement.Research has indicated that, " Quantitative and data-centric problems can be solved using computational thinking and an understanding of computational thinking will give students a foundation for solving problems that have real-world and social impact[3]." Continuing our efforts with the use of Computational Thinking Techniques(CTT), we focused on five participants during a summer program that assisted students in STEM topics to observe if similar outcomes can be seen for research engagement. The participants selected were both high school and university undergraduate students[1]. Projects that we highlighted included: "Predicting Facial Masking Efficacy Using Wireless Sensor Networks", "Object Recognition using Color Coding Detection" and "Environmental Impact in Visual Sensor Networks Based on Energy Consumption" which had both mathematics and computer science elements. Plans to engage larger undergraduate cohorts with CTT will be integrated into intro-level computing, data science and mathematics courses as well as Big Idea micro-projects during theSpring2022semester [2].The data obtained in this study assisted in evaluating our research question's goals seenbelow.1. How can computational thinking improve student engagement for STEM course content via in-person and online learning?2. How can computational thinking techniques be used to improve engagement in STEM research projects in secondary and undergraduate students?

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Oral Presentation: Leveraging Mathematics Identity in Pursuit of Computing Identity: Results of a Literature Review

Tim Ransom

Tyler Sullivan

Eliza Gallagher

Matthew Voigt

Clemson University

STEM identity is a well established construct linked to student retention (Patrick & Borrego, 2016), learning motivation (Jones & Skaggs, 2016), and predicting student career choice after graduation (Cribbs, Hazari, Sonnert, & Sadler, 2020; Simpson & Bouhafa, 2020). However, STEM is not monolithic. It is increasingly important to attend to disciplinary differences when establishing and understanding specific domain identities (e.g., the extent to which you see yourself as a "math person" or "engineering person") in order to best prepare professionals for their intended field. This is particularly important since the strength of domain identities developed during post-secondary education is also highly correlated to degree completion (Perez, Cromley, & Kaplan, 2014). Computing identity is of emerging interest as the technology sector rapidly expands across the globe and the nascent field of computing education is established. The origins of computing education are tightly linked to the discipline of mathematics because the first computing departments were composed of mathematics faculty transferred within the same institution (Denning & Tedre, 2019). As identity frameworks have yet to be wellestablished or extensively studied in the computing domain, we leverage the origins of computing education to draw on the well-established body of literature related to math identity frameworks. Mathematical identity has been significantly studied in the last two decades (Darragh, 2016) and is showing significant transferability to describing other STEM domains through translation of the underlying constructs (Godwin, 2016). Strengthening mathematical identity has been observed to positively affect outcomes for STEM students during their college careers, even outside of their math courses (Cribbs et al., 2020). Further, mathematical identity has been successfully translated to the domains of biology, chemistry, physics (Hazari, Sadler, & Sonnert, 2013), engineering (Godwin, 2016), and science 1 teaching (Cribbs et al., 2020). This translation has yet to be examined for computing students. Within the mathematics identity literature there is a rich variety of frameworks (Langer-Osuna & Esmonde, 2017), providing a wealth of prospective lenses for studying computing identity in educational spaces. As such we are driven by our research focus: In what ways can mathematics identity frameworks accelerate the development of computing identity framework development? We address this research focus by mapping reviews of mathematics identity literature to a systematic literature review of computing education using search terms drawn from the relevant constructs in mathematics

identity. For example, mathematical identity is strengthened by interest in applications of mathematical knowledge to real-world situations (Gresalfi & Hand, 2019; Owens, 2008). In the computing education literature, there is considerable work on performance and persistence outcomes related to interventions making direct use of real-world problems as motivation for computing tasks (Cooper & Cunningham, 2010). Situating results from the computer education research literature within potentially translational identity constructions from the mathematical identity research literature provides a starting point for a model of computing identity. This initial model can serve as a foundation for future foundational and intervention studies investigating computing identity.

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Oral Presentation: Biology Graduate Student Experiences with COVID-19 and Social Unrest

Joshua W. Reid

Middle Tennessee State University

A. Kelly Lane

University of Minnesota-Twin Cities

Zoe Koth

Northern Arizona University

During the 2020-2021 academic year, university stakeholders have dealt with the impacts of the pandemic, as well as the transition to Emergency Remote Teaching (ERT; Al-Taweel et al., 2020; Hodges et al., 2020), and the impacts of social justice movements occurring across the United States. While there has been some reporting on how the COVID-19 pandemic has affected medical students (Ahmed et al., 2020), there is a lack of research focused on the pandemic-related and social justice-related needs of graduate students, who are key contributors to the university community through their research, teaching, mentorship, and service (e.g., Connolly et al., 2016; Nicklow et al., 2007; Sundberg et al., 2005). In this study, we sought to illuminate pandemic-related and social justice-related needs of biology graduate students, based on their experiences of events that transpired in 2020. Two research questions guided our study: How has mentorship changed for graduate students over the course of the pandemic, beginning with immediately before, in both their teaching and research responsibilities? We used the Life-Grid Interview technique as described by Rowland et al. (2019) to better understand their experiences related to mentorship, support, and expectations during the COVID-19 pandemic and other 2020 events. We analyzed interview transcripts using a combination of inductive qualitative content analysis and thematic analysis (Braun & Clarke, 2012; Elo & Kyngäs, 2008; Saldaña, 2015). By using an inductive approach where the codebook is not predetermined but rather emerges from the data, allowed us to remain open to new ideas that emerge from the participants' lived experiences (Elo & Kyngäs, 2008). Meanwhile, thematic analysis allowed us to identify larger themes (Braun & Clarke, 2012). Our findings indicated several themes related to changes in mentorship for biology graduate students during 2020 (for brevity, we provide two here). First, we identified several modes of mentorship received by the graduate students. These included mentoring for career preparation, research/laboratory skills, and non-disciplinary mentorship typically related to social justice issues (i.e., the murder of George Floyd). Second, the students in our study indicated a sense of struggle related to balancing their personal and work life. Often the graduate students discussed this in terms of finding a balance between research and social responsibility. Take together, these findings suggest a multidimensional aspect to mentoring graduate students. More specifically, our study identifies areas that graduate

students seek mentorship outside of their researcher and teacher responsibilities. Understanding how graduate students' mentorship is impacted by national events and remote mentoring can provide insights beyond 2020 including how to improve mentorship of graduate students who deal with personal tragedies, the need for temporary or permanent remote mentorship (such as by a faculty member with multiple university appointments or positions), and how to respond to future events such as other pandemics or natural disasters. The findings from this study provide an overview of how biology graduate students experienced 2020, particularly related to their mentorship.

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Oral Presentation: ELL Students' Discursive Moves that Lead to Knowledge Construction in a POGIL-based Chemistry Class

Shaghayegh Fateh

Joshua Reid

Oluwatobiloba Ayangbola

Amy Phelps

Sylvia Zakher

Gregory Rushton

Middle Tennessee State University

Zubeyde Demet Kirbulut

Harran University

The United States is becoming increasingly diverse and the population of English Language Learners (ELLs), has been increasing rapidly in this country (Washburn, 2008). A review of the previous literature shows that ELL students in science classes may encounter challenges such as unfamiliarity with science class norms and expectations, feelings of not being valued and socially accepted, and instructors' lower expectations of them (Lee, 2005; Terry & Irving, 2010). Active learning is suggested as a solution for addressing these challenges by previous studies (Theobald et al., 2020). Active learning is a broad concept and instructors decide about implementing an active learning method based on the class size, the available physical space, and the time they have for activities (Zayapragassarazan & Kumar, 2012). Therefore, it seems necessary to investigate how different forms of active learning environments impact the ELL population. Process Oriented Guided Inquiry Learning (POGIL) is one of the socially mediated approaches to promote engagement of students and fosters opportunities for student collaboration in small groups (Rodriguez et al., 2020). POGIL is based on a social constructivist framework which posits that students need to be actively engaged in the learning process while interacting with their peers to construct, evaluate, and apply new knowledge (Amineh & Asl, 2015). The research literature is scant on how English Learners navigate the academic and pyschosocial aspects of the POGIL experience in a POGIL-based class. In this study, we focused on ELLs' engagement in a small group conversation and investigated their contribution in discursive moves that can lead to knowledge construction (e.g., reasoning, presenting a claim, or explanation seeking). Specifically, we asked the following research question: How do ELL students engage in discursive moves that can lead to knowledge construction during the small group interactions in a POGIL-based general chemistry class? The data was collected during the Spring 2021 semester in a General Chemistry hybrid class at a large, Southeastern, teaching-

focused university with an enrollment of 24 students including 6 ELLs who agreed to participate in this study (international students (ELL-I, n=2) and those who have been in the US for their K-12 education (ELL-K-12, n=4)). This hybrid course mainly utilized POGIL and students worked in small groups of four. The small group discussions in the breakout rooms were video recorded to capture the interaction among students. All videos were transcribed and qualitatively analyzed using a codebook related to key discursive moves for knowledge construction developed by the research team. Frequency of qualitative codes was quantified and compared among participants. Preliminary findings suggest that there is a remarkable difference between ELL-I and ELLK-12 in terms of small group interactions. ELL-I have the least contribution in small group interactions and in those key discursive moves for knowledge construction. For instance, we found that ELL-I students tended to invoke less reasoning and explanation discourse moves compared to ELL-K-12 students. Our data suggest that while ELL students represent a growing population in our undergraduate STEM courses, there might be nuances to the intersectionality of their identities that differentially influence their small group interactions. This finding can inform instructors that ELL-I might need special support for engaging more in group interactions.

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Oral Presentation: Design of evidence-based training in STEM online pedagogies

Evelyn Boyd

Madison Pollock

Bridget Trogden

Claire Dancz

Elizabeth Flanagan

Becky Tugman

Karen High

Clemson University

Online learning is constantly expanding in higher education and with it there is a growing need for instructor training in online pedagogy and technology. An online course was developed for Science, Technology, Engineering, and Mathematics (STEM) graduate students, post-docs, and faculty members alike to learn about effective online teaching pedagogy. The course was designed to serve as both instruction and to assist in community building between participants. The final project of the course allowed participants to (re)design their own STEM course to be taught online. The course was developed by a team representing a broad array of STEM disciplines with experience in conducting discipline-based education research (DBER). Recruitment for the course took place via email. Potential participants were sent information about the course through campus listservs. The first cohort of this course was offered during the Spring 2021 semester and was composed of 4 faculty members, 11 graduate students, and 1 post-doctoral researcher (a total of 16 participants). Participants were broken up into small groups based on discipline. Each group had one faculty participant, and three graduate students or post-docs. The groups worked on the redesign project throughout the semester with additional individual assignments. Participants filled out applications that addressed topics of interest for participants; this allowed the development team the opportunity to tailor the course to meet the needs of the participants before the course began. Pre- and Post- evaluation surveys of the course were also developed with the pre-surveys being given at the beginning of the semester, and the post-surveys being given at the end. Survey questions pertained to course component satisfaction and effectiveness of the community built by the course. This information has helped the course development team in continually improving the course for future semesters. The research questions for this project are: • What are the effects on participant attitudes and motivation towards teaching STEM courses online after this training course? • How does combining faculty and future faculty in a course impact the course community? • How can a teaching STEM online training course be improved for future cohorts? Qualitative portions of the survey were

consensus coded by two members of the research team. Responses to questions about aligning this course with professional goals and goals for the course include re-design, deliverables/student activities, student engagement, effective online teaching, and effective teaching. The quantitative portion of the pre-survey included participant responses on each item's relationship to successful online teaching and learning, and post-surveys were also analyzed to determine participants' changes in attitudes and motivation. Applications, pre-and post-surveys, participant assignments, and reflections are all indicators of participant attitudes and motivations towards taking this course and the impacts of the mentoring. We found immediate effects on the participants in their pedagogical practices, and in how they hope to continue to engage with the course community and content as they advance to future semesters. The course will be offered again in the Spring 2022 semester with adaptations suggested by the first cohort

Oral Presentation: Exploring the Potential for Integrating Place-Based Education and Modeling Pedagogies in 6th Grade Science Classes

Sara Salisbury

Middle Tennessee State University

Humans are deeply embedded in the complex ecological and socio-ecological systems in which they live their daily lives. As a result, humans have positively and negatively impacted virtually all ecosystems on the planet (Alberti et al., 2003). Regardless of this reality, humans are largely blind to the relationships between themselves and their local and broader ecosystems (Bigelow, 1992). For children, engaging with, learning about, and connecting to their local ecosystems can have long-lasting and meaningful impacts on sustainable decision-making, career choices, and community engagement (Otto & Pensini, 2017). Though ecology is a critical subject for children to learn about, the nature of the field of ecology (e.g., interdisciplinary, fieldbased, variable, and contextualized) makes it difficult for educators to address in increasingly standardized and time-limited k-12 science classes. This often leads educators to simplify and decontextualize ecology topics and practices (Hmelo-Silver et al., 2015). To address current issues in the implementation of ecology education in k-12 science classes, and explore how various contexts can support students in learning about ecology topics and practices, this preliminary design-based research project sought to design and test an innovative ecology education instructional design. Specifically, the instructional design engaged 6th grade students (n=20) from a large middle school located in the South-Central Region of the USA in a weeklong ecology lesson that prompted students to investigate plant and animal diversity in their schoolyard ecosystem. We designed open-ended modeling activities from both science-as-practice (Hodson, 2014) and place-based education perspectives (Sobel, 2004), and sought to contribute to students' locally-embedded ecological knowledge (i.e., place knowledge). Students took part in multiple whole class and small group discussions, completed a schoolyard- based investigation of plant and animal diversity, presented research presentations that shared their results, and provided feedback based on the presentations. Through a qualitative analysis, our findings suggested students' place knowledge grew more complex by the end of the activity, and shifted from more human-centric to place-centric perspectives. We noted that mechanisms of change in this context included students encountering new-to-them species, and grappling with the nature and causes of variation in species diversity across the schoolyard. These results highlight the power of leveraging local places in ecology education and modeling contexts. Furthermore, results helped us refine our design principles and the next iteration of the instructional design to emphasize variation as the target investigation construct, and to pay attention to the interplay amongst disciplinary, material, and human agency that arises during the modeling process (Pickering, 1995).

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Oral Presentation: Classroom Manufacturing Project to Support Work-Based Learning

Alyssa Mullins

Tennessee Tech University

In 2013, Governor Haslam of Tennessee responded to the projection that 55% of the jobs in Tennessee would require some post-secondary education by the year 2025 (Tennessee Department of Education, n.d.). The resultant Drive to 55 initiative led to the development of several statewide programs such as Tennessee Reconnect, which provides funding for adults to go back to school to complete vocational training programs at Tennessee Colleges for Applied Technology) and Tennessee Promise, which provides funding for Tennessee high school graduates who meet eligibility criteria to complete two years of community college (Tennessee Board of Regents, n.d.). As part of the Drive to 55, the Department of Education decided to revitalize the statewide work-based learning program by implementing new policies, standards, and training, and by focusing on collaboration with local employers (McQueen, 2016). In 2021, Sequatchie County High School was awarded an Innovative High Schools Grant to fund a restructuring and expansion of their work-based learning program. Part of this expansion was to make contacts with local employers including manufacturers and establish partnerships to support work-based learning opportunities in the high school. Manufacturing USA and their network designates the first Friday in October each year as Manufacturing Day (Manufacturing USA, n.d.). Sequatchie County High School leveraged this designation to further their goals in the work-based learning program and to promote manufacturing as a career choice to students.

Using a 30-minute block during the school day over four days in one week, a hands-on project was designed to expose students to the manufacturing experience while providing information about local manufacturers. Fourteen teachers volunteered to participate in this program and their classrooms became a manufacturing facility for paper cars. The teacher was provided with all of the supplies they needed for their students to "manufacture" 25 paper cars. A PowerPoint presentation was developed and provided to teachers that included instructions and videos that accompanied each day's focus. The goal of the presentations was to expose students to jobs in manufacturing that require different levels of education, as well as showcase local industries. Each day a different group of students watched the presentation and assembled part of the car. At the end of the week, all the assembled cars were collected and exhibited in a common area in the school. Next to each car was a label displaying the names of the students who worked on each part of the car.

This action research project used surveys and qualitative observations to determine the impact of the Manufacturing Week activities. Data showed that teachers appreciated the structure and resources that were provided to teach their students how manufacturing worked. Some teachers modified the activity as needed during the week as the number of students fluctuated and school activities interfered. All teachers indicated that they would participate again and that

they valued the instructional time required to complete this project. Observation data showed that the students were engaged with the hands-on project and were able to see how quality control and overtime are real concerns in a manufacturing facility. They became familiar with how production lines operate by working on paper cars in stages and with students across "shifts." Students enjoyed showing others the cars they worked on. The work-based learning program received more exposure and students were encouraged to stop by the program office to explore possible work opportunities in the region.

Overall, the data showed that this project was a positive experience for teachers and students. This project was successful in introducing students to careers in manufacturing as well as local manufacturers. The success of this small-scale weeklong manufacturing focus has implications for other school-wide projects in math, English, and engineering with possible tie-ins to end-of-course content review. An anecdotal finding was that students were not as familiar with scissors and had poorly-developed fine motor skills, which made "manufacturing" some aspects of the car quite tedious. Some teachers speculated that perhaps this could be a result of a movement away from arts, crafts, and cursive in the elementary grades. Fine motor skills are used in job skills such as welding and machine controls and neglecting them in the lower grades could be detrimental to future job skills. Future research should study this further.

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POSTER PRESENTATIONS

AUTHORS AND TITLES

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Poster Session

1. WIP: Using the Lens of Faculty Development to Address Inequitable Graduation Rates in STEM Transfer Students: The First Stage in Building a Regional Research Collaborative. Jennifer S. Brown, Eva Grace White, Karen High
2. Promoting a "Community of Users" Among Children in a Preschool Robotics Program. James A. Larsen, Tabatha Rainwater, The CRRAFT Partnership
3. Perpetuating the Cycle: The Difficulty of Talking about Equity in Mathematics Education. Sharetta Bufford, Golnaz Arastoopour Irgens, Matthew Voigt
4. Parallel and Diverging Paths of Teacher Leaders in a Professional Learning Program. Andrea Reeder, Fatma Kaya, Brett Criswell, Gregory Rushton
5. Aviation Maintenance Students' Perceptions of Educational Technology During COVID-19. Tim Ransom, Eliza Gallagher, Katie Shakour, Kapil Chalil Madathil
6. Exploring the Effects of Mentoring on Faculty Self-Efficacy and Faculty Productivity Leading to Tenure and Promotion. Steven Edalgo, Karen High, Gary Lichtenstein, Cindy Lee, Cate Tedford, Joyce Main
7. Exploring Transfer Student's Perceptions of Their Transition Experience in Calculus 2 at a Large Land Grant Research Institution: A Schlossberg's & Tinto's Theory Approach. Steven Edalgo, Karen High,
8. Engineering Students' Perceptions of Learning Experiences during COVID-19 Pandemic. Matthew Sheppard, Aradaryn Singleton, Lisa Benson,
9. Developing the Developer in STEM Education. Jen nifer Seat, Olena T. James,
10. Investigating the Effects of Instructor Facilitation on Student Engagement in a POGIL Based General Chemistry Class. Karolin Abouelyamin, Joshua Reid, Demet Kırbulut, Gregory Rushton
11. STEM Major Attrition: The Case of the U.S. Air Force Academy. Wilson Gonzalez-Espada, Daniel S. O'Keefe, Jorge Valentine-Rodríguez, David Meier, Lachlan T. Belcher,
12. Building community and creating a space for vulnerability in discussions of inclusive pedagogy among STEM Faculty. Oluwatobi T. Ayangbola, Fonya C. Scott, Sarah K. Bleiler-Baxter, Grant E. Gardner, Gregory Rushton, Olena T. James, Amanda L. Heath

13. Enrollment Patterns Along Demographic Lines in AP STEM Course Taking in South Carolina. Wysheka Austin, Eliza Gallagher,
14. Impact of an Online Professional Development Community (APTeach) on Teacher Beliefs about Effective Science Teaching: A Mixed Methods Study. Fatma Kaya, Preethi Titu, Amanda S. Perez, Steven Berryhill, Song Jiecheng, Chinmay Kulkarni, Wei Zhu, David J. Yaron, Gregory Rushton
15. A comparison between community college and university students' acceptance and understanding of evolution. Rebekkah Riley, Elizabeth Barnes, Chloe Bowen, Sara Brownell, Jacqueline Cala
16. A Comparison of Religious Cultural Competence in Evolution Education Online versus In-Person and its association with Students Outcomes. Chloe Bowen, Alexa Summersill, Jamie Jensen, Sara Brownell, Elizabeth Barnes
17. Promoting High School Students' Understanding of COVID-19 Pandemic and Complex Systems via Agent-based Computer Modeling. Lin Xiang, Caroline Bennett
18. Exploring Undergraduate Biology Students' Attitudes and Science Communication about COVID19 and COVID19 Vaccines: The Influence of Major, Politics, Religion, and Race/Ethnicity. Laine Matthews, Mariana de Araujo Bryan, Thipphaphone Niravong, Ying Jin,
19. Cross-curriculum Biology and Mathematics Learning Community Outcomes at an HBCU. Qingxia Li, Thomas Gross, Patricia McCarroll
20. Lessons Learned: TTU STEM Majors for Rural Teaching (SMaRT) Noyce Scholarship Program. Holly Anthony, Stephen Robinson
21. Isolation, Resilience, and Faith: Experiences of Black Christian Students in Biology Graduate Programs. Chloe Bowen, Angela Google, Lisa Hanson, Sara Brownell, Elizabeth Barnes
22. Putting Together the Pieces of the Social Justice Mathematics Puzzle. Jennifer Seat