PME-NA
Looking Back, Looking Ahead: Celebrating 40 years

PME-NA40
Looking Back, Looking Ahead

Editors: Thomas E. Hodges, George J. Roy, & Andrew M. Tyminski

CONFERENCE SCHEDULE
### THURSDAY, NOVEMBER, 15

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>2:00 to 6:00 pm</td>
<td><strong>THURSDAY REGISTRATION</strong>&lt;br&gt;PMENA&lt;br&gt;Special Event&lt;br&gt;Hyatt Regency: Floor 1st - Meeting Planner Office</td>
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<td>5:30 to 6:30 pm</td>
<td><strong>OPENING RECEPTION</strong>&lt;br&gt;PMENA&lt;br&gt;Special Event&lt;br&gt;Hyatt Regency: Floor 1st - Prefunction</td>
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<td>6:45 to 7:00 pm</td>
<td><strong>WELCOME</strong>&lt;br&gt;PMENA&lt;br&gt;Special Event&lt;br&gt;Hyatt Regency: Floor 1st - Regency A,B,C</td>
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<tr>
<td>7:00 to 8:30 pm</td>
<td><strong>HOW CAN UNDERSTANDING STUDENT EXPERIENCE IN THE MATHEMATICS CLASSROOM ENRICH, CHALLENGE, AND HELP US IMPROVE OUR OWN LEARNING AS TEACHER EDUCATORS AND RESEARCHERS?</strong>&lt;br&gt;PMENA&lt;br&gt;Plenary Session&lt;br&gt;Hyatt Regency: Floor 1st - Regency A,B,C</td>
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#### 004. HOW CAN UNDERSTANDING STUDENT EXPERIENCE IN THE MATHEMATICS CLASSROOM ENRICH, CHALLENGE, AND HELP US IMPROVE OUR OWN LEARNING AS TEACHER EDUCATORS AND RESEARCHERS?

In this paper, we explore the ways in which learning more about research on students’ experiences in mathematics classrooms has the potential to transform the work we do with teachers in teacher preparation, professional development, and research settings. We focus in particular on questions of student access to and participation in mathematics and highlight studies of the racialized and gendered experiences of students and the connections between these experiences and broader narratives about race, gender, and ability/disability. We conclude with questions and possibilities raised by these studies for our individual and collective efforts to support and understand teacher learning and changes in teacher practice.

Presider: Elham Kazemi, University of Washington
Discussant: Corey Drake, Michigan State University

### FRIDAY, NOVEMBER, 16

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<th>Time</th>
<th>Event</th>
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<tr>
<td>7:00 to 9:00 am</td>
<td><strong>FRIDAY MORNING COFFEE</strong>&lt;br&gt;PMENA&lt;br&gt;Special Event&lt;br&gt;Hyatt Regency: Floor 1st - Prefunction</td>
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<tr>
<td>8:00 to 5:00 pm</td>
<td><strong>FRIDAY REGISTRATION</strong>&lt;br&gt;PMENA&lt;br&gt;Special Event&lt;br&gt;Hyatt Regency: Floor 1st - Meeting Planner Office</td>
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#### 007. TEACHING AND CLASSROOM PRACTICE

**BRIEF RESEARCH REPORTS SESSION 1**

**Teaching and Classroom Practice**

**Brief Research Report Session**

8:30 to 9:10 am

Hyatt Regency: Floor 1st - Crepe Myrtle

**Participants:**

**MATHEMATICAL MODELING COMPETENCIES ESSENTIAL FOR ELEMENTARY TEACHERS:**

**THE CASE OF TEACHERS IN TRANSITION**

Jennifer M. Suh, George Mason University; Kathleen Matson, George Mason University

This report documents three teachers journeys as they engaged in a Teacher Research Study Group while implementing mathematical modeling in the elementary grades. In detailing three teachers’ perspectives, we provide a context and describe each of the teachers’ mathematical modeling journeys and their process of adopting the innovation of MM in their classrooms. Two main mathematical modeling competencies emerged as being central to the success of enacting mathematical modeling in the elementary classroom: 1) Developing explicit knowledge of Mathematical Modeling and Seizing Opportunities with Modeling Potential; 2) Having Discursive competencies to amplify the mathematical thinking.

**USING INTERACTIVE SIMULATIONS TO THINK MATHEMATICALLY AND ENGAGE IN COGNITIVELY DEMANDING TASKS**

Sebnem Atabas, Florida State University; Kelly Patrick Findley, Florida State University; Jennifer Schellinger, Florida State University

We report findings from two middle-school mathematics teachers who each used parallel module lesson plans across two of their sections, with one section following an interactive simulation-based lesson plan and the other following a business-as-usual lesson plan. Data collection was comprised of the teacher’s planned lesson tasks and our classroom observations. Tasks were analyzed in terms of their cognitive demand as written and enacted. Classroom videos were analyzed regarding whether teachers promoted or limited student thinking. Preliminary findings suggest that the students using sims had more opportunities for more cognitively demanding work, rather than focusing on procedures and reproducing knowledge.

#### 008. STUDENT LEARNING AND RELATED FACTORS

**BRIEF RESEARCH REPORTS SESSION 2**

**Student Learning and Related Factors**

**Brief Research Report Session**

8:30 to 9:10 am

Hyatt Regency: Floor 1st - Dogwood

**Participants:**

**LATINA/O STEM MAJORS’ PERSPECTIVES OF**
EXPERIENCES SUPPORTING THEIR MATHEMATICAL SUCCESS Sarah Oppland-Cordell, Northeastern Illinois University; Katherine Bird, Northeastern Illinois University
This study uses qualitative methods to examine eight Latina/o STEM majors’ perceptions of experiences that supported their mathematical success. Using NVivo software, an iterative coding scheme is applied to analyze interview data. Drawing on critical race theory and Latina/o critical theory, preliminary cross-case analysis reveals that participants’ mathematical success is related to experiences negotiated within institutional, interpersonal, and ideological/internal dimensions. Such experiences are related to their racial identity constructions, the co-construction of their racial identities with other salient identities, and experiences negotiated in multiple sociopolitical contextual layers. This presentation includes a brief video documentary that highlights powerful examples of participants’ counter-stories.

LATINX BILINGUALS’ PERSEVERANCE ON A MATHEMATICAL TASK Hector Morales, Northeastern Illinois University; Joseph DiNapoli, Montclair State University
Recent reform efforts have made explicit the importance of providing students with opportunities to persevere with challenging mathematics to help develop understanding. We posit translanguaging practice as a vital option by which Latinx bilingual students can sustain collective perseverance during problem solving. This paper examines classroom supports for translanguaging and perseverance practices of such students. Studying the collaborative problem solving of two groups of Latinx bilinguals, our findings suggest these students can spontaneously and dialogically leverage communicative resources to help persevere with in-the-moment obstacles, but only when provided freedom to explore mathematics on their own terms.

009. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 2
Preservice Teacher Education
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Gardenia
Participants:
 Bridging Beliefs, Values and Past Experiences with Instructional Practice Kayce Mastrup, University of California, Davis, School of Education
This research places direct emphasis on understanding in detail the connections between teachers' mathematical life stories and specific instructional sense making. More specifically, how do preservice teachers inform the development and implementation of their instructional practice over the course of their credential year and into the first two years of practice? What are the factors that influence this informing and what combinations of factors attribute to their development and implementation of instructional practice?

THE INFLUENCE OF MATHEMATICAL KNOWLEDGE FOR TEACHING AND BELIEFS ON PRESERVICE TEACHERS' NOTICING Lisa Skultety, University of Illinois at Urbana-Champaign
This study investigates the impact of Mathematical Knowledge for Teaching and beliefs about the role of students’ thinking in the math classroom on elementary preservice teachers' noticing of students' mathematical thinking within the context of fractions. Instruments were specifically designed to address past problems of coherence between instruments to investigate how knowledge and beliefs impact noticing. However, no statistically significant relationship was found between knowledge, beliefs, and noticing. The only statistically significant predictor of noticing at the end of the semester was if the PST was in the class that participated in three additional noticing activities throughout the semester.

010. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS BRIEF RESEARCH REPORTS SESSION 1
Early Algebra, Algebra, and Number Concepts
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Magnolia
Participants:
 A Covariational Understanding of Function: Putting a Horse Before the Cart Teo Paoletti, Montclair State University; Kevin C. Moore, University of Georgia
Supporting students developing function understandings has been a notoriously elusive task in mathematics education. In this report, we provide an empirical example of a student maintaining meanings compatible with Thompson and Carlson’s (2017) description of a covariational meaning of function. We use this students’ activity to illustrate nuances in Thompson and Carlson’s description and to highlight how such meanings can be powerful for students. Our goal is to highlight how a student who has develop meanings compatible with the covariational meaning of function has the horse (i.e. foundational understandings) needed to pull a cart (i.e. a formal definition of function).

Operationalizing Functions by Programming Robots Adam R. Scharfenberger, The Ohio State University; Arnulfo Perez, Ohio State University; Bailey M Braaten, The Ohio State University; JiHye Lee, The Ohio State University
This research in progress report describes how students used multiple representations of functions in a unit that incorporated functions to program the movement of a robot. Students conceptualize a bidirectional relationship between the algebraic and robotic representations of a function, but the relationships between the other representations remain unidirectional or disconnected. We hypothesize that students’ strong connection between the algebraic and robotic representations can be leveraged to facilitate increased understanding of the relationship between the other representations.

011. TECHNOLOGY BRIEF RESEARCH REPORTS SESSION 1
Technology
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud A
Participants:
MEASURING SELF-REGULATED LEARNING IN CALCULUS I
Benjamin David Sencindiver, Colorado State University; Mary Pilgrim, Colorado State University; James Folkestad, Colorado State University
Calculation 1 continues to be a key gateway course to STEM majors, contributing to a loss of students in the STEM pipeline. Self-regulated learning (SRL) competencies have widely been found to be related to academic achievement (e.g. Zimmerman, Moylan, Hudesman, White, & Flugman, 2011), though common tools to measure SRL have fallen under scrutiny (Winne & Jamieson-Noel, 2002). Using an SRL framework, online tools were designed to collect behavioral data which was used to create a SRL score based on in-course student activity. This brief report describes the development of the score and relationships with academic achievement in Calculus I.

STUDENTS’ ONTOLOGY AND EPISTEMOLOGY IN AXIOMATIC GEOMETRY USING TECHNOLOGY
Younggon Bae, Michigan State University
In this theoretical paper, I address students’ ontological and epistemological shifts that have been discussed in the existing literature of student learning of geometry. Drawing on the prior literature, I argue that making successful shifts can benefit students in axiomatic geometry and that such shifts can be facilitated by engaging in mathematical activities with supports of Dynamic Geometry Environments. Examples of those activities that involve construction and analysis of geometric proofs are illustrated.

012. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 3
Preservice Teacher Education
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud C
Participants:
LOOKING INWARD: (RE)NEGOTIATING AND (RE)NAVIGATING MATHEMATICS, TEACHING, AND TEACHER BELIEFS
Kayla Myers, Georgia State University; Susan Cannon, Georgia State University
This paper is a reflection on a co-teaching experience during the first mathematics methods course of a teacher preparation program, where a community of teachers (teacher educators and pre-
service teachers) could reflect on tensions (with teacher beliefs, with practice, and with mathematics). Cognitively Guided Instruction (CGI) was a central tenet to the course material and required learnings, opening up opportunities to (re)negotiate those tensions with beliefs, practice, and mathematics. We employ poststructural theories, attending to the documents that participants produced as well as the thinking and reading happening simultaneously, using writing as a method of inquiry.

PROSPECTIVE TEACHERS’ CENTRAL BELIEFS ABOUT MATHEMATICAL MISTAKES Matthew Duncan, Middle Tennessee State University

Standards-based documents suggest that mistakes should be viewed as more than dead ends and should be used as catalysts for learning. However, prospective teachers rarely experience the utility of mistakes, which influences their beliefs concerning mathematical mistakes and ultimately how they treat mistakes. The influence that beliefs have on teaching is well known, but the beliefs concerning mathematical mistakes are not. This study explored the beliefs of two prospective teachers concerning mathematical mistakes and how those beliefs changed during their enrollment in a content course for teachers designed to align with NCTM recommendations.

014. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORTS SESSION 1

Inservice Teacher Education/Professional Development Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency D2,E2,H

Participants:

CHANGING TEACHING PRACTICE: EXAMINING PROFESSIONAL DEVELOPMENT IMPACT ON MATHEMATICS DISCUSSION LEADING PRACTICE Nicole Garcia, University of Michigan; Meghan Shaughnessy, University of Michigan; Xueying Prawat, University of Michigan; Erin Pfaff, University of Michigan; Jillian Peterson Mortimer, University of Michigan; Nicole Cirino, University of Michigan; Merrie Blunk, University of Michigan; Darrius Robinson, University of Michigan

Decades of research has shown that most professional development fails to result in changes to teachers’ classroom practice. This project explores an innovative professional development focused squarely on mathematics teaching practice and seeks to understand the features of the professional development that affect classroom level change.

CHARACTERIZING REHEARSALS WITH IN-SERVICE TEACHERS Casey Hawthorne, Furman University; John Gruver, Michigan Technological University

To address the chasm between learning about effective teaching practices and being able to implement those practices, teacher preparation programs have begun to adopt rehearsals as a pedagogy. Teaching rehearsals are opportunities to develop an understanding of instructional practices in an authentic, but scaffolded environment. These have been shown to help novice teachers gain competency in complex teaching practices. In this study, we explore this pedagogy with in-service secondary teachers. Results indicate that in the rehearsals the teacher educators were less directive in their suggestions and teachers were more assertive in making suggestion as compared to rehearsals with pre-service teachers.

015. THEORY AND RESEARCH METHODS BRIEF RESEARCH REPORTS SESSION 1

Theory and Research Methods
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency D,E

Participants:

AN INTERPRETIVE FRAMEWORK TO ACCOUNT FOR COLLECTIVE LEARNING IN A MATHEMATICS CLASSROOM Teruni Lamberg, Ph.D.; Diana L. Moss, Utah State University; Claudia Marie Bertolone-Smith, SUNY Plattsburgh

An interpretive framework for organizing and reducing data from a whole class teaching experiment for further analysis is described. Design research typically generates extensive data and can become potentially unmanageable for analysis. The framework described in this paper uses a situated cognitive perspective: Meaning making arises out of activity with the context of the classroom. Each layer affords and constrains each other. Data from a whole class teaching experiment is used to illustrate how the framework was used to reduce and catalog the data for further analysis. The framework can be adapted by anyone who is engaging in design research.

PSYCHOMETRIC ASSESSMENT OF THE MATH ANXIETY SCALE WITH THE RASCH MEASUREMENT MODEL Ibrahim Burak Olmez, University of Georgia; Safiye Bahar Olmez, Duzce University

This study examined the psychometric characteristics of the Math Anxiety Scale (MANX) with data collected from 952 middle school students using the Rasch Rating Scale model. The results reveal that although the MANX is sensitive to detect students with moderate levels of math anxiety and not targeted to identify those with very high and low math anxiety levels, it has high reliability and validity. Moreover, the majority of the MANX items are of good quality. The results provide strong
evidence for the validation of the MANX despite the need for deletion of eight misfit items, and three redundant items.

016. GEOMETRY AND MEASUREMENT BRIEF RESEARCH REPORTS SESSION 1
Geometry and Measurement
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency F
Participants:
EXPLORING GENDER DIFFERENCES IN A SYMMETRY SOFTWARE INTERVENTION FOR YOUNG CHILDREN Nicole Fletcher, Teachers College, Columbia University; Diego Luna Bazaldúa, Universidad Nacional Autónoma de México; Herbert P. Ginsburg, Teachers College, Columbia University
Symmetry is a foundational geometric concept that receives minimal attention in early childhood mathematics curriculum. Differing exposure to informal play experiences involving symmetry exploration may contribute to gender differences in symmetry understanding. This study explored whether boys' and girls' performance on symmetry tasks differs after a symmetry software intervention. A significant gender effect benefiting boys was found on post-test rotation tasks but not on reflection or translation tasks, controlling for pre-test scores. A gender effect was not significant for identifying or explaining symmetric transformations at post-test. The findings have implications for learning opportunities and modes of assessment for all children.

EXPLORING TRIGONOMETRIC RELATIONSHIPS: IS IT A FUNCTION? Craig Cullen, Illinois State University; Tami S. Martin, Illinois State University
We examined conceptual understandings of preservice secondary mathematics teachers as they reasoned about chord length and arc length in a directed-length representation related to the sine function. We characterized the ways in which our participants understood the functional relationship between the geometric objects by describing various aspects of their concept images, and the progression of the images over time. Concept image components progressed from less useful to more useful, eventually aligning with components of a standard definition of function and key features of the sine function.

017. STATISTICS AND PROBABILITY BRIEF RESEARCH REPORTS SESSION 1
Statistics and Probability
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency G
Participants:
POSITIVE INTERDEPENDEANCE THROUGH DATA MODELING Corey Brady, Vanderbilt University; Ryan Seth Jones, Middle Tennessee State University; Isaac T Nichols-Paez, Vanderbilt University; Panchompoo Wisittanawat, Vanderbilt University
This paper describes work to integrate statistics and data modeling into weekly routines of classroom instruction, supporting positive interdependence at small-group and whole-class levels. It pursues a problem of practice identified by our collaborating teacher: how to promote students’ individual and collective agency with respect to their achievement. Our hypothesis was that designing, creating, interpreting, and revisiting anonymized data representations of aggregated assessment information could offer a context for classroom groups to formulate, guide, and monitor improvement efforts. We report preliminary results in promoting relations among data, representations, conceptual structures, and collective agency in these classes, and we discuss implications.

018. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS BRIEF RESEARCH REPORTS SESSION 2
Early Algebra, Algebra, and Number Concepts
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A
Participants:
HOW QUANTITATIVE REASONING CAN SUPPORT GRAPH UNDERSTANDING IN ALGEBRA Amy Ellis, University of Georgia; Halil Ibrahim Tasova, University of Georgia; Brandon K Singleton, University of Georgia
The construction and interpretation of graphs is a key mathematical activity, particularly at the middle school level, when students’ experiences form the foundation for their reasoning about functions and relations. However, research demonstrates that students experience challenges in interpreting and
understanding graphs. One promising avenue is an emphasis on graphs as representations of quantities varying in tandem. We present a case of two middle-school students, one who emphasized quantities and their relationships and one who did not. We found that attention to quantities fostered ratio concepts and supported appropriate slope conceptions.

SECOND AND FIFTH GRADERS’ INTEGER SUBTRACTION PERFORMANCE: LEARNING FROM CONTRASTING WORKED EXAMPLES
Laura Bofferding, Purdue University; Mahtob Aqazade, Purdue University
We explored 105 second and fifth graders’ performance on integer subtraction problems before and after analyzing different contrasting worked examples involving integers. The students completed a pretest, were randomly assigned to intervention groups, and participated in small-group sessions, one whole-class lesson on integer subtraction, and a posttest. The students progressed in solving integer problems from pretest to posttest. Here, we focus on students who provided only positive or zero answers on their pretest. The trends in their posttest answers show important differences among the intervention groups concerning their use of number order and interpretations of operations in integer arithmetic.

019. MATHEMATICAL PROCESSES BRIEF RESEARCH REPORTS SESSION 1
Mathematical Processes
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B
Participants:
AN ANALYSIS OF STUDENT CHALLENGES WITH ALGEBRA IN CALCULUS Stacy Reeder, University of Oklahoma; Sepideh Stewart, University of Oklahoma; Kate Raymond, University of Oklahoma; Jonathan Troup, University of Oklahoma
National data reveals that more than half of freshmen who declared STEM majors at the start of college left these fields before graduation. Our research suggests that students’ difficulties with algebra cause significant problems in many first-year math courses. This paper presents our analysis of student challenges with algebra in calculus and the nature of their errors.

DIFFICULTADES DE NATURALEZA LÓGICA IDENTIFICADAS EN LOS ESTUDIANTES EN UN PRIMER CURSO DE CÁLCULO Gabriel Herrera-Alva, CINVESTAV, IPN MÉXICO; Antonio Rivera-Figueroa, CINVESTAV, IPN MÉXICO; Kinra Aguirre-de la Luz, Universidad Autónoma Metropolitana, México
En este artículo reportamos los resultados de una investigación acerca de las dificultades de

020. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORTS SESSION 2
Inservice Teacher Education/Professional Development Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C
Participants:
EXPLORING TEACHERS’ DECISIONS IN UNIT DESIGN AND IMPLEMENTATION Ayfer Eker, Indiana University; Dionne Cross Francis, Indiana University
This study is about elementary mathematics teachers’ decisions in designing and implementing a fraction unit aligned with reform-oriented learning and teaching practices and the factors that influence their decisions. Four 4th grade teachers from different schools designed a fraction unit and implemented it in their classrooms. The findings suggest that one of the teacher’s relatively high level of mathematical knowledge for teaching (MKT) and her mathematical beliefs compatible with reform-oriented ideas might have affected the fidelity of her implementation of the designed unit.

K-8 TEACHERS’ STORIES OF MATHEMATICS-RELATED TRANSFORMATION Rebecca McGraw, University of Arizona; Aubrey Neihaus, University of Arizona
We describe our use of the frameworks of teacher transformation and narrative inquiry to investigate K-8 teachers’ self-reported transformations related to mathematics and teaching, and aspects of the transformations that are associated with participation in a specific professional development program. This report is part of a larger, ongoing investigation, but we are able, in the space of this report, to highlight the transformative journeys of two participating teachers.

021. MATHEMATICAL KNOWLEDGE FOR TEACHING BRIEF RESEARCH REPORTS SESSION 1
Mathematical Knowledge for Teaching
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participants:

ANALYZING AND OBSERVING THE DEVELOPMENT OF MKT IN MATHEMATICS CONTENT COURSES
Yvonne Lai, University of Nebraska-Lincoln; Jeremy F Strayer, Middle Tennessee State University; Alyson E. Lischka, Middle Tennessee State University

Improving the preparation of mathematics teachers is a “wicked problem” (Gomez, Russell, Bryk, LeMahieu, & Mejia, 2016, p. 10) requiring the participation of all stakeholders. One component of teacher preparation, mathematical content knowledge, is impacted by both mathematicians and mathematics educators. Looking back at prior NSF funded K-12 curriculum efforts, we see lessons learned from the features of educative curricula. Looking ahead, we see both opportunity and challenge in enacting educative curricula. We leverage research on development of mathematical knowledge for teaching to propose a framework that is a resource for writing and implementing educative curricula in teacher preparation.

FRACTALIZATION AS A METAPHOR FOR MATHEMATICAL KNOWLEDGE FOR TEACHING TEACHERS: SYNTHESIZING RESEARCH AND EXPLORING CONSEQUENCES
Dana Olanoff, Widener University; Rachael M. Welder, Western Washington University; Priya Vinata Prasad, University of Texas at San Antonio; Alison Castro Superfine, University of Illinois at Chicago

We aim to develop a theoretical foundation for the knowledge needed by mathematics teacher educators to support prospective teachers in developing the knowledge needed for teaching. We have approached this goal by exploring existing frameworks that not only generalize conceptualizations of teacher knowledge, but also position teacher knowledge as a subdomain of the knowledge needed for teaching. We envision this generalization to teacher educator knowledge as a “fractalization” of teacher knowledge. Applying this concept, we propose our own fractalization model for the knowledge of mathematics teacher educators and discuss some resulting consequences.

022. BUSINESS CALCULUS STUDENTS’ INTERPRETATIONS OF MARGINAL CHANGE IN ECONOMIC CONTEXTS
Mathematical Processes
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Boardroom

Participant:

BUSINESS CALCULUS STUDENTS’ INTERPRETATIONS OF MARGINAL CHANGE IN ECONOMIC CONTEXTS
Thembinkosi Peter Mkhathwa, Miami University

Despite the overwhelming amount of research on students’ interpretations of rates of change in real-world physical science contexts, similar studies in real-world economic contexts are sparse. Contributing towards addressing this gap in knowledge, this study reports on how 12 pairs of business calculus students interpreted marginal change (marginal cost and marginal revenue) in different economic contexts and function representations while solving two optimization tasks. Implications for instruction are discussed.

023. CAPTURING VARIABILITY IN FLIPPED MATHEMATICS INSTRUCTION
Teaching and Classroom Practice
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Crepe Myrtle

Participant:

CAPTURING VARIABILITY IN FLIPPED MATHEMATICS INSTRUCTION
Samuel Otten, University of Missouri; Zandra de Araujo, University of Missouri; Milan F. Sherman, Drake University

Flipped instruction is increasing in popularity but the research base is not yet well developed. Many studies of flipped instruction involve a small number of flipped classes being compared to non-flipped classes, but this methodology fails to account for variations in implementations. To aid in the systematic attention to variation, this article presents a framework for flipped mathematics instruction that identifies key features of the videos assigned as homework as well as features of the in-class activities. The framework components are accompanied by proposed quality indicators to further distinguish between flipped lessons that are structurally similar but different in enactment.

024. OBSERVING CHANGE IN STUDENTS’ ATTITUDES TOWARDS MATHEMATICS: CONTRASTING QUANTITATIVE AND QUALITATIVE APPROACHES
Student Learning and Related Factors
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Dogwood

Participant:

OBSERVING CHANGE IN STUDENTS’ ATTITUDES TOWARDS MATHEMATICS: CONTRASTING QUANTITATIVE AND QUALITATIVE APPROACHES
Wesley Maciejewski, San José State University

This work takes two approaches to exploring a group of students’ attitudes towards mathematics and how these change over a short university preparatory course. One is an analysis of the students’ writings about their experiences with mathematics whereas the other is an established, Likert-based instrument. The results of the study are
that the multi-dimensionality of the "attitude" construct is unavoidable - that any attempt to describe it necessarily reduces its complexity. Therefore, there is room for both quantitative and qualitative approaches, and these can work in unison to understand better students’ attitudes towards mathematics.

025. THE INTERPLAY OF FRUSTRATION AND JOY: ELEMENTARY STUDENTS’ PRODUCTIVE STRUGGLE WHEN ENGAGED IN UNSOLVED PROBLEMS
Student Learning and Related Factors Research Report Session 9:20 to 10:00 am Hyatt Regency: Floor 1st - Gardenia Participant: THE INTERPLAY OF FRUSTRATION AND JOY: ELEMENTARY STUDENTS’ PRODUCTIVE STRUGGLE WHEN ENGAGED IN UNSOLVED PROBLEMS Jenna Rae O’Dell, Bemidji State University In this study, I investigated elementary students’ emotions while they engaged in the exploration of unsolved mathematics problems, including the Graceful Tree Conjecture. Ten students from an after-school program in the Midwest participated in seven task-based interviews. The students exhibited a variety of emotions throughout the study, with frustration and joy displayed most frequently. I found the interplay of these emotions, joy and frustration, to describe the productive struggle that the students experienced while working on parts of the unsolved problems. Descriptive cases of two students is included to describe how the interplay of frustration and joy characterize productive struggle.

026. ANALYSIS OF TEACHERS’ QUESTIONING IN SUPPORTING MATHEMATICAL ARGUMENTATION BY INTEGRATING HABERMAS’ RATIONALITY AND TOULMIN’S MODEL
Theory and Research Methods Research Report Session 9:20 to 10:00 am Hyatt Regency: Floor 1st - Magnolia Participant: ANALYSIS OF TEACHERS’ QUESTIONING IN SUPPORTING MATHEMATICAL ARGUMENTATION BY INTEGRATING HABERMAS’ RATIONALITY AND TOULMIN’S MODEL Yuling Zhuang, University of Georgia; AnnaMarie Conner, University of Georgia In this study, we adapted Habermas’ construct integrated with Toulmin’s model for argumentation to analyze teachers’ questioning through the lens of supporting mathematical collective argumentation. The results of this study suggest that this theoretical integration provides us a more comprehensive perspective to investigate teachers' roles of questioning within collective argumentation. Furthermore, we found that the rational questioning the participant adopted during student teaching was consistent with her interpretations of argumentation. We suggest that our teacher education programs should emphasize the power of mathematical argumentation and promote teachers’ understanding of the roles of a teacher in questioning.

027. SUPPORTING A MATHEMATICIANS’ INSTRUCTIONAL CHANGE IN UNDERGRADUATE MATHEMATICS THROUGH FACULTY COLLABORATION
Inservice Teacher Education/Professional Development Research Report Session 9:20 to 10:00 am Hyatt Regency: Floor 1st - Redbud A Participant: SUPPORTING A MATHEMATICIANS’ INSTRUCTIONAL CHANGE IN UNDERGRADUATE MATHEMATICS THROUGH FACULTY COLLABORATION Nicholas Fortune, Western Kentucky University; Karen Keene, North Carolina State University In this study, we examined the ways in which a mathematician’s instruction unfolded during his participation in a faculty collaboration geared towards reforming instruction and aligning it with inquiry oriented instruction. Results indicate the participant’s mathematics background and research interests influenced how he used student thinking in his instruction. Further, there existed a tension between inquiry oriented instruction and anticipating student thinking. Lastly, results highlight the importance of active participation in faculty collaboration to support instructional change.

028. REFLECTED ABSTRACTION AS A MECHANISM FOR DEVELOPING PEDAGOGICAL CONTENT KNOWLEDGE
Mathematical Knowledge for Teaching Research Report Session 9:20 to 10:00 am Hyatt Regency: Floor 1st - Redbud B Participant: REFLECTED ABSTRACTION AS A MECHANISM FOR DEVELOPING PEDAGOGICAL CONTENT KNOWLEDGE Michael Tallman, Oklahoma State University; John Weaver, Oklahoma State University AUTHOR (2015) argued that pedagogical content knowledge is a form of content knowledge with particular characteristics that endow it with pedagogical utility. He conjectured that an essential characteristic of a teacher’s content knowledge is her conscious awareness of the mental processes that comprise her mathematical schemes. We report the results of a study that explored this conjecture
by examining the pedagogical implications of engaging a pre-service secondary teacher in a mathematical intervention to support her construction of a powerful scheme for constant rate of change and to engender her conscious awareness of the mental processes that constitute this scheme.

**029. EXAMINING TEACHER CANDIDATES’ RESPONSES TO ERRORS DURING WHOLE-CLASS DISCUSSIONS THROUGH WRITTEN PERFORMANCE TASKS**

Preservice Teacher Education  
Research Report Session  
9:20 to 10:00 am  
Hyatt Regency: Floor 1st - Redbud C

Participant:  
EXAMINING TEACHER CANDIDATES’ RESPONSES TO ERRORS DURING WHOLE-CLASS DISCUSSIONS THROUGH WRITTEN PERFORMANCE TASKS  
Erin E. Baldinger, University of Minnesota; Matthew P. Campbell, West Virginia University; Foster Graif, University of Minnesota  
Effectively leading whole-class mathematics discussions is made more difficult when students’ contributions are incomplete, imprecise, or not yet correct, and not easily correctable—what we call “errors.” Through purposefully designed opportunities to investigate, enact, and reflect on teaching, teacher candidates (TCs) can develop skill to productively respond to errors in whole-class discussions. We investigate how TCs respond to errors when engaging in a written performance task that calls for TCs to play out discussions in response to a classroom scenario. We consider what the performance task reveals about TCs’ practice and perspectives, with implications regarding theory and practice.

**030. DESIGN PRINCIPLES FOR THE DEVELOPMENT OF PROFESSIONAL NOTICING OF STUDENTS' TECHNOLOGICAL MATHEMATICAL PRACTICES**

Technology  
Research Report Session  
9:20 to 10:00 am  
Hyatt Regency: Floor 1st - Regency D,E

Participant:  
DESIGN PRINCIPLES FOR THE DEVELOPMENT OF PROFESSIONAL NOTICING OF STUDENTS’ TECHNOLOGICAL MATHEMATICAL PRACTICES  
Jane Lo, Western Michigan University; Dana Christine Cox, Miami University  
This self-study uncovers the concept images held by preservice elementary teachers when defining and classifying 3-D shapes. We also sought to understand the nature of observed difficulties with this work. We found that using both simple and composite shapes in classification activity exposed more nuanced and complex concept imagery than simple shapes alone. Opportunities to articulate assumptions creates a space for all learners to make language more precise and to create concept definitions that are more resilient.

**031. DEVELOPING AND USING DEFINITIONS FOR PRISMS AND PYRAMIDS**

Geometry and Measurement  
Research Report Session  
9:20 to 10:00 am  
Hyatt Regency: Floor 1st - Regency D,E

Participant:  
DEVELOPING AND USING DEFINITIONS FOR PRISMS AND PYRAMIDS  
Jane-Jane Lo, Western Michigan University; Dana Christine Cox, Miami University; Charity Cayton, East Carolina University; Lara K Dick, Bucknell University; Hollylynne S. Lee, NC State University  
In support of standards for the learning and teaching of mathematics and statistics that advocate for the use of technology to promote reasoning and sense making, and to elicit student thinking, we draw on the use of authentic student work in the form of video case instruction to develop prospective secondary mathematics teachers’ [PSMTs] knowledge of students’ understanding, thinking, and learning with technology in mathematics. Here we explicate six design principles situated in the literature, provide an example of a module designed based on these principles, and share findings from pilot studies utilizing the module.

**032. RELATIONSHIPS BETWEEN UNITS COORDINATION AND SUBITIZING RESEARCH REPORT**

Early Algebra, Algebra, and Number Concepts  
Research Report Session  
9:20 to 10:00 am  
Hyatt Regency: Floor 1st - Regency F

Participant:  
RELATIONSHIPS BETWEEN UNITS COORDINATION AND SUBITIZING  
Beth Loveday MacDonald, Utah State University  
This proposal explores relationships between young children’s unit development/coordination and young children’s subitizing. In particular, this theoretical commentary considers students’ degrees of abstraction, students’ development of actions on units, and students’ operations with units when subitizing. As a result of this commentary, this author offers questions regarding how subitizing may elicit actions on units and perceptual/figurative material in a different order. These questions indicate alternative means in which comprehensive operations with natural numbers may develop. Possible educational implications and future research around these questions are also discussed.
034. IMPACT OF A STUDENT-ADAPTIVE PEDAGOGY PD PROGRAM ON STUDENTS' MULTIPLICATIVE REASONING
Teaching and Classroom Practice
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A
Participant:
IMPACT OF A STUDENT-ADAPTIVE PEDAGOGY PD PROGRAM ON STUDENTS' MULTIPLICATIVE REASONING Ron Tzur, University of Colorado Denver; Heather Lynn Johnson, University of Colorado Denver; Nicola M. Hodkowski, University of Colorado Denver; Cody Jorgensen, University of Colorado Denver; Sally Nathenson-Mejia, University of Colorado Denver; Bingqian Wei, University of Colorado Denver; Amy Smith, University of Colorado Denver; Alan Davis, University of Colorado Denver
We examine how a PD program for teachers' shift toward a student-adaptive pedagogy impacts students' multiplicative reasoning (MR). We describe underpinnings of this pedagogy and components of the PD program. Then, we present participants, data collection/analysis methods, and the written assessment used to measure students' MR. We found a significant increase in students' MR, between (a) year-ends for different classes and (b) year-start to year-end for the same classes. We also found students of participating ("treatment") teachers outperformed those of non-participating ("comparison") teachers. We discuss the importance of these findings for theory, for teacher education, and for students' mathematical futures.

035. TENDENCIAS EN MODELACIÓN MATEMÁTICA EN LATINOAMÉRICA
Curriculum and Related Factors
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B
Participant:
TENDENCIAS EN MODELACIÓN MATEMÁTICA EN LATINOAMÉRICA Armando Solares-Rojas, Mathematics Education Department of the Center for Research and Advanced Studies of the National Polytechnic Institute (México); Armando Paulino Preciado Bab, University of Calgary; Fredy Peña, CINVESTAV México; Yudi Andrea Ortiz Rocha, andreortizun@gmail.com; Marisol Sandoval, Universidad Pedagógica Nacional. México; Remedios Soriano, Universidad Pedagógica Nacional México; Vicente Carrión Velázquez, National Pedagogical University México; Mauricio Alexis Farrugia Fuentes, Universidad Nacional Autónoma de México
Throughout the years Mathematical Modeling has gained international attention, not only in research but also in the development of curricula and its applications in the classroom. However, systematic literary surveys are scarce. In this paper, we present some findings from a survey of 485 international publications related to different aspects of mathematical modeling. Regarding Latin-American publications, the number of publications is rather small, contrasted to the number of international publications; nonetheless, the vitality of the currently discussed themes in this region and their innovative perspectives testify the international relevance of the developed work on mathematical modeling.

036. QUANTITATIVE (AND NON-QUANTITATIVE) METHODS USED BY FUTURE TEACHERS FOR SOLVING PROBABILITY-BASED PROPORTION PROBLEMS
Preservice Teacher Education
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C
Participant:
QUANTITATIVE (AND NON-QUANTITATIVE) METHODS USED BY FUTURE TEACHERS FOR SOLVING PROBABILITY-BASED PROPORTION PROBLEMS Dean Leigh Stevenson, University of Georgia; Sybilla Beckmann, University of Georgia; Sheri E. Johnson, University of Georgia; Rui Kang, Georgia College & State University
We have extended two perspectives of proportional reasoning to solve problems based in probability.
Four future middle grade teachers were enrolled in a mathematics content course that emphasized reasoning about multiplication with quantities. The course expected future teachers to generate and explain methods for solving proportions. Probability had not yet been discussed in the course, which gave insight into how reasoning fostered in the course was invoked in novel tasks. All four teachers could reason about multiplication with quantities to solve probability problems and could use quantitative methods that accurately reflected how empirical probabilities approach theoretical probabilities as trials increases.

037. PREPARING SECONDARY MATHEMATICS AND SCIENCE TEACHER LEADERS IN RURAL DISTRICTS
Inservice Teacher Education/Professional Development Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participant:
PREPARING SECONDARY MATHEMATICS AND SCIENCE TEACHER LEADERS IN RURAL DISTRICTS Jan A Yow, University of South Carolina; Christine Lotter, University of South Carolina; Matthew J Irvin, University of South Carolina
This study examines secondary mathematics and science teacher perceptions and enactments of teacher leadership during a professional development program focused on preparing teacher leaders in rural schools. Findings indicate four areas of growth for participants and project staff: participants began to expand their thinking and influence beyond the classroom, advocate more for students, develop a richer understanding of what content specific teacher leadership looks like, and gain a deeper understanding that teacher leadership in rural districts may be easier given the context of smaller settings but may also be more challenging in terms of teacher burnout.

038. FRIDAY MORNING BREAK
PMENA
Special Event
10:00 to 10:30 am
Hyatt Regency: Floor 1st - Prefunction

039. WORKING GROUP: DEVELOPING A RESEARCH AGENDA OF K-8 TEACHERS' IMPLEMENTATION OF DIGITAL CURRICA
Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Boardroom
Participant:
DEVELOPING A RESEARCH AGENDA OF K-8 TEACHERS’ IMPLEMENTATION OF DIGITAL CURRICA Shannon Driskell, University of Dayton; Steve Rhine, Pacific University; Rachel Harrington, Western Oregon University
The purpose of this working group is to understand how teachers are implementing digital curricula to teach elementary mathematics, to explore best teaching practices for using digital curricula, and to understand how students are learning from digital curricula. We propose a working group on digital curricula that focuses on the themes of: access, equity, and empowerment; data generation/use; mathematical content; motivation and mindset; and nurturing NCTM Mathematics Teaching Practices and Common Core State Standards for Mathematical Practices.

040. WORKING GROUP: MATHEMATICAL MAKING IN IMMERSIVE VIRTUAL ENVIRONMENTS
Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Crepe Myrtle
Participant:
MATHEMATICAL MAKING IN IMMERSIVE VIRTUAL ENVIRONMENTS WORKING GROUP Justin Dimmel, University of Maine; Megan Nickels, University of Central Florida; Craig Cullen, Illinois State University; Camden Glenn Bock, UNIVERSITY OF MAINE
Our working group will bring mathematics education researchers together to explore how immersive spatial display technologies (e.g., room scale virtual reality) can be used for the teaching and learning of mathematics. The sessions will provide participants with the opportunity to explore a range of virtual worlds, including mathematics-specifics environments that were designed by session organizers. Participants will work together to plan research studies, discuss instructional activities, and design virtual environments. Our group aims to look ahead to a time in the near future and anticipate the research, design, and development that can guide how these technologies will be integrated into schools.

041. WORKING GROUP: SPECIAL EDUCATION AND MATHEMATICS WORKING GROUP
Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Dogwood
Participant:
SPECIAL EDUCATION AND MATHEMATICS WORKING GROUP Yan Ping Xin, Purdue University; Jessica Heather Hunt, NCSU; helen thouless, UCL Institute of Education; Ron Tzur, University of Colorado Denver
This Working Group will continue the conversation
started since PME-NA-34, with a goal to move forward the teaching and learning of mathematics involving students with learning disabilities or difficulties in mathematics (LDM). This Working Group is rooted in following premises: (1) students with LDM are capable of and need to develop conceptual understanding of mathematics, and (2) special education as well as inclusive classroom instruction need to transition toward this focus. Participants will continue (a) the collaborative research agenda for the group, and (b) the dissemination effort through publications that reflect the cross-disciplinary collaborative work of this international group.

042. WORKING GROUP: ADDRESSING EQUITY AND DIVERSITY ISSUES IN MATHEMATICS EDUCATION: LOOKING BACK AND LOOKING AHEAD
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Gardenia
Participant:
ADDRESSING EQUITY AND DIVERSITY ISSUES IN MATHEMATICS EDUCATION: LOOKING BACK AND LOOKING AHEAD Joel Amidon, University of Mississippi; Jennifer Langer-Osuna, Stanford University; Gregory Larnell, University of Illinois at Chicago
Embracing the theme of this year’s meeting, we seek as a community to embrace the history of mathematics education research/PMENA, and the promise of the future of mathematics education by continuing on the reestablished purpose of this group and supporting the development of new directions for equity-oriented research working groups. The sessions will focus on regrouping attendees interested in equity, generating and brainstorming new subtopics and potential projects, and working to establish standalone working groups dedicated to furthering research on equity. The purpose being to encourage a move away from “big-tent” equity thinking and toward more productive working collectives.

043. WORKING GROUP: MATHEMATICS TEACHER EDUCATORS’ INQUIRY INTO THEIR PRACTICE: UNPACKING METHODOLOGIES FOR PROFESSIONAL AND PERSONAL GROWTH
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Magnolia
Participant:
MATHEMATICS TEACHER EDUCATORS’ INQUIRY INTO THEIR PRACTICE: UNPACKING METHODOLOGIES FOR PROFESSIONAL AND PERSONAL GROWTH Elizabeth Suazo-Flores, Purdue University; Signe Kastberg, Purdue University; Jennifer Ward, Kennesaw State University; Dana Christine Cox, Miami University; Olive Chapman, University of Calgary
In this working group, we introduce narrative inquiry, self-study, and autoethnography as methodologies that focus on the study of the self. Through posing research questions and creation of research texts from existing field texts, participants will explore these methodologies. Field texts used will be videos, personal journals, and transcripts of conversations that the leaders of the working group and Melva Grant have constructed in their different research studies. The creation of a nurturing space to conduct and review research using these methodologies will be promoted in this working group.

044. WORKING GROUP: THE MATHEMATICS EDUCATION OF ENGLISH LEARNERS
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Redbud A
Participant:
THE MATHEMATICS EDUCATION OF ENGLISH LEARNERS Zandra de Araujo, University of Missouri; William Zahner, San Diego State University; Sarah A Roberts, University of California, Santa Barbara; Craig Willey, Indiana University, IUPUI
This Working Group builds on the work of Working Groups in 2015 and 2016. We will continue considering multiple aspects of research and practice related to mathematics learning and teaching with English Learners. Our goals for the 2018 Working Group include: (1) sharing current perspectives on extant research related to mathematics and English learners, (2) understanding venues for dissemination of research on ELs, including novel outlets that connect research to practice, and (3) fostering new collaborations and supporting further connections among researchers.

045. WORKING GROUP: COMPLEX CONNECTIONS: REIMAGINING UNITS COORDINATION
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Redbud B
Participant:
COMPLEX CONNECTIONS: REIMAGINING UNITS COORDINATION Beth Loveday MacDonald, Utah State University; Steven James Boyce, Portland State University; Jessica Heather Hunt, NCSU; Cameron Byerley, Colorado State University; Diana L. Moss, Utah State University
Students’ construction, coordination, and abstraction of units underlie success across multiple
mathematics domains. Structures for coordinating units underscore notions of numbers as composite units (e.g., five is a unit of five and five units of one). In this working group, we seek to facilitate collaboration amongst researchers and educators concerned with composite unit formation and units coordination. The aim for this working group is two-fold: (1) to extend our research around units coordination to new grade levels; and (2) to collaborate with researchers who investigate students with learning differences in school settings to determine diverse students’ mathematics learning trajectories.

046. WORKING GROUP: MODELS AND MODELING WORKING GROUP
Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Redbud C
Participant:
MODELS AND MODELING WORKING GROUP
Corey Brady, Vanderbilt University; Angeles Dominguez, ITESM, MX; Aran Glancy, University of Minnesota; Hyunyi Jung, Marquette University; Jeffrey A McLean, University of North Carolina at Chapel Hill
The Models and Modeling Working Group at PME-NA has provided a forum for discussing and collaborating on research projects fundamental to this area since the first PME-NA conference in 1978. We propose to convene this Working Group at PME-NA 40 with a dual purpose: (1) to build on discussions at PME-NA 37-39, extending collaborative research directions formulated at the Indianapolis meeting, and (2) to continue to invite newcomers to the Models and Modeling Perspective (MMP), giving them an introduction to this rich tradition in design research.

047. NATIONAL SCIENCE FOUNDATION FUNDING OPPORTUNITIES FOR MATHEMATICS EDUCATORS IN THE DIRECTORATE OF EDUCATION AND HUMAN RESOURCES (EHR)
PMENA
Special Event
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency A,B,C
Presider:
Karen Keene, North Carolina State University

048. WORKING GROUP: GENDER AND SEXUALITY IN MATHEMATICS EDUCATION: LINKING THE PAST TO THE FUTURE
Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency D2,E2,H
Participant:
WORKING GROUP ON GENDER AND SEXUALITY IN MATHEMATICS EDUCATION: LINKING THE PAST TO THE FUTURE
Katrina Piatek-Jimenez, Central Michigan University; Rebecca McGraw, University of Arizona; Lynda Wiest, University of Nevada, Reno; Jennifer Hall, Monash University; Angie Hodge, Northern Arizona University; Elizabeth Ann Kersey, Purdue University; Laurie Rubel, Brooklyn College CUNY & University of Haifa; Kathleen Jablon Stoehr, Santa Clara University
After not having met for a number of years, the Gender and Sexuality in Mathematics Education Working Group will meet again this year with a new name, new members, and a new focus. During this Working Group, we will discuss current research being conducted on this topic and will identify themes for discussion and possible research collaborations. We plan to include a discussion about how research assumptions, such as language assuming that gender is binary, can affect research findings. All PME-NA attendees with an interest in gender and sexuality in mathematics education are invited to attend.

049. WORKING GROUP: CONCEPTIONS AND CONSEQUENCES OF WHAT WE CALL ARGUMENTATION, JUSTIFICATION, AND PROOF
Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency D,E
Participant:
CONCEPTIONS AND CONSEQUENCES OF WHAT WE CALL ARGUMENTATION, JUSTIFICATION, AND PROOF
AnnaMarie Conner, University of Georgia; Carlos Nicolas Gomez, Clemson University; Hyejin Park, University of Georgia; Jonathan Kyle Foster, University of Georgia; Yuling Zhuang, University of Georgia; Megan Staples, University of Connecticut; Michelle Cirillo, University of Delaware; Kristen Bieda, Michigan State University; Jill Newton, Purdue University
Argumentation, justification, and proof are conceptualized in many ways in mathematics education literature. The descriptions of these objects and processes are sometimes compatible or complementary; they can also be inconsistent or contradictory. Collaboration is needed to move toward highlighting connections and exploiting ways in which they may be used to address overarching research questions. The 2018 working group sessions will extend previous conversations into issues of teacher preparation with respect to argumentation, justification, and proof. The group will also discuss how issues of equity, social justice, and marginalized populations intersect with the teaching and learning of argumentation, justification, and proof.
050. WORKING GROUP: FORGING NEW PATHS THROUGH CRITICAL PERSPECTIVES ON DISABILITY AND MATHEMATICS EDUCATION

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency F
Participant:
FORGING NEW PATHS THROUGH CRITICAL PERSPECTIVES ON DISABILITY AND MATHEMATICS EDUCATION Amber Grace Candela, University of Missouri - St. Louis; Katherine E Lewis, University of Washington; Paulo Tan, University of Hawaii, Manoa; James Sheldon, University of Arizona; Kai Rands, National Coalition of Independent Scholars; Jessica Heather Hunt, NCSU Research on mathematics and disabilities traditionally has been conducted within a special education paradigm, which often implicitly or explicitly adopts a deficit model of the learner. The deficit model locates the “problem” within the individual student rather than in the social, discursive, political, or structural context. Our working group is composed of researchers and educators who draw upon critical theories, such as Disability Studies in Education, Critical Race Theory, and DisCrit, in order to offer an alternative vision of mathematics education based around a different conceptualization of disability and learning differences.

051. WORKING GROUP: EMBODIED MATHEMATICAL IMAGINATION AND COGNITION (EMIC) WORKING GROUP

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency G
Participant:
EMBODIED MATHEMATICAL IMAGINATION AND COGNITION (EMIC) WORKING GROUP Erin Ottmar, Worcester Polytechnic Institute; Edward Melcer, Univ. of California, Santa Cruz; Dor Abrahamson, University of California, Berkeley; Mitchell J. Nathan, The University of Wisconsin - Madison; Emily Fye, Indiana University; Carmen Smith, University of Vermont

Embodied cognition is growing in theoretical importance and as a driving set of design principles for curriculum activities and technology innovations for mathematics education. The central aim of the EMIC Working Group is to attract engaged colleagues into a growing community of discourse around theoretical, technological, and methodological developments for advancing the study of embodied cognition for mathematics education. EMIC builds upon our prior working groups with a focus on how we can leverage emerging technologies to study embodied cognition and mathematics learning. We aim to develop new theories and extend frameworks and perspectives from which collaboration and activities can emerge.

052. WORKING GROUP: EXPLORING THE NATURE OF MATHEMATICAL MODELING IN THE EARLY GRADES

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A
Participant:
EXPLORING THE NATURE OF MATHEMATICAL MODELING IN THE EARLY GRADES Jennifer M. Suh, George Mason University; Kathleen Matson, George Mason University; Mary Alice Carlson, Montana State University; Rachel Levy, Harvey Mudd College; Megan Wickstrom, Montana State University; Amy Roth McDuffie, Washington State University; Spencer Jamieson, Fairfax County Schools; Erin Turner, University of Arizona; Padmanabhan Seshaiyer, George Mason University; Cynthia Oropesa Anhalt, The University of Arizona

This working group will focus on the research that deepens our understanding of early modeling. Our aim is to first explore the nature of mathematical modeling across the early grades and map out the learning pathways of mathematical modeling that can connect elementary to secondary mathematics education. Second, we will discuss efforts to design and implement professional development that introduces K-8 teachers to mathematical modeling. Our goal is to broaden the access of mathematical modeling to elementary grades and advance the field’s collective understanding of the interrelated processes of mathematical modeling in the elementary grades and beyond.

053. WORKING GROUP: WORKING TO UNDERSTAND MEDIATED FIELD EXPERIENCES AND STUDY THEIR IMPACT

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B
Participant:
WORKING TO UNDERSTAND MEDIATED FIELD EXPERIENCES AND STUDY THEIR IMPACT Barbara A Swartz, McDaniel College; Esther Marie Billings, Grand Valley State University; Melinda Knapp, Oregon State University-Cascades; Rajeev K Virmani, Sonoma State University; Charlotte Sharpe, Syracuse University; Dawn Woods, Southern Methodist University; Sararose Lynch, Westminster College; Holly H Pinter, Western Carolina University

This group of mathematics teacher educators has been working to integrate preparation efforts by purposefully designing coursework around
McDonald et al.’s (2013) learning cycle to include mediated field experiences. Our goals as a working group are to establish cross-cutting and essential features of these mediated field experiences and identify future research questions and ways to standardize data collection to create clear lines of investigation to explore the impacts of such experiences.

054. WORKING GROUP: MATHEMATICAL PLAY: ACROSS AGES, CONTEXT, AND CONTENT
Working Groups
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C
Participant:
MATHEMATICAL PLAY: ACROSS AGES, CONTEXT, AND CONTENT Caro Williams-Pierce, University at Albany, SUNY; David Plaxco, Clayton State University; Paul N. Reimer, AIMS Center for Math and Science Education; Amy Ellis, University of Georgia; Muhammed F. Dogan, Adiyaman University
Mathematical play has a fairly short history, with strong roots further back in time (e.g., Papert, Montessori), and understanding the role of mathematical play from early childhood to adulthood is, as yet, unmapped. This working group will provide a community space to explore and discuss mathematical play broadly, ranging from early childhood to undergraduate learners, with an emphasis on physical and digital interactions designed specifically to support mathematical play.

055. WORKING GROUP: DEVELOPING THEORY, RESEARCH, AND TOOLS FOR EFFECTIVE LAUNCHING
Working Groups
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Teal Ballroom
Participant:
DEVELOPING THEORY, RESEARCH, AND TOOLS FOR EFFECTIVE LAUNCHING Rob Wieman, Rowan University; Jill A Perry, Rowan University; Andrew Tyminski, Clemson University; Grace Kelemanik, Fostering Math Practices; Gloriana Gonzalez, University of Illinois at Urbana-Champaign; Aaron Trocki, Elon University; Jennifer Ann Eli, The University of Arizona
Launching cognitively demanding tasks is a much valued, but little understood, aspect of ambitious mathematics teaching. This working group supports the development of descriptions, theory, and tools to support teachers, teacher educators, and researchers in understanding and developing skill in launching. We will identify the purposes of effective launches, common challenges teachers face, and structures and skills that teachers use when launching. The working group will facilitate and support ongoing discussion and collaboration between researchers, teacher educators, and practitioners that will contribute to our knowledge of effective launches.

056. WORKING GROUP: DESIGNING AND RESEARCHING ONLINE PROFESSIONAL DEVELOPMENT
Working Groups
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participant:
DESIGNING AND RESEARCHING ONLINE PROFESSIONAL DEVELOPMENT Jeffrey Choppin, University of Rochester; Julie Amador, University of Idaho; Cynthia Callard, University of Rochester; Cynthia Carson, University of Rochester; Ryan Gillespie, University of Idaho
In this working group, we continue with previous efforts to consider design and research methodologies related to teacher learning in online professional development contexts. Year Two of this discussion group will combine whole-group and subgroup time to converse about: (a) the challenges of online professional learning experiences, (b) research tools, methods, and analyses, (c) the connections among different projects and studies, and (d) future collaborations. Given recent technological advances and demands to support teachers in various contexts, we contend that researching these online models, as well as other online models is important for the broader field of mathematics education.

057. LUNCH AND GRADUATE STUDENT MENTORING LUNCH 1
12:00 to 1:00 pm
Hyatt Regency: Floor 1st - Regency A,B,C

057-1. FRIDAY LUNCH
PMENA
Special Event

057-2. GRADUATE STUDENT MENTORING LUNCH 1
PMENA
Graduate Student Event

058. MATHEMATICAL KNOWLEDGE FOR TEACHING BRIEF RESEARCH REPORT SESSION 2
Mathematical Knowledge for Teaching Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Crepe Myrtle
Participant:
EXAMINING TEACHER KNOWLEDGE RESOURCES FOR PROPORTIONAL REASONING WITH EPISTEMIC NETWORK ANALYSIS Chandra Hawley Orrill, UMass Dartmouth; Rachael Erikson Brown, Penn State Abington
We examine teachers' understanding of proportional reasoning using Epistemic Network Analysis as our lens. This allows us to see connections between the knowledge resources teachers use across a set of tasks. For this study, 32 teachers were divided into groups based on their performance on the LMT for Proportional Reasoning. The groups were then examined to compare the knowledge resources used and the connections between them. Implications for teacher development will be discussed.

**KNOWLEDGE RESOURCES FOR PROPORTIONAL REASONING IN DYNAMIC AND STATIC TASKS**
Rachael Eriksen Brown, Penn State Abington; Jinsook Frances Park, University of Massachusetts Dartmouth; Chandra Hawley Orrill, UMass Dartmouth

In this study, we consider the knowledge resources invoked by middle school teachers as they solve two related proportional reasoning tasks. In one, teachers were asked to think aloud about a situation in which an artist scales an image of a Santa. The other asked about the relationship in size between bears in a dynamic sketch during a clinical interview setting. Analysis focused on how the teachers solved both items. Findings focus on the homogeneities in response patterns. Latent class revealed three distinct latent classes based on teachers' math anxiety levels based on 952 students, limiting their academic achievement and mathematics self-confidence about mathematics. Findings focus on the knowledge resources that were invoked. Implications focus on why the knowledge resources matter and opportunities for additional research.

**059. STUDENT LEARNING AND RELATED FACTORS**
**BRIEF RESEARCH REPORTS SESSION 1**
Student Learning and Related Factors
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Dogwood

**LATENT CLASSES OF MIDDLE GRADES STUDENTS ON MATH ANXIETY**
Ibrahim Burak Olmez, University of Georgia

This study examined differences in middle grades students' math anxiety levels based on 952 Turkish 8th grade students' responses to the Math Anxiety Scale (Erol, 1989) located in different regions of Turkey. A mixture partial credit model analysis revealed three distinct latent classes based on homogeneities in response patterns. Latent class membership indicated that students in Class 1 had the lowest anxiety towards mathematics lessons, mathematics in daily life, and test and evaluation, and highest self-confidence about mathematics opposed to students in Class 3 with the highest anxiety in these characteristics and with the lowest self-confidence about mathematics.

**MATHEMATICS ANXIETY AND MEDITATION**
Geillan Aly, University of Hartford

Mathematics anxiety debilitates many mathematics students, limiting their academic achievement and quantitative literacy. Various treatments have been researched, however there is no definitive cure or successful intervention for this phenomenon. Meditation has been recognized as helping individuals reduce other forms of anxiety. However, research in this field is limited due to the internal nature of this practice. In this study, a technological tool called a Muse Headband is used to address the limitations of researching meditative practices to determine whether meditation can reduce mathematics anxiety. Results show that meditation can potentially help students reduce their mathematics anxiety.

**060. STUDENT LEARNING AND RELATED FACTORS**
**BRIEF RESEARCH REPORTS SESSION 3**
Student Learning and Related Factors
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Gardenia

**MATHMATICAL IDENTITIES: NARRATIVES AND DISCOURSES OF FEMALE STUDENTS IN AN 8TH GRADE CLASSROOM**
Bailey M Braaten, The Ohio State University

This research in progress examines two 8th grade female students’ socially constructed mathematical identities. Using ethnographic and discourse analytic methods, the study examined how these evolving mathematical identities intersect with gender identities. Preliminary results indicate female students in this study actively disrupt stereotypes of femininity and of women in mathematics. This study offers a fine-grain analysis of how female students identify with mathematics at a sociocultural level, and it provides insight on how these mathematical identities can develop and change over time.

**SELF-EFFICACY BELIEFS OF ADULTS WHO DISLIKE MATHEMATICS: CHALLENGING HOW WE MEASURE THE SOURCES**
Kevin Voogt, Michigan State University

To date, most research on the sources of mathematics self-efficacy has been quantitative in nature. The purpose of this study was to examine the sources of self-efficacy for a small group of young adults who dislike mathematics to uncover the more covert aspects of the sources of their mathematics self-efficacy. In this report, I share evidence from the analysis of semi-structured interviews with four such adults. Findings reveal complexity in how the sources inform participants' confidence in their mathematical ability as well as flaws in the methodology used in prominent quantitative studies examining the sources of mathematics self-efficacy.

**061. TEACHING AND CLASSROOM PRACTICE**
**BRIEF RESEARCH REPORTS SESSION 2**
Teaching and Classroom Practice
Brief Research Report Session
INVESTIGATING COLLEGE CALCULUS INSTRUCTORS’ KNOWLEDGE, DISPOSITION, AND RESPONSIVENESS TO STUDENT THINKING Jessica Gehrtz, Colorado State University
Effective instruction relies on an instructor’s knowledge of student thinking and ability to attend and respond to students’ mathematical strategies. Additionally, their disposition towards student thinking further influences how they respond to students, impacting student learning. A survey and task-based interviews were used to investigate instructors’ responsiveness to student thinking. Results from these analyses indicate that responsiveness to student thinking can be present during multiple phases of instruction (planning, assessing, and in-the-moment teaching) and provides specific instructional practices that relate to responsiveness to student thinking.

STUDENTS’ REACTIONS TO TEAM ACTIVITIES IN A LARGE-SCALE PRECALCULUS CLASS: A MIXED METHODS STUDY Gregory Downing, North Carolina State University; Karen Keene, North Carolina State University; Brooke Outlaw, North Carolina State University
Results from this study indicate that students who participated in Team Activities and other learner-centered activities in a large scale precalculus undergraduate classroom report a good experience and are more positive in their attitudes towards mathematics. Particularly, students valued the collaborative efforts in this mathematics classroom, something they do not often have the opportunity to do in a traditional mathematics course. This report has implications for large universities where many of the classes are taught at a large scale while instructors are focused on bringing in more active learning to improve instruction.

MEASURING TEACHER KNOWLEDGE OF TEACHING FOR ALGEBRA READINESS Hea-Jin Lee, The Ohio State University, Lima; Jaime Kautz, Ohio State University; Ivo Herzog, The Ohio State University, Lima
The purpose of this paper is to explore the impact of a year-long PD on teachers’ content and pedagogical knowledge of algebra readiness. Thirty-one 7th and 8th grade teachers participated in the study, and survey data and artifacts were analyzed to measure their understanding of teaching algebra readiness. This session shares teachers’ knowledge about students, teachers’ knowledge about algebra curriculum, and teachers’ knowledge about teaching algebra. Results suggest that teachers focus too much on pre 7th grade math concepts, have some misunderstanding about the content progression, and need to revisit both algebraic and non-traditional algebraic content.

STUDYING LESSON STUDY: CASES OF SECONDARY GEOMETRY TEACHERS Jenifer Hummer, University of Delaware
When teachers anticipate student responses, they are likely to be prepared to respond to student thinking in the moment and facilitate rich mathematical discussions. In this study, three participants in lesson study, secondary geometry teachers, anticipated student responses for selected tasks. The researcher, then, observed the teachers enact the tasks and investigated how the anticipation of student responses influenced enactment. The findings suggest that although participation in lesson study provides opportunities to anticipate student responses, this feature may not be sufficient in supporting teachers with enacting tasks in ways that facilitate open-ended discourse and maintain high levels of cognitive demand.

063. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS BRIEF RESEARCH REPORTS SESSION 3
Early Algebra, Algebra, and Number Concepts
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Redbud B
Participants:
A LONGITUDINAL STUDY: THE EFFECTS OF TIME AND EARLY INSTRUCTION ON STUDENTS’ INTEGER LEARNING Mahtob Aqazade, Purdue University; Laura Bofferding, Purdue University; Lizzie Chen, Graduate Student
We explored 102 students’ performance on integer addition and subtraction problems. Twenty-nine second graders received integer instruction (instruction-only) and three years later participated in our study again as fifth graders (instruction + time). Additionally, we analyzed seventy-three fifth graders to investigate the effect of time without instruction (time-only). The findings indicate no significant difference between instruction-only and time-only groups, a significant improvement for the instruction-only to instruction + time group on integer addition and subtraction problems, and a significantly better performance for the instruction + time group on integer subtraction problems. We further investigated students’ solution strategies for subtraction problems.
Comparisons with Closest and Most: Second and Fifth Graders’ Conceptions of Integer Value

Lizhen Chen, Graduate Student; Laura Bofferding, Purdue University; Mahtob Aqazade, Purdue University

Elementary students holding a whole number understanding have difficulty learning integer values. We administered a pretest and a posttest to 204 second and fifth graders and collected their answers to three types of integer comparison problems. We coded each comparison phrasing for students’ integer mental models and looked at changes within. Results showed that all students had difficulty determining which of three negative numbers was most positive but found it easy to determine which of three positive numbers was most positive and which of three negative numbers was most negative. Students had improvement, albeit varied, in their integer mental models.

064. Geometry and Measurement Brief Research Reports Session 2

Geometry and Measurement
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Redbud C

Participant:
Measurement and Conservation of Length: A Teaching Experiment with Tony and Sam
Brooke Mullins, Virginia Tech; Tiffany LaCroix, Virginia Tech

Measurement is a complex concept that involves the coordination of other ideas such as number, subdivision, and change of position. However, elementary school instruction on measurement differs from the concept of operational measurement and conservation of length. The purpose of this study is to investigate how two first grade students conceptualize measurement and conservation of length. Results show that although both students began at the same stage, one student was able to progress further than the other student and achieve operational measurement and conservation of length. Differences in each student’s thinking are analyzed and insights to future research are offered.

065. Inservice Teacher Education/Professional Development Brief Research Reports Session 3

Inservice Teacher Education/Professional Development
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency D2,E2,H

Participants:
Designing Spaces to Support Teacher Learning About Teaching Statistics
Gemma Foust Mojica, NC State University; Hollylynne S. Lee, NC State University; Jennifer N. Lovett, Middle Tennessee State University

This study examined how participation in online professional development impacted participants’ perspectives about statistics and teaching statistics. From 2015-2017, over 2500 educators from 50 US states and 84 countries participated in six offerings of the course. We will briefly describe the course design and how educators with diverse characteristics and experiences engaged in course material. We will discuss impacts on perspectives and how the design of the course influenced changes in perspective.

UNDERSTANDING THE WAYS GRADUATE TEACHING ASSISTANTS LEARN TO TEACH THROUGH DISCOURSE IN PROFESSIONAL DEVELOPMENT

Hayley Milbourne, San Diego State University; Susan Nickerson, San Diego State University

Across the United States, there is increased national interest in improving the way mathematics departments prepare their GTAs. We need an understanding of how GTAs interpret and make sense of various teaching practices. We report preliminary results on the ways in which the understandings of GTAs of various teaching practices changed over a term. With this analysis, we can better support GTAs with their teaching in the future. The research presented here represents the start of an increased understanding of how GTAs appropriate and transform their understanding of teaching practices.

066. Preservice Teacher Education Brief Research Reports Session 5

Preservice Teacher Education
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency D,E

Participants:
How Do Preservice Teachers Elicit the Thinking of a Student Who Has Made a Mistake?
Meghan Shaughnessy, University of Michigan; Rosalie DeFino, University of Michigan; Erin Pfaff, University of Michigan; Merrie Blunk, University of Michigan

Learning about the reasoning and understandings that underlie mathematical mistakes made by students is necessary for responsive instruction. We report on a study of the specific knowledge and skills that novices bring to teacher education for eliciting when a student has made a mistake and, if sufficiently probed, is able to recognize the mistake and revise their work. We illustrate how such data can be gathered through the use of a simulation. Our findings reveal the skills and capabilities of preservice teachers in one teacher education program.

Overcoming Implicit Bias: Perspectives from Pre-Service Mathematics
067. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 6
Preservice Teacher Education
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency F
Participants:

CRITICAL MATHEMATICS TEACHER NOTICING: TECHNOLOGY TO EXPLORE PRE-SERVICE TEACHERS OF COLOR NAVIGATING RACIAL POSITIONINGS Theodore Chao, The Ohio State University; Melissa Adams, The Ohio State University
Mathematics teacher noticing is a popular construct in mathematics teaching and mathematics teacher education. However, just as noticing draws attention to what a teacher "sees", noticing on what a teacher does NOT "see" is equally important. All teachers hold "blind spots". We utilized an online video commenting tool to analyze what elementary pre-service teachers of color notice about the language and positioning of their case study students through four-weeks of problem solving interviews. This tool served as a voice for teachers of color to reveal and confront the racist and deficit ideologies present in how their peers positioned their students.

INDIGENIZING THE MATHEMATICS CURRICULUM WITH PRE-SERVICE TEACHERS Sean Chorney, Simon Fraser University
In this research report, we examine shifts in the attitudes of pre-service teachers related to Indigenizing the mathematics curriculum. The implementation of a more social and activity-based approach to mathematics, alongside respectful discussions of how these approaches may align with Indigenous ways of knowing were explored. Through the use of positioning theory, student written responses were examined. By understanding the attitudes and concerns that pre-service teachers have regarding how to incorporate an Indigenous approach to learning in mathematics, we can begin to have productive conversations about how to embark upon this challenging task.

068. TECHNOLOGY BRIEF RESEARCH REPORTS SESSION 2
Technology
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency G
Participants:
PROMOTING COLLABORATION AND MATHEMATICAL ENGAGEMENT IN A DIGITAL LEARNING ENVIRONMENT Alden Jack Edson, Michigan State University; Merve Nur Kursav, Michigan State University; Amit Sharma, MSU
Promoting mathematics learning without developing students' engagement is a critical issue in the teaching and learning of mathematics. This study reports on the student and teacher perceptions on mathematics engagement in collaborative settings. Emerging themes arose through open coding of the responses. Findings of this present study revealed two themes: (a) the digital learning environment holds promise for promoting real-time collaboration and productive disciplinary engagement in mathematics and (b) in the digital learning environment, students requested explicit opportunities for initial individual work before accessing a shared workspace on the digital platform.

RESULTS OF A COMMON CORE MATHEMATICS TRAINING PROGRAM: VETERAN TEACHERS’ PERSPECTIVES Evelyn Seeve, Daemen College
This project reports on preliminary data gleaned from a Common Core mathematics professional development training with veteran elementary school teachers. The study investigated ways in which the training influenced the teachers' mathematics instruction, the teachers' perspectives regarding influences of the training on their students' mathematics communication and performance, and features of the program the teachers perceived useful in better aligning their instruction with Common Core mathematics standards. Results included the teachers' use of collaborative learning tasks and questioning strategies as well as the students' increased risk taking and use of varied mathematics strategies.

069. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORTS SESSION 4
Inservice Teacher Education/Professional Development
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A
Participants:
NOTICING IN SMALL GROUPS: BEYOND MATHEMATICAL THINKING Byungeoen Pak,
Participants: Hyatt Regency: Floor 2nd
1:00 to 1:40 pm
Brief Research Report Session

SESSION 3

TEACHER NOTICING OF STUDENTS’ PRIOR KNOWLEDGE
Gloriana Gonzalez, University of Illinois at Urbana-Champaign; Lisa Skultety, University of Illinois at Urbana-Champaign; Gabriela Elizabeth Vargas, University of Illinois at Urbana Champaign; Michelle Samet, University of Illinois at Urbana-Champaign

We investigate teacher noticing of students’ prior knowledge in the context of a professional development intervention that integrated lesson study, animation discussions, and video clubs with in-service geometry teachers. We analyzed video club discussions at different moments in the program using an adapted framework for teacher noticing of students’ prior knowledge. Results show that the animation discussion that preceded the video club did not include substantial discussion of students’ prior knowledge. Discussions in the middle of the 2-year intervention had the highest level of teacher noticing, coinciding the lesson revision process.

070. TECHNOLOGY BRIEF RESEARCH REPORTS SESSION 3
Technology
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B

Participants:
INVESTIGATING SPATIAL AND TEMPORAL REASONING OF ELEMENTARY STUDENTS THROUGH GAMIFIED MATHEMATICS SOFTWARE
Sheunghyun Yeo, University of Missouri-Columbia

The purpose of this study is to explore how elementary school students engage with the mathematical concepts embedded within “Spatial-Temporal” (ST) representations. I found the students tended to articulate the mathematical meaning of ST representations when they had more access to the mathematical concepts and the explicit structure of the task. However, some students appeared to make little sense of the apparent mathematical concepts. These findings suggest that ST Math tasks could improve engagement with the operational mathematical concepts, but a sense-making approach would additionally support a better relationship between ST representations and mathematical concepts.

THE EFFECT OF A COMPUTER-ASSISTED MODEL-BASED PROBLEM-SOLVING PROGRAM FOR STUDENTS WITH LEARNING DIFFICULTIES IN MATHEMATICS
Yan Ping Xin, Purdue University; Soo Jung Kim, Purdue University; Signe Kastberg, Purdue University; Yingjie Chen, Purdue University; Bingyu Liu, Purdue University; Qiengli Lei, Purdue University; Wudong Wang, Purdue University; Sue Ellen Richardson, Purdue University; Shuang Wei, Purdue University

According to recent National Assessment of Educational Progress (2015), 60% of American 4th graders performed below proficiency level in mathematics. For students with disabilities, about 85% performed below the proficiency. In the meantime, there is a serious shortage of curriculum materials and teachers in providing high quality Response-to-Intervention (RtI) programs to students who are struggling in mathematics. The purpose of this study was to evaluate the effect of a computer-assisted RtI program that emphasizes mathematical model-based problem solving on enhancing problem-solving performance of students with learning disabilities/difficulties. Findings from this study indicate promising effects of the program.

071. MATHEMATICAL PROCESSES BRIEF RESEARCH REPORTS SESSION 2
Mathematical Processes
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C

Participant:
EL EFECTO DE LOS ESTADOS EPISTÉMICOS (CERTEZA, DUDA) SOBRE EL APRENDIZAJE. MICROANÁLISIS DE UNA INTERACCIÓN
Rigo Lemini, Centro de Investigación y de Estudios Avanzados del I. P. N.

The study focuses on the relation between epistemic states (of doubt and certainty) and learning mathematics. Taking up the thread of concepts involved in Ausubel's theory of learning, the study specifically argues that epistemic states act inherently and directly on the parameters and intrinsic conditions of the learning processes of said discipline, by exercising a driving or inhibiting effect on the learning. Based on the analytical tools of the Grounded Theory, the argument is supported by way of the microanalysis of a case in which 2 secondary school students interact as they solve a ratio problem.

072. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 4
Preservice Teacher Education
CONSTRUCTING A FRAMEWORK
ACKNOWLEDGING THE SOCIOCULTURAL, CRITICAL, SPATIAL, AND QUANTITATIVE WAYS OF KNOWING THE WORLD
Lisa Poling, Appalachian State University; Travis Weiland, Appalachian State University
In this paper we discuss an epistemological framework rooted in a dialectic ontology of social, historical, and spatial dimensions. The framework is designed to make explicit the intersecting sociocultural, critical, quantitative, and spatial ways of knowing the world, which are inherent in mathematics education and quantitative learning environments more broadly. We posit this framework could be powerful for both designing learning experiences for pre-service mathematics teachers and for making explicit to pre-service teachers a lens for making sense of their own future classroom environments to enact a more just and comprehensive mathematics curriculum.

EXCHANGING DEFICIT FOR AFFORDANCE:
DEVELOPING PRESERVICE TEACHERS’ CAPACITY TO SEE EMERGENT BILINGUAL STUDENTS’ RESOURCES
Aaron T Wilson, University of Texas Rio Grande Valley; Hyung Won Kim, University of Texas Rio Grande Valley; M. Alejandra Sorto, Texas State University
In recent years educational researchers have been moving away from seeing students and learning through deficit lenses toward seeing them through affordance lenses, from focusing on what students cannot do to focusing on what they can do, and on the rich often cultural funds of knowledge that students from diverse backgrounds bring to learning, instead of on details and reasons for achievement gaps. This study was aimed at helping pre-service teachers to grasp the importance of their emergent bilingual students’ bilingualism and cultural backgrounds as resources to serve these students in apprehending mathematics instruction and explaining their mathematics to others.

ACHIEVING, LABORING, AND SURVIVING:
POSITIONING THROUGH MATERIAL AND IDEATIONAL IDENTITY RESOURCES IN STUDENT AUTOBIOGRAPHY
Emma Carene Gargroetzi, Stanford University
This study examined identity resources used and subject positions taken by 54 secondary students in autobiographical narratives of their experiences with mathematics (mathographies). The study asked 1) What material resources do students use to position themselves as different kinds of mathematics students? What typology of mathematics identities is revealed? And, 2) What ideational resources do students use to position themselves as different kinds of mathematics students? Findings revealed three predominant mathematics subject positions: celebrated high achiever, earnest laborer, and trauma survivor. Ideational identity resources included discourses of mathematics, of America and American schooling, and of race, language, and immigration.

073. LEARNING FROM NAEP RELEASED ITEMS:
U.S. ELEMENTARY STUDENTS’ GRASP OF MULTIPLICATIVE RELATIONSHIPS
Jack Smith, Michigan State University
This paper reports an analysis of all grade 4 released NAEP items that have expressed some multiplicative relationship, either numerically or quantitatively. Results show that items amenable to interpretation as equal groups are easier than other types of relationships among discrete quantities and to multiplicative items involving continuous quantities. The results provide measured support for the conjecture the additive introduction to multiplication may limit the development of elementary students’ understandings of the full range of multiplicative relationships.

074. REPRESENTATIONAL SAMENESS AND DERIVATIVE
Alison Mirin, Arizona State University
This study focuses on students’ understanding of multiple representations of functions. It examines student responses to a task in which calculus students are asked to evaluate the derivative at a point of the cubing function when represented...
piecewise. Results suggest that attending to the graph of the piecewise function does not improve students’ ability to differentiate it. Results also suggest that students tended to view a piecewise-defined function not as a singular function, but as a set of instructions for which function to use.

076. FRAMING ELEMENTARY SCHOOL TEACHERS’ CONSIDERATIONS WHEN ENGAGING WITH THEIR OWN STUDENT WRITTEN WORK
Inservice Teacher Education/Professional Development Research Report Session 1:50 to 2:30 pm Hyatt Regency: Floor 1st - Gardenia Participant: FRAMING ELEMENTARY SCHOOL TEACHERS’ CONSIDERATIONS WHEN ENGAGING WITH THEIR OWN STUDENT WRITTEN WORK Naomi Allen Jessup, Georgia State University Professional development (PD) is widely used to support teacher development and improve student learning. In PD, experienced facilitators use research-based frameworks to support and provide a lens for teachers’ engagement with artifacts of practices (e.g., student-written work). However, often what is unaccounted for in PD design is the use of teachers’ insider knowledge of their students. This study investigated considerations that arose when teachers engaged with student written work from their classes outside the PD experience. Results identify the range and prevalence of considerations used in teachers’ conversations with their written work. Also discussed are implications for professional developers.

077. INCOHERENT CALCULATIONS IN PROPORTIONAL TASKS
Preservice Teacher Education Research Report Session 1:50 to 2:30 pm Hyatt Regency: Floor 1st - Magnolia Participant: INCOHERENT CALCULATIONS IN PROPORTIONAL TASKS Surani Joshua, Arizona State University; Mi Yeon Lee, Arizona State University We investigated how pre-service teachers (PSTs) interpret their calculations in proportional tasks. A written questionnaire was administrated to 199 PSTs and an inductive content analysis approach used for data analysis. We found that one item that asked PSTs to interpret the meaning of their results had unusually low success; open coding on the responses revealed several common themes. We argue these common errors cannot be dismissed as simple unit or rounding mistakes; they are a reflection on how respondents think about quantities, story problems, and the nature of mathematics itself. We end with suggestions on how to address this problem.

078. USES OF COORDINATE SYSTEMS: A CONCEPTUAL ANALYSIS WITH PEDAGOGICAL IMPLICATIONS
Theory and Research Methods Research Report Session 1:50 to 2:30 pm Hyatt Regency: Floor 1st - Redbud A Participant: USES OF COORDINATE SYSTEMS: A CONCEPTUAL ANALYSIS WITH PEDAGOGICAL IMPLICATIONS Hwa Young Lee, Texas State University; Hamilton L Hardison, Texas State University; Teo Paoletti, Montclair State University Conventional coordinate systems are often considered representational tools for graphing and reasoning with mathematical concepts. However, researchers have shown that students experience persistent difficulties as they engage in graphing activity. In this theoretical report, we outline a framework based on a conceptual analysis of the use of coordinate systems as representational tools. We present examples from our research and textbooks in various domains to illustrate the different uses of coordinate systems. We discuss the implications that our framework could have for student learning, curriculum design, and teaching of coordinate systems and graphing activity and pose future research directions.

079. GENERALIZATION OF AN INVARIANT RELATIONSHIP BETWEEN TWO “QUANTITIES”
Mathematical Processes Research Report Session 1:50 to 2:30 pm Hyatt Regency: Floor 1st - Redbud B Participant: GENERALIZATION OF AN INVARIANT RELATIONSHIP BETWEEN TWO “QUANTITIES” Halil Ibrahim Tasova, University of Georgia; Kevin C. Moore, University of Georgia In this report, we present an analysis of prospective secondary mathematics teachers’ generalizing activities in quantitative contexts. Specifically, we draw from a teaching experiment to report how Lydia and Emma engaged in different generalizing processes for the same task. Based on these differences, we found Lydia’s generalizing activities (i.e., coordinating quantities) to be a more productive generalization than Emma’s (i.e., slopes of tangent lines). The former was extendable to a new case, instance, or situation, whereas the latter was constrained to a specific representational system.

080. A FINE-GRAINED ANALYSIS OF PROOF SUMMARIES: A CASE STUDY OF ABSTRACT ALGEBRA STUDENTS
**081. INVESTIGATING MTE QUESTIONING AS A RELATIONAL TEACHING PRACTICE**

Teaching and Classroom Practice
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Regency D2,E2,H

**Participant:**

INVESTIGATING MTE QUESTIONING AS A RELATIONAL TEACHING PRACTICE Alyson E. Lischka, Middle Tennessee State University; Signe Kastberg, Purdue University; Susan L. Hillman, Saginaw Valley State University

As mathematics teacher educators (MTEs), we present findings from interrogating our questioning practice in mathematics methods courses with the goal of improving our practice. Despite differences in our contexts, we found common characteristics across our questioning practices that informed ways we found to improve our practice so that it more closely aligned with our goals of relational teacher education, drawing on our prospective teachers’ (PTs’) experiences. Considering MTEs’ questioning practice within mathematics methods courses as an instantiation of practice for PTs, examining exemplars of practice such as this provide opportunity to engage in inquiry of questioning practice for improvement.

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**082. MIDDLE AND SECONDARY TEACHERS’ INFORMAL INFERENCEAL REASONING**

Statistics and Probability
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Regency D,E

**Participant:**

MIDDLE AND SECONDARY TEACHERS’ INFORMAL INFERENCEAL REASONING

Christopher Engledowl, New Mexico State University; James E. Tarr, University of Missouri

This study examined secondary mathematics teachers’ knowledge structures and informal inferential reasoning (IIR). Using task-based clinical interviews and cross-case analysis, nine teachers responded to four LOCUS assessment tasks. Responses were used to construct knowledge structure maps for measures of center, spread, and shape. Teachers’ IIR was analyzed for the appropriateness of responses and key components of IIR were identified. Teachers with more connected knowledge structures and fewer undesirable knowledge elements exhibited more acceptable forms of IIR. Although teachers engaged in the inference and data components of IIR, they rarely referenced uncertainty. Implications for teacher education and future research are discussed.

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**083. EMERGENT BILINGUALS AS TEACHERS: CONSTRUCTING STORYLINES IN AN ELEMENTARY MATHEMATICS CLASSROOM**

Teaching and Classroom Practice
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Regency F

**Participant:**

EMERGENT BILINGUALS AS TEACHERS: CONSTRUCTING STORYLINES IN AN ELEMENTARY MATHEMATICS CLASSROOM

Erin Smith, University of Southern Mississippi

Stereotypes and storylines for emergent bilinguals (EBs) permeate U.S. culture, have been historically deficit-oriented, and determine ways teachers and students interact with each other in classroom contexts. As a way to disrupt and challenge such narratives, one elementary teacher, Courtney, leveraged her authority to construct and foster the storyline of mathematical competence for EBs across multiple school years. One of the most frequent ways Courtney did this was to interactively position EBs as teachers in whole class mathematical interactions.

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**084. THE COMMON CORE MORAL PANIC**

Curriculum and Related Factors
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Regency G

**Participant:**

THE COMMON CORE MORAL PANIC Kevin Lee Watson, Virginia Tech; Steven Williams, Brigham Young University

The Common Core State Standards (CCSS) Initiative was initially met with great enthusiasm from politicians and education experts. However, as states began rolling out the standards, backlash...
against the Common Core became widespread, and several states ended up pulling out of the initiative. To explore and better understand why there was such a negative reaction to the Common Core, we make use of the sociology construct of Moral Panics, and present an argument that the response to the CCSS was indeed a moral panic.

085. DEVELOPMENT AND USE OF A CONJECTURE MAP FOR ONLINE PROFESSIONAL DEVELOPMENT MODEL
Theory and Research Methods
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A
Participant:
DEVELOPMENT AND USE OF A CONJECTURE MAP FOR ONLINE PROFESSIONAL DEVELOPMENT MODEL Jeffrey Choppin, University of Rochester; Julie Amador, University of Idaho; Cynthia Carson, University of Rochester; Cynthia Callard, University of Rochester
We discuss the development and use of a conjecture map for a research project on the design and implementation of an online professional development model. Following Sandoval’s (2014) model, we built the conjecture map to reflect our high-level conjectures, the features of the learning environment, the mediating processes, and the outcomes. After developing the conjecture map, we used it as an anchor for a number of our data analysis activities and for initiating design conjectures and theoretical conjectures. We also found that it was an expedient way to communicate the core conjectures and theoretical aspirations of our model.

086. RESOLUCIÓN DE PROBLEMAS Y USO DE TECNOLOGÍAS DIGITALES EN UN MOOC: DISEÑO E IMPLEMENTACIÓN
Technology
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B
Participant:
RESOLUCIÓN DE PROBLEMAS Y USO DE TECNOLOGÍAS DIGITALES EN UN MOOC: DISEÑO E IMPLEMENTACIÓN William Enrique Poveda Fernández, Centro de Investigación y de Estudios Avanzados del IPN; Daniel Aurelio Aguilar-Magallón, Centro de Investigación y de Estudios Avanzados del IPN; Adrián Gómez-Arciga, Centro de Investigación y de Estudios Avanzados del IPN
En este estudio se analizan y discuten los elementos del diseño y resultados de la implementación de un curso masivo abierto en línea (MOOC) que promueve la resolución de problemas basado en el uso de tecnología digital. Los resultados muestran que el diseño de las actividades, la intervención del equipo de diseño del MOOC en los foros de discusión y la interacción entre los participantes permitió y favoreció la creación de un ambiente de colaboración en la resolución de problemas. Los participantes compartieron y discutieron sus ideas matemáticas, lo que les permitió formular conjeturas y buscar propiedades para sustentar relaciones.

087. USING STRIP DIAGRAMS TO SUPPORT EXPLANATIONS FOR KEEP-CHANGE-FIP FOR FRACTION DIVISION
Preservice Teacher Education
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C
Participant:
USING STRIP DIAGRAMS TO SUPPORT EXPLANATIONS FOR KEEP-CHANGE-FLIP FOR FRACTION DIVISION Eric Siy, University of Georgia
In this presentation, I present data in which prospective middle school teachers explain a commonly used rule for fraction division—keep-change-flip. This paper shows different forms and uses of strip diagrams in fraction division and how prospective teachers used strip diagrams. I argue that using both strip diagrams and a single, quantitative definition for multiplication support prospective teachers when explaining why the rule works. The results of the study provide impetus for both mathematics teachers and mathematics teacher educators to teach with strip diagrams to provide coherence across multiple mathematical topics.

088. PROFESSIONAL DEVELOPMENT AND KNOWLEDGE GAINS FOR HIGH SCHOOL MATHEMATICS TEACHERS
Inservice Teacher Education/Professional Development
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participant:
PROFESSIONAL DEVELOPMENT AND KNOWLEDGE GAINS FOR HIGH SCHOOL MATHEMATICS TEACHERS Kristi Martin, North Carolina State University
This study examined the effects of the Local Systemic Change Through Teacher Enhancement Initiative (LSC) on in-service high school mathematics teachers’ knowledge. Because data are clustered by schools, a hierarchical linear model was calculated. It was found that five of the characteristics of the professional development had statistically significant effects on increasing teacher knowledge.

089. FRIDAY AFTERNOON BREAK
PMENA
Special Event
2:30 to 2:45 pm
Hyatt Regency: Floor 1st - Prefunction

090. FRIDAY POSTER SETUP
PMENA
Special Event
2:30 to 2:45 pm
Hyatt Regency: Floor 2nd - Teal Ballroom

091. BUSINESS MEETING
PMENA
Special Event
2:45 to 3:00 pm
Hyatt Regency: Floor 1st - Regency A,B,C

092. LOOKING BACK, LOOKING AHEAD: EQUITY IN MATHEMATICS EDUCATION
PMENA
Plenary Session
3:00 to 4:30 pm
Hyatt Regency: Floor 1st - Regency A,B,C
Presider:
Marta Civil, The University of Arizona
Discussant:
Laurie Rubel, Brooklyn College CUNY & University of Haifa

093. POSTER SESSION 1 & HAPPY HOUR
4:30 to 5:30 pm
Hyatt Regency: Floor 2nd - Teal Ballroom

093-1. CURRICULUM AND RELATED FACTORS
POSTER SESSION 1
Curriculum and Related Factors
Poster Session
Participants:
DYNAMIC GEOMETRY SOFTWARE (DGS) TASKS IN SECONDARY CURricula Milan F. Sherman, Drake University; Sarah Lorraine Wenaas, Drake University; Charity Cayton, East Carolina University; Alexandra Funsch, East Carolina University
This study examines the prevalence and use of Dynamic Geometry Software (DGS) in current secondary curricula. Mathematical tasks were analyzed from a sample of 20 Geometry, Algebra 2, and Integrated textbooks. Tasks were coded with regard to how DGS was used: (1) amplifier vs. reorganizer of students' thinking, and (2) whether DGS was used for exploration, justification, or verification. Of 1316 technology tasks, 110 tasks used DGS: 39 used DGS as an amplifier, while 71 used it as a reorganizer. With regard to DGS use, 90 tasks included exploration, 22 included justification, and 48 included verification.

EXAMINING CRITICAL CONVERSATIONS DURING CO-DESIGN OF INSTRUCTIONAL GUIDANCE DOCUMENTS Arren Duggan, UNC Greensboro; Catherine Schwartz, East Carolina State University; Michelle L. Stephan, UNC Charlotte; Denise Schulz, North Carolina Department of Public Instruction; Katherine Mawhinney, Appalachian State University
In this poster session, we share how a co-design team of 70 diverse stakeholders (state agency consultants, administrators, district curriculum directors, teachers, and higher education faculty) brought different lenses to inform decision-making about the clustering and sequencing of content standards and the duration needed to teach them. We report on the tensions in critical conversations about clustering and sequencing of standards during the initial phases of our design process, highlighting the ways in which actors drew on previous experiences, assessment concerns, curriculum materials, and mathematical learning progressions/trajectories to inform decision-making during the development of the instructional frameworks.

HOW TWO PROJECT-BASED MATHEMATICS TEXTBOOKS POSITION STUDENTS TOWARDS MATHEMATICS Kelly Curtis, University of Delaware
When examining the “voice” and the cognitive demand of the Core Plus (CP) and Mathematics Visions Project (MVP) written curriculums, the results revealed that even project-based curriculums do not position students in similar ways. CP tended to use more inclusive language and position students as thinkers more often than the MVP problems. Also, CP maintain the cognitive demand across in-class tasks and homework problem while MVP tended to lower the cognitive demand from in-class tasks to homework. Finally, CP tended to position students as high thinkers more often than MVP did. Therefore, the textbooks positioned students in very different ways.

INFLUENCE OF INTEGRATED STEM CURRICULA ON INSTRUCTION Christa Jackson, Iowa State University; Mollie Appelgate, Iowa State University; Ashley Delaney, Iowa State University; Kari Jurgenson, Iowa State University
Although many studies have shown teachers recognize the importance of STEM education, several educators do not agree on what constitutes STEM education (Wang et. al., 2011). Some argue STEM are siloed disciplines, others claim it is an integration of mathematics and science, while others contend it is an integration of all four disciplines. In this study, we examine how the implementation of DESCARTEs, an integrated STEM curricula unit, influence the fourth grade teachers’ perception of STEM instruction. Qualitative data was analyzed using an inductive approach. The results reveal the teachers valued the connection DESCARTEs made between the subjects.

THE DIFFERENCES IN HOW CALCULUS TEXTBOOKS INTRODUCE THE CONCEPT OF
DERIVATIVE COULD IMPACT CONCEPTUAL UNDERSTANDING Anita Nicole Alexander, Lent State University

There are several ways to introduce the concept of derivative in a calculus course. Deciding which method to introduce first can have implications for students’ conceptual understanding of the concept of derivative, which is critical for success in calculus and several subsequent mathematics courses, yet often educators use their primary textbook as their guideline for curriculum. This calculus textbook analysis attends to how five different textbooks introduced the concept of derivative, along with the types of examples provided, followed by the possible implications each of the three emerging methods could have on a conceptual understanding of the concept of derivative.

093-2. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS POSTER SESSION 1

Early Algebra, Algebra, and Number Concepts Post Session

Participants:

ASSESSMENT OF K-2 RELATIONAL REASONING SKILLS: STRENGTHS AND LIMITATIONS OF ITEM TYPES AND FORMATS Lindsey Perry, Southern Methodist University; Leanne Ketterlin-Geller, Southern Methodist University

On this poster, we will present instruments found to assess K-2 students’ numeric relational reasoning competence and examples of the items from each assessment. Examples for each of the three identified item types will be presented, and the depth of reasoning elicited by the items will be discussed.

COVARIATION GRAPHING PRACTICES: THE CHANGE TRIANGLE Konda Luckau, Brigham Young University; Daniel Siebert, Brigham Young University

Using a sociocultural lens to study graphing, we investigate the graphing practices of an experienced function-based algebra teacher to see how she uses the change triangle to support students reasoning about covariation and rates of change. We describe the elements of a change triangle and the ways the teacher attends to and reasons with these elements and multiple copies of the change triangle to enact a variety of practices as she completes common tasks related to functions and their graphs.

RANKING COGNITIVE DEMAND ACROSS MATHEMATICAL DOMAINS Sarah Kerrigan, Virginia Tech

M-capacity is an age-dependent construct describing the number of schemes or actions one can simultaneously hold in working memory at a time. Units coordination describes students’ engagement with various levels of units in mathematical tasks. Students are able to solve tasks with different levels of cognitive demand depending on their stage of units coordination and their M-capacity. We present a model that uses M-capacity to explain and predict students’ performance on tasks across different mathematical domains (multiplicative reasoning, fractions, algebraic reasoning), integrating schemes and actions from units coordination research.

RELATING UNITS COORDINATING AND READINESS FOR CALCULUS Jeffrey A Grabhorn, Portland State University; Steven James Boyce, Portland State University; Cameron Byerley, Colorado State University

Students sometimes experience success in school mathematics if they learn to reason with three levels of units in activity, which means they “build” an ephemeral third level of units as part of their way of reasoning rather than assimilating situations with a units (of units (of units)) structure. What connections exist, if any, between students’ units coordination and their readiness for Calculus? In this poster we compare calculus readiness and units coordination of 32 students enrolled in first-term Calculus at a university in United States. Implications for attending to students’ units coordination and teaching and learning Calculus are discussed.

SEEING THE MATH IN PATTERNS: CHILDREN’S ATTENTION TO NUMERICAL INFORMATION IN A REPEATING PATTERN TASK Emily Fyfe, Indiana University; Martha Alibali, University of Wisconsin-Madison

Patterns are ubiquitous in mathematics and children’s patterning skills are predictive of their concurrent and future performance on formal mathematics tasks. It is certainly beneficial for children to “see the patterns” in mathematics – for example, the regularity of the count sequence or the rules that govern the base-ten system. However, in the current study, we focused on children’s ability to “see the math” in patterns – for example, the number of different items in the pattern. The results provide evidence that some children spontaneously attend to the numerical information in patterns and this predicts their performance on a formal math task.

093-3. GEOMETRY AND MEASUREMENT POSTER SESSION 1

Geometry and Measurement Poster Session

Participants:

THE EFFICACY OF AN ALTERNATIVE HIGH SCHOOL GEOMETRY CURRICULUM ON STUDENT ACHIEVEMENT WITH PROOFS Wayne Nirode, Miami University

Looking back over the past 30 years, professional
organizations and policy makers have continued to make recommendations that high school geometry students should study proof, but students have continued to struggle with proof. Furthermore, teachers have claimed to lack instructional strategies to adequately help students. This research analyzes student achievement with proofs when learning geometry through an alternative curriculum. The results indicate that looking ahead this curriculum may be helpful in raising overall student achievement with proofs, but further refinement of the curriculum is needed in the area of students writing proofs given only a conditional statement.

YOUNG CHILDREN’S RESOURCES FOR DEFINING ASPECTS OF 3D SHAPE Megan Joanne Wongkamalasai, Vanderbilt University

Studies of young children highlight relations between their cognitive development and experiences moving in space (Oudgenoeg-Paz et al., 2015). Yet, current early mathematics instruction often ignores the resources children have to make sense of foundational properties of space. I present a design study conducted in a rural 1st grade classroom aimed at co-developing children’s concepts of 3D shape and defining practices to answer these research question: What resources from children’s everyday experiences with 3D shape and space help them define and conceptualize properties of 3D shape? How do children’s resources support the development of a new classroom practice of defining?

093-4. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT POSTER SESSION 1
Inservice Teacher Education/Professional Development Poster Session
Participants:

COACHING THE 5 PRACTICES THROUGH LESSON IMAGING Amanda R. Casto, UNC Charlotte; Rukiye Ayan, Middle East Technical University; Michelle L Stephan, UNC Charlotte; Luke Reinke, UNC Charlotte
Stein and Smith’s book, 5 Practices for Orchestrating Productive Mathematics Discussions, outlines five practices that support teachers who attempt to use a student-centered approach to instruction. Even though teachers may understand these practices after reading the book, it is another thing to be able to implement them, especially if there is little mentoring support at their school. The purpose of this poster proposal is to present preliminary data from a research study in which a mathematics coach attempted to lead a team of 7th-grade teachers to implement the five practices for the first time.

DEVELOPING SPECIAL EDUCATION TEACHER OBSERVATION INSTRUMENTS FOR MATHEMATICS INSTRUCTION Angela Rae Crawford, Boise State University

This poster presents the development of several teacher observation instruments focused on mathematics instruction for students with disabilities. Attention is placed on phases of development intended to translate mathematics education and special education research into practice. The results of an analysis of one rubric using many-facet Rasch measurement are described.

EXPLORING CONVERSATION THEMES IN PROFESSIONAL LEARNING GROUPS Jennifer Holm, Wilfrid Laurier University; Ann Kajander, Lakehead University

This poster examines and discusses the themes that were observed in the conversations of a professional learning group over the three-year research period. Since professional learning groups are participant-driven, this research adds to the existing literature by exploring what conversations the teachers felt were important in their mathematics teaching development.

HEAD START PRESCHOOL EDUCATORS’ CONCEPTIONS OF MATHEMATICS LEARNING AND TEACHING Paul N. Reimer, AIMS Center for Math and Science Education; Ralph T. Putnam, Michigan State University

We are working together with Head Start preschool educators in a professional development program focused on mathematics learning and teaching. Here we examine how these preschool teachers conceptualize children's mathematical learning and their own roles as teachers. Analysis of data collected from semi-structured interviews with teachers suggests that most teachers view their roles as instructors and nurturers, and value active engagement in children’s learning. Implications for
ongoing professional development and future study are discussed.

REHEARSALS WITH IN-SERVICE TEACHERS: RECOGNIZING AND RESPONDING TO TEACHERS’ CONFIDENCE Gemma Lynn Oliver, Michigan Technological University; John Gruver, Michigan Technological University

This study looks at using rehearsals in professional development with in-service teachers. In the past, Dewey expressed the need for teachers to have laboratory experience as part of their education. We studied how in-service teachers engage in these rehearsals so that math teacher educators can become more aware of how they can improve their students' engagement and create this laboratory style experience for them.

RURAL INSERVICE MATH TEACHERS’ PERSPECTIVES FROM A THREE-YEAR SUMMER MATH INSTITUTE PROFESSIONAL DEVELOPMENT PROJECT Karen R. Cheng, University of Tennessee, Knoxville; Nicholas King, University of Tennessee, Knoxville; Nicholas Scott Kim, University of Tennessee; Lynn Hodge, The University of Tennessee

This study examines the effects of a Summer Math Institute that is part of a three-year professional development project known as Math Counts. Math Counts focuses on supporting elementary teachers’ learning in math pedagogy and content in the context of a rural Appalachian school district. In this analysis, we focus on the development of the participating teachers’ pedagogical perspectives and content knowledge, drawing from surveys, content assessments, and interview data. The study informs the ongoing project and contributes to efforts that seek to support the mathematics learning of elementary students and their teachers in historically underserved communities.

TEACHER PERSPECTIVES ON FEEDBACK: A COMPARISON BETWEEN IMPLICIT THEORIES Kristin Hartland, Middle Tennessee State University

Learning is driven by what teachers and students do in the classroom; students build mathematical knowledge by discussing their thinking with peers and receiving meaningful feedback. However, studies have shown there are various factors that influence the feedback teachers provide. Although inconsistent feedback practices have been attributed to teachers’ beliefs, the implicit theory teachers hold has yet to be explored. Given the potential for a teacher’s implicit theory to have an impact on the type of feedback offered to students, the purpose is to examine whether teachers’ implicit theories act as a mediator of feedback given during mathematics instruction.

UNPACKING A GEOMETRIC LEARNING TRAJECTORY THROUGH THE ANALYSIS OF A MATHEMATICAL TASK AND STUDENTS’ STRATEGIES Jennifer M. Suh, George Mason University; Sara Birkhead, George Mason University

This study examines teachers use of the learning trajectory to plan, implement and debrief on student strategies to better understanding the developmental progression of geometric thinking during a Lesson Study. We found that the PD design and the VAULT tool allowed the teachers and the coach to focus on important elements of planning, implementing and reflecting on the learning. An essential learning for all teachers and researchers was how one single task can elicit the continuum of strategies that demonstrated where students were in their conceptual development and intermediate understandings.

093-5. MATHEMATICAL KNOWLEDGE FOR TEACHING POSTER SESSION 1

Mathematical Knowledge for Teaching Poster Session

Participants:

FUTURE TEACHERS’ PEDAGOGICAL CONTENT KNOWLEDGE IN MATHEMATICAL MODELING INSTRUCTION Ayse Ozturk, Ohio State University

This poster details a research findings on secondary preservice teachers’ pedagogical content knowledge for teaching mathematical modeling. Ferrini-Mundy and colleagues (2005) conceptualized three types of pedagogies that draw explicitly on mathematical knowledge domain of teachers: Decompressing, Trimming, and Bridging. Relying on this framework we examined preservice teachers’ knowledge of teaching mathematical modeling using case based interviews. Three secondary preservice teachers were on-one interviewed three times. In each interview, the participants worked on a modeling task and then commented on how they would implement the same task, challenges they anticipated regarding learners’ difficulties and their plans for addressing them.

PRESERVICE ELEMENTARY TEACHERS’ RECOGNITION OF ARITHMETIC PROPERTIES Gayle Maree Millsaps, Eastern Washington University; Carlow William Castillo-Garsow, Eastern Washington University

This study examines elementary preservice teachers’ (EPTs) recognition of the commutative, associative, and distributive properties prior to instruction. The goal of the study was to ascertain whether EPTs can recognize and use embedded arithmetic properties to categorize a set of equations when prompted to organize the equations into groups based on changes that they observe from one side of an equation to the other. Results indicate that EPTs do not implicitly recognize the properties before instruction and they still struggle with recognizing the distributive property after
Participants:

Poster Session

093-6. MATHEMATICAL PROCESSES POSTER SESSION 1
Mathematical Processes
Poster Session
Participants:

ELEMENTARY STUDENTS ATTEMPTS TO IDENTIFY AND JUSTIFY PATTERNS WITH A GRAPH THEORY PROBLEM Jenna Rae O'Dell, Bemidji State University

In this study, I investigated Grade 4 and 5 students attempts to identify and justify patterns while they were engage in the exploration of the Graceful Tree Conjecture. Ten students from an after-school program participated in seven task-based interviews. The students examined star, path, and caterpillar graphs. Overall, the Graceful Tree Conjecture was accessible to the students and they found patterns that enabled them to gracefully label the three specific classes of graphs.

EXPLORING STUDENTS’ UNDERSTANDING OF MODE AND MEDIAN Md Amiruzzaman, Kent State University

This study presents middle grade students understanding of mode and median. A teaching experiment shows how their learning has grown and how do they explain their understanding. Finding of this study suggests that some students may have less effective understanding and manipulative can be used to deepen their understanding.

THE RELATIONSHIP BETWEEN COGNITIVE RESOURCES IN MATHEMATICAL MODELING AND MATHEMATICS ACHIEVEMENT Jihyun Hwang, University of Iowa; Kyong MI Choi, University of Virginia; Brian Hand, University of Iowa

The purpose of this research is to connect cognitive attributes in mathematical modeling – analyze, select, compute, and represent – to mathematics achievement. We attempt to answer which cognitive resources significantly contribute to students’ achievement scores. We analyze students’ responses from grades 4 to 8 in standardized tests administrated from 2006 to 2012. Applying the generalized DINA and linear regression models result that the four cognitive attributes collectively have positive relationships to mathematics achievement. Additionally, students mastering “select” and “compute” can achieve high scores across grades 4 to 8. We suggest that different instructional emphasis is necessary at different grade levels.

TEACHING RATE OF CHANGE TO STUDENTS WITH DISABILITIES USING AN INTEGRATED CONCRETE-REPRESENTATIONAL-ABSTRACT APPROACH Kaitlin Bundock, Utah State University; Sharlene Kiuara, University of Utah

Rate of change is a challenging mathematical concept that has yet to be studied with students with disabilities. This poster reports the results of a multi-component intervention implemented within a single-subject multiple baseline study focused on improving the rate of change understanding of four 9th grade students with disabilities. The multi-component intervention consisted of an integrated Concrete-Representational-Abstract (CRA-I) approach, a problem-solving heuristic, and a writing to learn strategy. All participants improved their math scores following the intervention.

Improvements in math scores were maintained on assessments 1-7 weeks post-intervention.

093-7. PRESERVICE TEACHER EDUCATION POSTER SESSION 1
Preservice Teacher Education
Poster Session
Participants:

ELEMENTARY PRESERVICE TEACHERS BELIEFS RELATED TO MATHEMATICS Jennifer Cribbs, Oklahoma State University; John Weaver, Oklahoma State University; Adrienne Redmond-Sanogo, Oklahoma State University

In this study, we surveyed 70 elementary preservice teachers at a large public university in the Mid-west region of the United States. We explored the correlation between their beliefs and self-perceptions related to mathematics including: professional mathematics identity, mathematics identity, math mindset, math anxiety, teaching self-efficacy, and beliefs about teaching and learning mathematics. In addition, we assessed changes in these beliefs and self-perceptions over the course of a semester-long mathematics methods course. Our findings suggest significant correlations between the mathematics constructs being measured as well as changes in beliefs about teaching and learning mathematics.

PRACTICING TEACHERS PERCEPTIONS OF CONNECTIONS TO KNOWLEDGE AND SKILLS LEARNED IN THEIR TEACHER PREPARATION PROGRAM Brian Bowen, West Chester University

This purpose of this study was to develop a better understanding of the critical knowledge and skills
Prospective Elementary Teachers’ Use and Planning to Teach. We examine how secondary mathematics preservice teachers (PTs) respond to student thinking during rehearsals during a mathematics methods course. A trend practice-focused mathematics teacher education is the use of rehearsals to support PTs learning of the complex practice of mathematics teaching. Preliminary findings suggest that PTs made substantial use of questioning, but responses left students’ mathematical thinking opaque and left connections to students’ thinking implicit. These findings have implications for the design of coursework incorporating rehearsals as well as what teacher educators attend to while supporting PTs during rehearsals.

Preservice Teachers’ Use and Connections of Representations of Quadratic Function in Solving and Planning to Teach. This research a response to an enduring challenge of supporting preservice teachers (PT) to learn about teaching mathematics. We situate this work as an inquiry into how PTs use representations in learning and planning to teach. Initial analysis revealed PT were explicit about the nature of the growth in the dependent quantity (length or speed), and independent quantity (area or time) and were able to identify constant rate of rate of change in tables, but less explicit in graphical representations. There was a strong trace from PT use of representations for their own problem solving to their planning for instruction.

Prospective Elementary Teachers’ Noticing: Introducing a Trajectory of Children’s Multiplicative Thinking in a Content Course. This poster reports on the design and enactment of an intervention to support elementary prospective teachers (PTs) development of noticing children’s thinking in a first semester content course. We examine the following research questions: (1) How does the OGAP framework support PTs’ noticing of children’s multiplicative thinking; and (2) How does the OGAP framework support PTs’ development of knowledge of children’s multiplicative thinking? The results shared indicate PTs made improvements in their noticing and knowledge of children’s multiplicative thinking from pre- to post-survey.

Rights of the Learner and Rough Draft Thinking: Two Commitments for Humanizing Mathematics Teacher Education. This study examines the development of four preservice elementary teachers in their facilitation of discourse during their teacher preparation program. Video-recorded lessons were collected from each participant throughout the program. Using an existing matrix of discourse types along a continuum, all five-minute segments of the lessons were coded as to the primary discourse type evident. Findings indicate two participants showed progress over time in how they were facilitating math talk while the other two participants’ lessons remained relatively similar. This study can spark discussion in our field about how we measure, make sense, and generate developmental trajectories for mathematics pedagogy.

Using Self-Directed Learning to Promote Mathematical Engagement Among Preservice Teachers. A significant challenge in math education is to get students to engage with the material in meaningful ways. Self-directed learning (SDL), allowing
students to design their own learning projects around mathematics, is a powerful way to allow preservice teachers (PSTs) to connect math to their own needs and interests and thus, more deeply engage with mathematical concepts. Theoretical arguments for SDL as a way to deepen PSTs’ engagement in math are supported by the experience of two college professors who have used SDL in this capacity in their classrooms.

**USING THE ARRAY MODEL TO DEVELOP PROSPECTIVE TEACHERS’ UNDERSTANDING OF MULTIPLICATION AND ITS PROPERTIES**

Dana Olanoff, Widener University; Neet Priya Bajwa, Illinois State University; Ziv Feldman, Boston University; Eva Thanheiser, Portland State University; Rachael M. Welder, Western Washington University; Jennifer M. Tobias, Illinois State University

Research suggests that prospective teachers (PTs) should know other models of multiplication beyond equal groups. However, in our experience working with PTs, we have found that they struggle to interpret the area or array model of multiplication. We designed a sequence of tasks that focus on using an array model to understand the distributive property of multiplication over addition and the traditional and partial products algorithms for multiplication. We share our tasks, student work, and some ways that we revised the tasks to better meet our goals.

**093-8. STATISTICS AND PROBABILITY POSTER SESSION 1**
Statistics and Probability
Poster Session
Participants:

**MIDDLE AND SECONDARY TEACHERS’ PCK WITHIN IIR CONTEXTS**
Christopher Englewo, New Mexico State University; James E. Tarr, University of Missouri

This study examined middle and secondary mathematics teachers’ pedagogical content knowledge (PCK) for statistics within the context of informal inferential reasoning (IIR). Using task-based clinical interviews, nine teachers responded to four LOCUS tasks (Jacobe, 2016) and then two follow-up questions to identify plausible levels of PCK (Callingham et al., 2011). Teachers were found to exhibit higher levels of PCK when LOCUS items did not require engagement in IIR. Moreover, teachers’ background knowledge was not as consistently attributed to content background knowledge. Additional findings will be included on the poster, as well as implications for future research and teacher education.

**UNDERSTANDING PROBABILITY LITERACY OF HIGH SCHOOL STUDENTS**
Fred Albert Coon, University of North Carolina at Charlotte; Anthony Fernandes, UNC Charlotte

The purpose of the study is to understand the probability literacy of high-school students as stated by Gal’s (2005) framework. The result of uncovering students’ misconceptions and holes in probability literacy would be the devolvement of teacher training to improve probability literacy. Thus, students can become better prepared for using big data as they enter the work force. Semi-structured interviews will be conducted with high-school students with probability tasks that relate to chance, randomness, independence, and sample space. This poster will outline the students’ probabilistic thinking as they engage in the tasks.

**093-9. STUDENT LEARNING AND RELATED FACTORS POSTER SESSION 1**
Student Learning and Related Factors
Poster Session
Participants:

**CHARACTERIZING ABSTRACT ALGEBRA STUDENTS’ EPISTEMOLOGICAL BELIEFS ABOUT MATHEMATICS**
Rachel Rupnow, Virginia Tech

This poster examines the beliefs of abstract algebra students from two classrooms with different instructional approaches. Students’ beliefs were analyzed based on their responses to survey questions, and responses to open-ended questions in semi-structured interviews. Although differences between students’ beliefs were expected in the two classes based on differing instructional approaches, clearer differences in responses have emerged based on students’ backgrounds, such as the number of previous math classes taken, grades in previous classes, and students’ majors. Reasons for such differences will be explored.

**COGNITIVE AGENCY AND COMPUTER-BASED TASKS**
Meghan Riling, Boston University

While computer-based programs are responsive to student input, their algorithmic basis makes it more difficult for them to be prepared for divergent thinking, especially in comparison to teachers. How do students approach mathematics while using online materials? In this study, students worked in dynamic geometric environments (DGEs) during a geometry lesson. Of particular interest were episodes in which students asked one another to share results, which prompted students to reconsider previously set approaches, and episodes in which students interacted with DGEs containing many drag-able components, which corresponded to some students spontaneously suggesting and revising approaches for manipulating the DGEs.

**EXPLORING THE RELATIONSHIP BETWEEN PEDAGOGICAL APPROACHES AND STUDENTS’ MATHEMATICS IDENTITY DEVELOPMENT**
Paran Norton, Clemson University; Karen High, Clemson University
This poster will report the qualitative piece of a larger mixed-methods study aimed at comparing students’ mathematics identity in a traditional lecture and an active learning calculus classroom. Twelve semi-structured interviews were conducted to explore students’ perceptions of the pedagogy used in their calculus class. We will explore the normative identity established by the pedagogical methods as well as students’ personal identities, which will be described using the lens of self-determination theory. Preliminary analysis revealed that the active learning environment provided more opportunities that promoted students’ feelings of competence, autonomy, and relatedness than students in the traditional lecture classroom described.

INFLUENCING FACTORS THAT APPEAR IN THE TRANSITION FROM MONTESSORI MATH MATTERS: FIGURING MATHEMATICS TO TRADITIONAL METHODS Zachariah Benton Hurdle, Southern Arkansas University

CGI analysis was used to determine where the difficulties may lie in student understanding for fourth grade mathematics. Further, the learning pace and methods of discovery, the change of declaring solutions from materials to handwriting, and shifting role of students and teachers were all analyzed as potential factors in leaving Montessori.

MATH MATTERS: FIGURING MATHEMATICS LEARNING SPACES AROUND IMPORTANCE, UTILITY, AND SMARTNESS Missy D. Cosby, Michigan State University; Oyemolade Osibodu, Michigan State University

Building off Martin’s (2000) mathematical identity framework, we sought to understand how a group of second and fourth graders conceptualized aspects of mathematics learning such as what it means to be smart in mathematics, the utility of mathematics, and if mathematics matters in the world. Using theoretical framing around situated meanings, social languages, figured worlds, and Discourses (Gee, 2014), coupled with critical discourse analysis of the focus group transcripts, preliminary findings reveal that teacher actions, various student behaviors, and summative assessment grades play a major role in students meaning-making about mathematical competence.

POWERFUL KNOWLEDGE: LANGUAGES AND IDENTITY IN CHILDREN’S MATHEMATICS LEARNING THROUGH FAMILY WORKSHOPS Cristina Valenica Mazzanti, University of Georgia; Martha Allesaht-Snider, University of Georgia

Educators concerned with equity in mathematics education have called us to view mathematics and schooling through parents’ eyes (Caspe & Alves, 2017) and to consider Latino and other immigrant parents as intellectual resources, recognizing their knowledge, languages and experience as important resources in mathematics teaching and learning (Civil, 2007). In this study we considered what we learned from a series of family workshops utilizing the following research question: How can we create diverse spaces for family engagement that support mathematics learning and draw on the wide range of knowledge and experiences that immigrant families bring to their young children’s education?

STUDENTS’ FRAMING OF MATHEMATICAL TASKS IN CLINICAL INTERVIEWS Monica Anthony, University of Maryland, College Park; Janet Walkoe, University of Maryland, College Park

Framing has been used in science education research to attend to how students understand tasks, and how that understanding impacts their performance on the task and their interactions with others. This study describes the framing employed by two college-Algebra students during clinical interviews.

093-10. TEACHING AND CLASSROOM PRACTICE POSTER SESSION 1
Teaching and Classroom Practice Poster Session

Participants:

BEGINNING MATHEMATICS TEACHERS’ USES OF INSTRUCTIONAL STRATEGIES AND ORGANIZATION OF STUDENTS FOR LEARNING Michele Cudd, North Carolina State University; Derek A Williams, Montana State University; Karen Hollebrands, North Carolina State University

We observed beginning secondary mathematics teachers’ classrooms to investigate the ways in which they organized students for learning, their uses of instructional strategies, how these may differ based on the level of course being taught, and whether these choices vary over time. We found teachers consistently utilized whole class instruction for about half the time and provided students opportunities to learn in small groups more than as individuals. Differences in both student organizations and instructional strategies were noted when comparing different levels of courses.

COMPARING INTERDISCIPLINARY TEACHING APPROACHES Tara Colleen Davis, Hawaii Pacific University; Katherine Vera Aumer, Hawaii Pacific University

This study compares the synthetic interdisciplinary approach with the informed disciplinary approach in math and psychology on its impact on math efficacy, perception of psychology as a science, and mathematics problem solving ability. We used a survey instrument, which included math tasks, as well as 10 questions from the PISA survey so that we can make broader comparisons. Preliminary results show that students taking the interdisciplinary course felt that their math abilities
improved from the beginning to the end of the semester, while students taking the disciplinary math course did not feel like their math abilities improved.

CONNECTING A TEACHER'S USE OF SCAFFOLDING PRACTICES TO IN-THE-MOMENT NOTICING JiHy Lee, The Ohio State University; Arnulfo Perez, Ohio State University; Adam R. Scharfenberger, The Ohio State University; Bailey M Braaten, The Ohio State University

This brief research report discusses analysis of an in-service teacher's in-the-moment noticing and its relation to scaffolding practices in the context of an exploratory robotics unit. The study contributes to the body of knowledge on noticing and scaffolding with a focus on those practices that amplify the effectiveness of hands-on or inquiry-based approaches in mathematics. In particular, findings highlight the scaffolding strategies that were effective in translating in-the-moment teacher noticing into opportunities for students to engage more fully in mathematical ideas and practices.

EXPLORING FIRST GRADERS' ORAL AND WRITTEN MATHEMATICAL EXPLANATIONS Nicole Venuto Gearing, Georgia State University

Communicating their thinking in mathematics is challenging for young children. This brief report studied the change in first-grade students' oral and written solution explanations before and after six problem-based mathematics lessons that focused on developing conceptual understanding of adding or subtracting a 2-digit number and a multiple of ten. To encourage growth in their communication skills, students in both groups were asked to talk about their strategies, while the intervention group was asked to both talk and write about their strategies during each lesson. Results for each group are reported.

INVESTIGATING GROUP PROBLEM POSING FOR SECONDARY STUDENTS IN A LINEAR FUNCTIONS-BASED INTERVENTION Robert Anthony Mixell, University of Delaware

The NCTM has advocated student use of multiple representations and mathematical connections. Additionally, one important 21st-century skill is collaboration. I explored how high-school student groups participating in group problem posing incorporate representations and mathematical connections and how students intellectually engage with respect to role negotiation. Groups of Integrated Mathematics 2 students participated in daily lessons and problem-posing sessions. Problem scenarios, video transcriptions, field notes, and written reflections were analyzed. Groups struggled to purposefully incorporate mathematical connections and representations. One group failed to intellectually engage in collaborative ways. More research is needed for fostering representation use, connections, and shared intellectual engagement.

RECOGNIZED MATHEMATICS INSTRUCTORS' BELIEFS ABOUT LEARNING Valentin Küchle, Michigan State University

Prior research on teachers' beliefs suggests a relationship between teachers' instructional practices and their beliefs about learning. The focus of this work, however, has largely been limited to the beliefs of K–12 teachers. In an attempt to extend this line of research to the undergraduate level, this qualitative methods study tackles the question of what beliefs about learning mathematics are being held by undergraduate mathematics instructors who have been recognized for their teaching excellence through institutional awards. The purposes of the study are to document these beliefs as well as to compare them with views espoused by mathematics educators.

THE EFFECTS OF INQUIRY-BASED PEDAGOGY ON STUDENTS' ATTITUDES IN MATH AND INTENT TO PURSUE STEM Karisma Morton, The University of Texas at Austin; Ursula Nguyen, The University of Texas at Austin

Utilizing data from the U.S. portion of the TIMSS, this study investigates whether students' experiences of inquiry-based learning in their mathematics classrooms predict having favorable attitudes towards math, and whether and how such patterns might vary by gender as well as by race/ethnicity.

TRADITIONAL VERSUS STANDARDS-BASED GRADING: A COMPARISON OF THE TEACHING PRACTICES OF SECONDARY MATHEMATICS TEACHERS Michelle Ann Morgan, University of Northern Colorado; Robert Powers, University of Northern Colorado

There has been a movement in recent years towards developing alternative systems for measurement and evaluation of academic achievement and performance. This quantitative survey study sought to determine and describe the impact of standards-based grading practices on instruction in traditional, secondary (Grades 7–12) mathematics classrooms across a state in the Rocky Mountain region of the United States. The research team developed an online questionnaire and invited 2565 secondary mathematics teachers to participate. The results of this study suggest a need for follow-up research studies as well as a need for pre-service and in-service teacher preparation and support.

WRITING IN MATHEMATICS CLASS: ELEMENTARY MATHEMATICAL WRITING TASK FORCE RECOMMENDATIONS Madelyn Colonnese, University of North Carolina Charlotte

Discourse has long been emphasized as a central component of mathematics instruction. Written
discourse however, has not been clearly defined. To address this lack of clarity, the Elementary Mathematical Writing Task Force was convened. The purpose of this poster is to provide a description of the processes used by the task force to identify recommendations for the overarching goals, and the types of and purpose for mathematical writing. Additional considerations for elementary mathematical writing will also be shared.

GROUPING FOR "DIVERSITY": AN EQUITABLE PRACTICE? Cara Haines, University of Missouri; Charles Munter, University of Missouri

In this presentation, we share an investigation of how a group of secondary mathematics teachers, working in an urban district in which racial equity was a focus of leadership, described equitable approaches to arranging students for small-group work. We focus on a subset of results in which teachers described arranging students so that each small group mirrors the whole-class demographics—grouping for “diversity.” In particular, we discuss teachers’ rationales for this strategy, which we interpret as a conflation of “equity” and “diversity” rooted in a misinterpretation of the value of racial desegregation. Implications for both research and practice are considered.

093-11. TECHNOLOGY POSTER SESSION 1
Technology Poster Session

Participants:
CONSTRUCTING MICROWORLDS,
CONSTRUCTING KNOWLEDGE,
CONSTRUCTING COMMUNITIES:
MATHEMATICAL MICROWORLDS AND
CONSTRUCTIVIST THEORY James Sheldon,
University of Arizona; Kai Rands, National Coalition
of Independent Scholars

Mathematical microworlds are computer-based exploratory environments with a restricted set of operations but which have no fixed goals. Theories of learning take on a particular importance, as the way in which these environments are used in the classroom depends on how a particular instructor believes that students learn. This literature review surveys nine key articles on learning theory and microworlds, with a particular focus on how social constructivist theories can be used to explain the interactions between the student and the computer.

FLIPPED MATHEMATICS INSTRUCTION OBSERVATION PROTOCOL Wenmin Zhao,
University of Missouri; Jaepil Han, University of Missouri; Jessica Kamuru, University of Missouri; Zandra de Araujo, University of Missouri; Samuel Otten, University of Missouri

Extant classroom observation protocols do not adequately examine the key aspects of flipped mathematics instruction or the nuances between flipped and non-flipped instruction. In this poster, we will share our Flipped Mathematics Instruction Observation Protocol (FMIOP) designed to capture variations in flipped and non-flipped mathematics lessons. FMIOP may serve as a tool that better informs practice in flipped classroom settings.


We explored how directed actions, body movements that learners are instructed to formulate, combine with language systems to produce co-speech gestures in learning geometric proofs. Gestures have been shown to reveal abstract and generalizable mathematical thinking; this evidence was used to inform the design of an augmented reality game, The Hidden Village (THV). THV uses verbal prompts to connect actions (arm motions) to mathematical ideas that the game automatically detects in real-time using motion-capture hardware like Microsoft Kinect. In two randomized controlled trials, researchers found both quantitative and qualitative evidence for the connections between language and gesture in learning geometry.

MATHEMATICAL OPPORTUNITIES FOR LEARNING IN FREELY AVAILABLE PBS APPLICATIONS Amy Noelle Parks, Michigan State University; Laura Tortorelli, Michigan State University

The goal of this study is to explore the affordances of freely available technological resources by answering the question: What opportunities for learning mathematics do mathematics applications designed and made available by the Public Broadcasting Company make possible for urban kindergarteners? This poster reports Phase 1 of the study, which included a mathematical content analysis of PBS applications, an analysis of initial teacher feedback, and a preliminary analysis of usage data that revealed how frequently children engaged with mathematics games in their classrooms.

PRE-SERVICE TEACHERS’ USE OF TPACK THROUGH THE CREATION OF VIDEO LESSONS
TOOCH INTERACTIVE LEARNING GAME.

A study conducted explores first graders' learning gains and reactions to using touchscreen tablets and computer mice in an interactive learning game. A study conducted failed to reveal significant differences between computer and iPad groups in first graders when using a dynamic math notation tool.

WIDE WALLS, COMPUTATIONAL THINKING, AND MATHEMATICS Brandon Dickson, Huron University College at Western University; Lauren M Harris, Huron University College at Western University; Taylor Boyd, Huron University College at Western University; Donna Kotsopoulos, Huron University College at Western University

In this research, we explored two different approaches to integrating computational thinking in the learning of mathematics in a grade seven class. Some propose that computational thinking should be the medium through which mathematical thinking is explored. Others suggest that computational thinking is an object of itself and should be introduced as the basis of other subject-based learning. To explore these contexts we consider learning framed as “wide-walls” and we contemplate optimal structures for engaging in both computational thinking and mathematical learning. Implications for classroom instruction and further research will be discussed.

093-12. THEORY AND RESEARCH METHODS

POSTER SESSION 1

Theory and Research Methods
Poster Session
Participants:

NATURE, CHALLENGES, AND STRATEGIES OF STEM RESEARCH TEAMS William Samuel Walker, Purdue University; Elizabeth Suazo-Flores, Purdue University; Mahtob Aqazade, Purdue University; Hanan Alyami, Purdue University; Signe Kastberg, Purdue University

Researchers examined the nature of STEM research collaborations, challenges, and strategies to enrich interactions by reviewing eight research articles from mathematics education journals. The nature of the research collaborations was multidisciplinary or interdisciplinary. Challenges included: (a) interacting and conducting research in two or more disciplines, (b) translating integrated findings into viable applications, and (c) having institutional/community support for research involving multiple disciplines. Strategies for enriching interdisciplinary research included: (a) focusing on communication and collaboration, (b) developing reconceptualized or more efficient models, (c) identifying shared research questions, and (d) understanding the role mathematics plays with other disciplines.

WHERE IS (IN)EQUITY? EXAMINING AN URBAN SCHOOL DISTRICT’S POLICIES FOR PURSUITING RACIAL EQUITY IN MATHEMATICS Charles Munter, University of Missouri; Cara Haines, University of Missouri; Erica N. Mason, University of Missouri

We describe an approach to assessing the alignment
in how school districts frame problems of inequity in mathematics and how they respond with equity-focused policies and initiatives. In our examination of one urban school district, our analyses revealed that at times district leaders framed sources of inequity and corresponding pursuits of equity at different levels (classroom, institutional, etc.) and according to different equity dimensions (achievement, access, identity, or power), suggesting that their attempts to address inequities were sometimes misdirected. With our poster we will discuss implications for research and policy.

094. STEERING COMMITTEE MEETING
PMENA
Special Event
5:00 to 6:00 pm
Hyatt Regency: Floor 1st - Boardroom

095. GRADUATE STUDENT SOCIAL
PMENA
Graduate Student Event
5:45 to 6:30 pm
Embassy Suites: Up on the Roof

096. SATURDAY MORNING COFFEE
PMENA
Special Event
7:00 to 9:00 am
Hyatt Regency: Floor 1st - Prefunction

097. SATURDAY REGISTRATION
PMENA
Special Event
8:00 to 5:00 pm
Hyatt Regency: Floor 1st - Meeting Planner Office

098. NATIONAL SCIENCE FOUNDATION MENTORING SESSION
PMENA
Special Event
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Boardroom
Bring an idea and get feedback from a program director.
Presider: Karen Keene, North Carolina State University

099. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 8
Preservice Teacher Education
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Crepe Myrtle
Participants:
CO-PLANNING WITH INTERNS: ENVISIONING NEW WAYS TO SUPPORT INTERN DEVELOPMENT OF EFFECTIVE LESSON PLANNING Maureen Grady, East Carolina University; Charity Cayton, East Carolina University; Ronald V Preston, East Carolina University; Catharina Middleton, East Carolina University

In this presentation we examine the potential of co-planning to assist interns in making the transition from mathematics education student to mathematics teacher. Learning to plan effectively is an important part of interns’ experiences, yet little guidance is provided to mentors about working with interns to develop knowledge of planning. We will share background on the development of six co-planning strategies. Data will be shared from our research study about interns’ and mentors’ perceptions about comfort level with particular strategies, benefits and challenges of co-planning, and the value of using co-planning in the internship setting.

PRE-SERVICE TEACHER DESIGN OF ACTIVITIES THROUGH COLLABORATION AND AUTHENTIC ENACTMENT Michael S Meagher, Brooklyn College - CUNY; Michael Todd Edwards, Miami University of Ohio; Asli Ozgun Koca, Wayne State University
Pre-service mathematics teachers collaborated with a Master Teacher in the authentic implementation of lesson plans in high school classrooms. The pre-service teachers made small strides in their own ability to design activities. There were indications that the pre-service teachers experienced growth in recognizing the value of collaboration and revision. There were limits to their ability to enact lesson learned about cognitive demand in their own activity design.

100. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS BRIEF RESEARCH REPORTS SESSION 4
Early Algebra, Algebra, and Number Concepts
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Dogwood
Participants:
CONCEPTUAL ANALYSIS OF STUDENTS’ SOLVING EQUAL SHARING PROBLEMS Jaehong Shin, Korea National University of Education; SooJin Lee, Korea National University of Education
In the present study, we conduct conceptual analysis based on schemes and operations to explain how students with different mathematical levels would solve equal sharing problems. We suggest two distinctive schemes (distributive sharing scheme and splitting scheme for composite units) as the key schemes each of which independently supports the students’ solving equal sharing problems.

USING VISUAL MODELS IN FRACTION DIVISION: NUMBER LINES SUPPORT CHILDREN’S ACCURACY AND CONCEPTUAL UNDERSTANDING Pooja Gupta Sidney, Kent State University; Clarissa Ann Thompson, Kent State University; Ferdinand Rivera, SAN JOSÉ STATE UNIVERSITY
101. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 7
Preservice Teacher Education
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Gardenia
Participants:
ASSESSING PRESERVICE SECONDARY TEACHERS’ PRACTICE WITH ‘STANDARDIZED STUDENT INTERVIEWS’ Allyson Hallman-Thrasher, Ohio University
This study used a standardized, practice-based assessment of 13 preservice secondary math teachers to determine how they responded to a common student error in algebra. Data included a video-recorded interview with a researcher who played the role of a ninth-grade algebra student demonstrating a common student error that indicated a lack of conceptual understanding. Data were analyzed using cognitive demand of a task implementation and features of a math-talk community. Findings indicate participants were able to elicit student thinking but were not able to respond in meaningful ways that supported conceptual understanding or made connections among representations.

PROMOTING KNOWLEDGE INTEGRATION IN TEACHER PREPARATION Matthew Winsor, Illinois State University; David Barker, Illinois State University; J Vince Kirwan, Kennesaw State University
In this study, we investigated the opportunities secondary pre-service teachers (PSTs) had to integrate their knowledge of mathematics, learners, and pedagogy in a methods and content course taught in tandem. In particular, we describe and report on the instructional moves associated with this potential knowledge integration. Implications for pre-service teacher education and directions for further research will be provided.

102. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORTS SESSION 7
Inservice Teacher Education/Professional Development
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Magnolia
Participants:
SEEING GOALS “COME TO LIFE”: THE AFFORDANCES OF PRACTICE FOR TEACHERS’ WORKGROUP CONVERSATIONS Anna Weltman, University of California, Berkeley
Shifts in student participation prompted by math teachers’ experiments with a new teaching strategy created opportunities for the teachers to learn about student perseverance. The practice, in which teachers asked students stuck on a math problem to share three things they know, achieved one desired goal and got students “unstuck,” but the teachers wondered whether the practice supported students to persevere in the sense of learning to draw on one another as resources. Through negotiation of a shared, new, and problematic experience in the classroom, the teachers problematized their prior conceptions of perseverance.

SUPPORTING AN INQUIRY STANCE THROUGH DOUBLE DEMONSTRATION LESSONS Lucy Watson, Middle Tennessee State University; Angela T. Barlow, University of Central Arkansas; Alyson E. Lischka, Middle Tennessee State University
We present discussion of a professional development (PD) model aimed at engaging teachers in an inquiry stance (Farmer, Gerretson, & Lassak, 2003) toward teaching. Our ongoing PD project employed demonstration lessons in various forms to explore classroom practices. In the double demonstration lesson format, teachers took an active role in changing an observed lesson and then viewing impacts of those changes as a second lesson was taught. We provide evidence that this structure provided opportunities for teachers to engage in an inquiry stance on teaching and discuss implications for PD providers in structuring activities to foster an inquiry stance.

103. THEORY AND RESEARCH METHODS BRIEF RESEARCH REPORTS SESSION 2
Theory and Research Methods
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud A
Participants:
THEORIZING A TRANSLANGUAGINGSTANCE: ENVISIONING AN EMPOWERING PARTICIPATORY MATHEMATICS EDUCATION JUNTOS CON EMERGENT BILINGUAL STUDENTS Luz Angelica Maldonado, Texas State University; Melissa Adams, The Ohio State University; Gladys Helena Krause, The University of Texas at Austin
This session proposes a conceptualization of a
translanguaging stance in the bilingual mathematics classroom. This conceptualization is illustrated in observations of emergent bilingual students by making mathematical connections to four important translanguaging elements: (1) Con respeto for other’s ideas, leading to positive intellectual relations, (2) Con cariño, a commitment to the learning of others, (3) Como familia, working for the good of the classroom collective and for the benefit of individuals, and (4) Con acompañamiento, where teachers actively do math with their students. Through a translanguaging stance we posit a new lens through which to better cultivate bilingual mathematics classrooms.

THEORY, ETHICS, AND EQUITY IN INTRA-ACTION IN MATHEMATICS EDUCATION: LOOKING BACK, LOOKING FORWARD

This paper considers the intra-actions between poststructural theories and mathematics education over the last 40 years and considers how these theories have resulted in different ways to think students, teachers, and knowledge production. I argue that thinking in intra-action with various and different theories can allow us to ask different questions and radically rethink school mathematics.

104. TECHNOLOGY BRIEF RESEARCH REPORTS
SESSION 5
Technology
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud B
Participants:

USING TABLET TECHNOLOGY TO PROMOTE PARENT/CHILD MATHEMATICAL DIALOGUE

Emily Nicole Dennett, The Ohio State University; Theodore Chao, The Ohio State University; Christa Jackson, Iowa State University; Ashley Delaney, Iowa State University; Kari Jurgenson, Iowa State University

This study investigated how a weekly mathematically-focused text message to parents, which shared 1) what children were learning about in mathematics class, and 2) an idea to build on this mathematics topic at home, were perceived and used by parents. We found that parents highly valued this regular communication, not only because they appreciated hearing from the school but because it connected them more with their child and their child’s mathematical learning. Parents also shared that the texts influenced how they thought about their child’s mathematical learning and increased mathematical talk at home.

105. TECHNOLOGY BRIEF RESEARCH REPORTS
SESSION 4
Technology
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud C
Participants:

AN EXPLORATORY APPROACH TO ANALYZING STUDENTS’ EYE MOVEMENTS WHEN SOLVING MATH PROBLEM

Shuang Wei, Purdue University; Yingjie Chen, Purdue University; Yan Ping Xin, Purdue University; Signe Kasberg, Purdue University

Eye movement is important data to understand students’ cognition process. But the big size of data makes it challenge for educator and researchers discover valuable patterns. This paper proposes using visualization to explore eye movement raw data and applying Shneiderman visual information-searching theory: “Overview first, zoom and filter, details on demand” to eye movement data exploration process to enable educators to discover temporal and spatial patterns easily and logically.

FAILING TO REWIND: STUDENTS’ LEARNING FROM INSTRUCTIONAL VIDEOS

Aaron Weinberg, Ithaca College; Jason Martin, University of Central Arkansas; Matthew Thomas, Ithaca College; Michael Tallman, Oklahoma State University

We investigate how students watch and learn from a set of calculus instructional videos, which were designed to support the development of covariational reasoning between related quantities needed to graph the function modeling the instantaneous speed of a car. Using pre- and post-video problems, a survey about the students’ sense-making and data about the students’ interactions with the video, we found that many students failed to make significant learning gains and appeared to not recognize their own moments of confusion or lack of understanding. These results highlight potential issues that students face when trying to learn from instructional videos.

106. STUDENT LEARNING AND RELATED FACTORS
BRIEF RESEARCH REPORTS SESSION 4
In this brief report of some ongoing research, we propose expanding traditional conceptions of teachers' MKT to include decision making. We explore this idea using the decisions two teachers make while implementing an exponential task to create an equation from context using a table to highlight how. This framing allows us to better understand the mathematical reasoning teachers know to be relevant for students to complete a mathematical process and the actual actions they choose to engender this reasoning.

108. MATHEMATICAL PROCESSES BRIEF RESEARCH REPORTS SESSION 3
Mathematical Processes
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency F
Participants:

MAGNITUDE REASONING: CHARACTERIZING A PRE-CALCULUS STUDENT’S QUANTITATIVE COMPARISON BETWEEN COVARYING MAGNITUDES

Biyao Liang, University of Georgia; Irma Emma Stevens, University of Georgia; Halil Ibrahim Tasova, University of Georgia; Kevin C. Moore, University of Georgia

This paper discusses a student coordinating and comparing amounts of change in two covarying
quantities’ magnitudes (as opposed to numerical values). We describe not only his coherent system of mental actions involved in coordinating magnitudes, but also how this system affords his reasoning about graphical concavity and a quotient between magnitudes. We find that multiplicatively comparing quantities’ magnitudes plays a critical role in this construction.

THE PARALLELOGRAM PROBLEM: SUPPORTING COVARIATIONAL REASONING IN THE CONSTRUCTION OF FORMULAS

Irmak Emma Stevens, University of Georgia

In this study, I consider students’ uses of covariational reasoning with a dynamic situation to construct symbolic representations, namely, a formula to represent the covariational relationship between one of the interior angles of a parallelogram and its area. In this report, I propose a definition for reasoning covariationally with formulas and provide a first order model of what it means to do so. I then provide the results of the analysis of two preservice teachers’ activities with this task, highlighting the role of their formula and the bidirectional relationship between students’ images of a situation and their representation of it.

109. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORT SESSION 8

Inservie Teacher Education/Professional Development Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency G

Participants:

SITUATING DEFICIT DISCOURSE IN THE CONTEXT OF SOCIAL INTERACTION

Sunghwan Byun, Michigan State University

The persistence of deficit discourse has been one of the enduring challenges in mathematics education. This paper aims to contribute to the discussion by situating deficit discourse in the context of social interaction. Drawing on conversation analysis and discursive psychology, I offer an analysis of a conversation that happened in an equity-oriented professional development session. The findings show that deficit discourse was mobilized to do a particular context-specific action, and the action was achieved with multiple rhetorical devices. Thus, successfully countering deficit discourse involves micropolitics and rhetorical resources and skills.

TEACHERS’ INSIGHTS ON EARLY MATH EDUCATION AS A WAY TO CONNECT WITH REFUGEE CHILDREN

Elif Karsli-Calakmak, University of South Carolina; Martha Allexsah-Snider, University of Georgia; Sinan Olkun, Final International University

In this study, we draw on a RefugeeCrit framework and focus on teachers’ perspectives on the interplay of culture, language, and early mathematics in the teaching and learning of Syrian children in Turkey. In our 2-year exploratory project we focus on mathematical patterns and bring together components, each of which require the consideration of the needs of the teachers. One trend we see is the teachers’ ideas about what mathematical patterns as a content offer children’s algebraic thinking, and teachers’ previous multicultural teaching experience, along with their own personal histories, seem to shape the way they support refugee children in mathematics.

110. TEACHING AND CLASSROOM PRACTICE BRIEF RESEARCH REPORTS SESSION 3

Teaching and Classroom Practice
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A

Participants:

A CHARACTERIZATION OF STUDENT MATHEMATICAL THINKING THAT EMERGES DURING WHOLE-CLASS INSTRUCTION: AN EXPLORATORY STUDY

Laura Van Zoest, Western Michigan University; Keith Rigby Leatham, Brigham Young University; Okan Arslan, Mehmet Akif Ersoy University; Mary Achieng Ochieng, Western Michigan University; Joshua Michael Ru, Western Michigan University; Blake Peterson, Brigham Young University; Shari L Stockero, Michigan Technological University

This exploratory study investigated 164 instances of student mathematical thinking that emerged during whole-class instruction in a high-school geometry course. The MOST Analytic Framework provided a way to categorize these instances according to their Building Potential—that is, the potential for learning to occur if the student thinking of the instance were made the object of consideration by the class. We discuss variations in Building Potential that emerged from our analyses to highlight the complexity of teaching, and the need to support teachers in identifying and appropriately responding to instances with different levels of Building Potential.

STUDENT PARTICIPATION, AUTHORITY AND TOGETHERNESS IN A COLLABORATIVE MATH TASK: WITH AND WITHOUT THE TEACHER

Heather Fink, University of California - Berkeley; Anna Zarkh, University of California, Berkeley

To support equitable learning opportunities during group work, it’s important that participation imbalances are visible to teachers. We analyze two seemingly collaborative student-pairs working on a math task to understand what is made available to notice about participation and positioning on two levels: (1) what a teacher can observe during teacher-group interactions (2) what is noticeable
during group work when the teacher is absent. We found that while participation in the content and mathematical discourse practices was imbalanced during group work for both pairs, for one of the pairs, balance in authority and togetherness masked the participation imbalance during teacher-group-interaction.

111. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 9
Preservice Teacher Education
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B
Participants:
ONLINE LEARNING EXPERIENCES AND IMPACT ON STATISTICS EDUCATION PERSPECTIVES
Taylor Harrison, NC State University; Christina Azmy, NC State University; Hollylynne S. Lee, NC State University
Results from a study examining how teaching materials specifically designed for providing rich experiences in teaching and learning statistics in an online environment may impact the statistics education perspectives of preservice and inservice teachers.
PRE-SERVICE TEACHERS’ PERCEPTIONS OF THE USE OF REPRESENTATIONS AND SUGGESTIONS FOR STUDENTS’ INCORRECT USE MI Yeon Lee, Arizona State University; Ji-Eun Lee, Oakland University
We investigated how elementary pre-service teachers (PSTs) perceive using representations in teaching mathematics and what models they suggest to guide students’ incorrect use of representations in teaching fractions. A written questionnaire was administrated to 151 PSTs and an inductive content analysis approach was used for data analysis. Findings suggested that PSTs valued understanding concepts and making connections between representations and concepts. Findings also showed that PSTs tended to use models procedurally and predominantly depended on circular area models in guiding students who use representations incorrectly. Implications for designing mathematics methods courses in terms of effective use of representations are discussed.

112. STUDENT LEARNING AND RELATED FACTORS BRIEF RESEARCH REPORTS SESSION 5
Student Learning and Related Factors
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C
Participants:
DEVELOPMENT OF MATHEMATICS COMPETENCE, IDENTITY, AND SENSE OF BELONGING TO A COMMUNITY OF MATHEMATICS LEARNERS Michael Duane Hicks, Texas State University; Hiroko K Warshauer, Texas State University; Max Leon Warshauer, Texas State University
In this paper, we consider the ways in which out-of-school educational programs extend support to young high-achieving African-American students with an interest in STEM. We present a qualitative case study of three female African-American students enrolled in a mathematics summer camp intended for high school students interested in higher-level mathematics. We report on how these students found the program impacted their own growth and development in several specific domains.

EFECTS OF AN INTENSIVE REMEDIAL MATH COURSE ON ENGINEERING STUDENTS’ MATH ANXIETY AND MATH SELF-EFFICACY Gustavo Moran-Soto, Instituto Tecnologico de Durango; Paranh Norton, Clemson University
This article explores the relationship between an intensive remedial math course for freshmen engineering majors and students’ math anxiety (MA) and math self-efficacy (MSE) levels. Data were collected from 565 students using items from the existing Mathematics Anxiety Rating Scale and the Mathematics Self-Efficacy Survey. This study uses Analysis of Covariance (ANCOVA) to determine the effects of the remedial course on students’ MA and MSE while controlling for confounding variables. Results showed a significant increase in students’ MA and MSE levels after the intensive course. Implications for math instructors designing this type of remedial course are discussed.

113. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORTS SESSION 6
Inservice Teacher Education/Professional Development
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participants:
IMPLEMENTING MATHEMATICAL MODELING FOR EMERGENT BILINGUALS Ji-Yeong I, Iowa State University; Ricardo Martinez, Iowa State University of Science and Technology; Betsy Anne Araujo Grando, Iowa State University of Science and Technology
In this study, a researcher collaborated with a middle school mathematics teacher through co-planning, teaching and reflecting upon mathematical modeling lessons to support emergent bilinguals to make sense of mathematics. We investigate how this collaboration impacts the process of co-teaching and co-planning in terms of the interactions between the researcher and the teacher. Through this project, the researcher and the teacher employed multi-tier
design-based research to co-develop mathematical lessons based on modeling problems and co-taught the lessons for emergent bilinguals in an urban middle school.

MODELS AND MODELING PERSPECTIVE IN MEXICO, THE MICHOACÁN FOREST Veronica Vargas-Alejo, University of Guadalajara; César Cristóbal-Escalante, University of Quintana Roo; Aarón Víctor Reyes-Rodriguez, Autonomous University of Hidalgo
This study describes the processes of solving a Model-eliciting activity called the Avocado Cultivation. The goal is to examine the potential of the activity in supporting mathematical knowledge and rethinking the mathematical learning in this new age. The theoretical framework was the Models and Modeling perspective. Eight teachers took part in this qualitative research. They were teaching at high school. The findings indicate that MEA provides opportunities for teachers to modify, extend and refine ways of thinking, validate the estimation to predict situations, and confront traditional ideas.

114. AN ANALYSIS OF HIGH SCHOOL STUDENTS TAKING STATISTICS USING THE HSLS:09 DATASET
Statistics and Probability
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Boardroom
Participant:
AN ANALYSIS OF HIGH SCHOOL STUDENTS TAKING STATISTICS USING THE HSLS:09 DATASET Travis Weiland, Appalachian State University
I report results of an analysis using a large scale public dataset (HSLS:09) to investigate which students are taking statistics courses in high school to begin to understand the access students have to opportunities to learn statistics concepts and practices in high schools in the United States. The main result of this study is that predominantly the top academically performing high school students are earning credit for taking statistics. This is concerning as all students should have experiences learning concepts and practices from statistics to be prepared to engage and play active roles in today’s data centric societies.

115. RAZONAMIENTO DIGITAL: REPRESENTAR, EXPLORAR Y RESOLVER PROBLEMAS VERBALES CON EL USO DE GEOGEBRA
Technology
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Crepe Myrtle
Participant:
RAZONAMIENTO DIGITAL: REPRESENTAR, EXPLORAR Y RESOLVER PROBLEMAS VERBALES CON EL USO DE GEOGEBRA Adrián Gómez-Arciga, Centro de Investigación y de Estudios Avanzados del IPN; Carmen Olvera-Martínez, Facultad de Ciencias Exactas de la Universidad Juárez del Estado de Durango; Daniel Aurelio Aguilar-Magallón, Centro de Investigación y de Estudios Avanzados del IPN; William Enrique Poveda Fernández, Centro de Investigación y de Estudios Avanzados del IPN
En este estudio se analizan y contrastan acercamientos que futuros profesores de matemáticas de bachillerato muestran al resolver problemas de palabras con el uso de papel y lápiz y, posteriormente, con el uso de un Sistema de Geometría Dinámica (SGD). Se analizan los recursos, representaciones, estrategias y formas de razonamiento matemático que exhiben los participantes cuando utilizan GeoGebra en el proceso de resolución de los problemas. Los resultados muestran que el uso de la herramienta favorece la exploración dinámica de los conceptos involucrados, la formulación de conjeturas y la búsqueda de distintos argumentos para validar la solución.

116. TACIT, TRICK, OR “TEACH”: WHAT IS GINA’S MATHEMATICAL REALITY?
Student Learning and Related Factors
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Dogwood
Participant:
TACIT, TRICK, OR “TEACH”: WHAT IS GINA’S MATHEMATICAL REALITY? Jessica Heather Hunt, NCSU; Beth Loveday MacDonald, Utah State University; Juanita Maria Silva, Texas State University
We present findings from design research that depicts the natural and fractional number knowledge of one third grade student with learning disabilities (LDs) in seven experimental sessions. We utilize qualitative analysis methods to illustrate how this student evidenced her knowledge of natural number and fractions through her interactions with varied learning situations. Through presenting this data, we raise questions about the child’s reality and what the child’s apparent knowing and learning was relying upon. We report on the child’s mathematical reality specific to her number and fractional knowledge as modeled across varying task types and persistent difficulties the child experienced.

117. ON TEACHING ACTIONS IN MATHEMATICAL PROBLEM-SOLVING Contexts
Teaching and Classroom Practice
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Gardenia
Participant:
ON TEACHING ACTIONS IN MATHEMATICAL PROBLEM-SOLVING CONTEXTS Jerome Proulx, UQAM
In this research report, the question of the role of the teacher in problem-solving contexts is addressed, particularly in relation to the development of mathematical concepts. Data extracts from a problem-solving session are used to draw out three sorts of teaching actions that aim to push forward the mathematics in the classroom. These teaching actions are discussed in light of verbatim extracts and of available theoretical constructs from the research literature.

118. HOW DO UNDERGRADUATE STUDENTS MAKE SENSE OF POINTS ON GRAPHS IN CALCULUS CONTEXTS? 
Mathematical Processes
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Magnolia
Participant:
HOW DO UNDERGRADUATE STUDENTS MAKE SENSE OF POINTS ON GRAPHS IN CALCULUS CONTEXTS? Erika J David, Arizona State University; Kyeong Hah Roh, Arizona State University; Morgan Early Sellers, Arizona State University
This study examines undergraduate students’ graphical interpretations in the Cartesian coordinate system while evaluating Calculus statements. We found that the students we interviewed attended to different attributes of points on graphs that we provided. Some students focused on the input and output values represented by the points, which we term value-thinking. Others focused on the location of the points in space, which we call location-thinking. We report our classification of students’ graphical interpretations in these terms, which emerged from our data. Our findings indicate that students’ thinking about graphs accounts for key differences in their understandings of mathematical statements.

119. MATHEMATICS AND LANGUAGE INTEGRATION IN A CLIL CLASSROOM: AN ANALYSIS OF GENRE 
Student Learning and Related Factors
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Redbud A
Participant:
MATHEMATICS AND LANGUAGE INTEGRATION IN A CLIL CLASSROOM: AN ANALYSIS OF GENRE José Manuel Martínez, Michigan State University
Teachers in mathematics classrooms where the language of instruction differs from students' first language face competing demands regarding mathematics and language teaching. In this study, I conducted an analysis of genre of teaching episodes to examine how a teacher in a Spanish immersion third-grade classroom in the US responded to those demands. Findings indicate that the genres on which the teacher drew are associated with mathematics and with language classrooms, in addition to general genres that can be found in either classroom. I argue that the teacher's awareness of school demands and of students' needs influenced how genre-switching unfolded.

120. BEGINNING TEACHER FEEDBACK IN THE CONTEXT OF A CO-TAUGHT INCLUSION MATH COURSE 
Inservice Teacher Education/Professional Development Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Redbud B
Participant:
BEGINNING TEACHER FEEDBACK IN THE CONTEXT OF A CO-TAUGHT INCLUSION MATH COURSE Corinne Rose Glenwerks, Tufts University
As schools adopt co-teaching models to implement inclusion practices (US Department of Education, 2010), teachers are increasingly being asked to operate with a co-teacher (Scruggs et al., 2007). However, most co-teaching research does not examine factors that may influence co-teaching relationships over time (Scruggs et al., 2007). This paper seeks to address that gap by considering the feedback two co-teachers gave one-another as they taught a high school mathematics course and how that feedback affected their practice. The results of this work contribute to the body of co-teaching research by offering insights into a specific case of mathematics teacher collaboration.

121. GRADE 5 STUDENTS’ NEGATIVE INTEGER MULTIPLICATION STRATEGIES RESEARCH REPORT 
Early Algebra, Algebra, and Number Concepts
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Redbud C
Participant:
GRADE 5 STUDENTS’ NEGATIVE INTEGER MULTIPLICATION STRATEGIES Camilla Hope Carpenter, George Fox University; Nicole Marie Wessman-Enzinger, George Fox University
Twenty-four Grade 5 students participated in clinical interviews where they solved integer multiplication number sentences. Drawing on the theoretical perspective of strategies that students use with whole number multiplication and within the integer literature, we modified the strategies that children employ when negative integers are incorporated with multiplication. The students used
similar strategies for whole number multiplication (e.g., direct modeling), but used these strategies differently (e.g., using cubes to represent -1). The students also used unconventional strategies for solving integer multiplication, such as analogies. The results highlight the important constructions of students prior to formal integer instruction on multiplication.

122. IDENTIFYING LATENT CLASSES OF MIDDLE GRADES TEACHERS BASED ON REASONING ABOUT FRACTION ARITHMETIC
Mathematical Knowledge for Teaching
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Regency D2,E2,H
Participant:
IDENTIFYING LATENT CLASSES OF MIDDLE GRADES TEACHERS BASED ON REASONING ABOUT FRACTION ARITHMETIC Ibrahim Burak Olmez, University of Georgia; Andrew Izsak, Tufts University
This study examined distinct latent classes of middle grades teachers with respect to reasoning about fractions. Survey response data came from a nationwide sample of 990 in-service middle grades teachers. The survey focused on four components of reasoning about fractions in terms of quantities: referent unit, partitioning and iterating, appropriateness, and reversibility. The mixture Rasch model analysis detected three latent classes, each with strengths and weaknesses. Chi-square tests indicated significant relationships between latent class membership and various teacher characteristics including gender, mathematics credential, grade-level experience, and highest grade-level certification. The results extend recent advances in measuring mathematical knowledge of teachers.

123. NAVIGATING DILEMMAS OF STUDYING MATHEMATICS ENGAGEMENT IN SECONDARY CLASSROOMS
Theory and Research Methods
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Regency D,E
Participant:
NAVIGATING DILEMMAS OF STUDYING MATHEMATICS ENGAGEMENT IN SECONDARY CLASSROOMS Amanda Jansen, University of Delaware; Adi Wiezel, Arizona State University; Xiaoxue Zhang, University of Delaware; Kelly Curtis, University of Delaware; James A Middleton, Arizona State University
To better understand how to support high school students’ engagement with mathematics, advancements in research methods that provide greater understandings of malleable factors of engagement and conditions that affect students’ engagement are needed. In this conceptual paper, we introduce four dilemmas that researchers need to navigate to study secondary students’ engagement with mathematics: How can we concurrently capture engagement in-the-moment and at scale? What counts as a moment or experience? What sorts of experiences could be engaging? Whose perspectives on the experience should be privileged? We propose approaches for navigating these dilemmas in the context of a current research project.

124. SECONDARY MATHEMATICS STUDENT TEACHERS’ TYPES OF NOTICING WHILE TEACHING
Preservice Teacher Education
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Regency F
Participant:
SECONDARY MATHEMATICS STUDENT TEACHERS’ TYPES OF NOTICING WHILE TEACHING Dawn Teuscher, BYU; John Matthew Switzer, Texas Christian University
We will share how secondary mathematics student teachers’ notice student mathematical thinking while teaching. We will discuss the importance of focusing on the interrelatedness of the noticing skills rather than reporting on individual skills separately. We will identify student teachers’ ability to elicit and interpret student mathematical thinking in-the-moment while teaching. Results suggest that our student teachers are eliciting and attending to student mathematical thinking while teaching, but how they are interpreting the elicited student thinking varies. We hypothesize three reasons for why student teachers may have interpreted student mathematical thinking at a general level.

125. THE INITIAL TREATMENT OF THE AREA MEASUREMENT IN THE SELECTED US AND KOREAN ELEMENTARY TEXTBOOKS
Curriculum and Related Factors
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 1st - Regency G
Participant:
THE INITIAL TREATMENT OF THE AREA MEASUREMENT IN THE SELECTED US AND KOREAN ELEMENTARY TEXTBOOKS Dae S. Hong, University of Iowa; Kyong MI Choi, University of Virginia; Cristina Runnalls, University of Iowa; Jihyun Hwang, University of Iowa
This study compared area lessons from Korean textbooks and US standards-based textbooks to understand differences and similarities among these textbooks, as well as how these textbooks address known learning challenges in area measurement.
126. WHAT INFLUENCES DO INSTRUCTORS OF THE GEOMETRY FOR TEACHERS COURSE NEED TO CONTEND WITH?
Geometry and Measurement
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A
Participant:
WHAT INFLUENCES DO INSTRUCTORS OF THE GEOMETRY FOR TEACHERS COURSE NEED TO CONTEND WITH? Patricio G Herbst, University of Michigan; Amanda M Milewski, University of Michigan; Michael Ion, University of Michigan; Heather Bleecker, University of Michigan
This paper reports on a project aimed at developing a system of professional support for the improvement of the Geometry for Teachers course that mathematics departments teach to preservice secondary teachers. We share data from interviews with 20 instructors to report on how they perceive their position of geometry instructors and the work they do in the course. We unpack the tensions they have to contend with using the framework of professional obligations to the discipline, to individual students, to the institution, and to the classroom community. We share how these professional obligations emerged in the interview data.

127. HIGH-QUALITY INSTRUCTION ≠ HIGH-LEVEL NOTICING: EXAMINING FACTORS THAT INFLUENCE TEACHERS’ NOTICING
Teaching and Classroom Practice
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B
Participant:
HIGH-QUALITY INSTRUCTION ≠ HIGH-LEVEL NOTICING: EXAMINING FACTORS THAT INFLUENCE TEACHERS’ NOTICING Dionne Cross Francis, Indiana University; Ayfer Eker, Indiana University; Jinqing Liu, Indiana University; Kemol Lloyd, Indiana University; Abdul Alhaayan, Indiana University; Courtney Flessner, Indiana University
In this study, we investigate the relationship between teachers’ noticing and the quality of their mathematical instruction. Seven elementary teachers participated in five coaching cycles in efforts to improve their mathematics instruction. We analyzed teachers’ conversations about their coaching videos and scored their level of noticing and the mathematical quality of the instruction of the lesson. We compared teachers’ noticing levels with their MQI scores for each coaching cycle. In this proposal, we discuss the cognitive and psychological constructs that seemed to influence with teacher’s noticing. Results show that each of the constructs influenced the teacher’s noticing to varying degrees.

128. PRESERVICE SECONDARY MATHEMATICS TEACHERS’ PERCEPTIONS OF PROOF IN THE SECONDARY MATHEMATICS CLASSROOM
Preservice Teacher Education
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C
Participant:
PRESERVICE SECONDARY MATHEMATICS TEACHERS’ PERCEPTIONS OF PROOF IN THE SECONDARY MATHEMATICS CLASSROOM Kristin Lesseig, Washington State University; Gregory Hine, The University of Notre Dame Australia; Kaleinani S Titcomb, Washington State University
The purpose of this survey research was to investigate how PSMTs in Australia and the United States perceive of proof in the context of secondary mathematics teaching and learning. PSMTs were able to outline various mathematical and pedagogical aspects of proof, including: purposes, characteristics, reasons for teaching, and imposed constraints. In addition, PSMTs attended to differing, though overlapping, features of proof when asked to determine the extent to which proposed arguments constituted proofs or to decide which arguments they might present to students.

129. MATHEMATICS EDUCATION STAKEHOLDERS PROFESSIONAL NETWORKS AND USE OF RESEARCH EVIDENCE
Inservice Teacher Education/Professional Development
Research Report Session
9:20 to 10:00 am
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participant:
MATHEMATICS EDUCATION STAKEHOLDERS PROFESSIONAL NETWORKS AND USE OF RESEARCH EVIDENCE Jared Webb, North Carolina A&T State University; Peter Holt Wilson, UNC-Greensboro; Lisa Ashe, NC Dept of Instruction
We present findings from an exploratory study of mathematics education stakeholders to understand their professional networks and acquisition and use of research on mathematics teaching and learning. Evidence suggests that mathematics leaders are key to promoting organizational sensemaking and are more likely to acquire and use research on mathematics teaching and learning which has important implications for improvement efforts at scale.

130. SATURDAY MORNING BREAK
PMENA
Special Event
10:00 to 10:30 am
Hyatt Regency: Floor 1st - Prefunction

131. WORKING GROUP: DEVELOPING A RESEARCH
AGENDA OF K-8 TEACHERS' IMPLEMENTATION OF DIGITAL CURRICULA

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Boardroom

Participant:

DEVELOPING A RESEARCH AGENDA OF K-8 TEACHERS' IMPLEMENTATION OF DIGITAL CURRICULA Shannon Driskell, University of Datyon; Steve Rhine, Pacific University; Rachel Harrington, Western Oregon University

The purpose of this working group is to understand how teachers are implementing digital curricula to teach elementary mathematics, to explore best teaching practices for using digital curricula, and to understand how students are learning from digital curricula. We propose a working group on digital curricula that focuses on the themes of: access, equity, and empowerment; data generation/use; mathematical content; motivation and mindset; and nurturing NCTM Mathematics Teaching Practices and Common Core State Standards for Mathematical Practices.

132. WORKING GROUP: MATHEMATICAL MAKING IN IMMERSIVE VIRTUAL ENVIRONMENTS

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Crepe Myrtle

Participant:

MATHEMATICAL MAKING IN IMMERSIVE VIRTUAL ENVIRONMENTS WORKING GROUP
Justin Dimmel, University of Maine; Megan Nickels, University of Central Florida; Craig Cullen, Illinois State University; Camden Glenn Bock, UNIVERSITY OF MAINE

Our working group will bring mathematics education researchers together to explore how immersive spatial display technologies (e.g., room scale virtual reality) can be used for the teaching and learning of mathematics. The sessions will provide participants with the opportunity to explore a range of virtual worlds, including mathematics-specifics environments that were designed by session organizers. Participants will work together to plan research studies, discuss instructional activities, and design virtual environments. Our group aims to look ahead to a time in the near future and anticipate the research, design, and development that can guide how these technologies will be integrated into schools.

133. WORKING GROUP: SPECIAL EDUCATION AND MATHEMATICS WORKING GROUP

Working Groups
Working Group
10:30 to 12:00 pm

Hyatt Regency: Floor 1st - Dogwood

Participant:

SPECIAL EDUCATION AND MATHEMATICS WORKING GROUP Yan Ping Xin, Purdue University; Jessica Heather Hunt, NCSU; Helen Thouless, UCL Institute of Education; Ron Tzur, University of Colorado Denver

This Working Group will continue the conversation started since PME-NA-34, with a goal to move forward the teaching and learning of mathematics involving students with learning disabilities or difficulties in mathematics (LDM). This Working Group is rooted in following premises: (1) students with LDM are capable of and need to develop conceptual understanding of mathematics, and (2) special education as well as inclusive classroom instruction need to transition toward this focus. Participants will continue (a) the collaborative research agenda for the group, and (b) the dissemination effort through publications that reflect the cross-disciplinary collaborative work of this international group.

134. WORKING GROUP: ADDRESSING EQUITY AND DIVERSITY ISSUES IN MATHEMATICS EDUCATION: LOOKING BACK AND LOOKING AHEAD

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Gardenia

Participant:

ADDRESSING EQUITY AND DIVERSITY ISSUES IN MATHEMATICS EDUCATION: LOOKING BACK AND LOOKING AHEAD Joel Amidon, University of Mississippi; Jennifer Langer-Osuna, Stanford University; Gregory Larnell, University of Illinois at Chicago

Embracing the theme of this year’s meeting, we seek as a community to embrace the history of mathematics education research/PMENA, and the promise of the future of mathematics education by continuing on the reestablished purpose of this group and supporting the development of new directions for equity-oriented research working groups. The sessions will focus on regrouping attendees interested in equity, generating and brainstorming new subtopics and potential projects, and working to establish standalone working groups dedicated to furthering research on equity. The purpose being to encourage a move away from “big-tent” equity thinking and toward more productive working collectives.

135. WORKING GROUP: MATHEMATICS TEACHER EDUCATORS' INQUIRY INTO THEIR PRACTICE: UNPACKING METHODOLOGIES FOR PROFESSIONAL AND PERSONAL GROWTH

Working Groups
MATHEMATICS TEACHER EDUCATORS’ INQUIRY INTO THEIR PRACTICE: UNPACKING METHODOLOGIES FOR PROFESSIONAL AND PERSONAL GROWTH

Elizabeth Suazo-Flores, Purdue University; Signe Kastberg, Purdue University; Jennifer Ward, Kennesaw State University; Dana Christine Cox, Miami University; Olive Chapman, University of Calgary

In this working group, we introduce narrative inquiry, self-study, and autoethnography as methodologies that focus on the study of the self. Through posing research questions and creation of research texts from existing field texts, participants will explore these methodologies. Field texts used will be videos, personal journals, and transcripts of conversations that the leaders of the working group and Melva Grant have constructed in their different research studies. The creation of a nurturing space to conduct and review research using these methodologies will be promoted in this working group.

THE MATHEMATICS EDUCATION OF ENGLISH LEARNERS

Zandra de Araujo, University of Missouri; William Zahner, San Diego State University; Sarah A Roberts, University of California, Santa Barbara; Craig Willey, Indiana University, IUPUI

This Working Group builds on the work of Working Groups in 2015 and 2016. We will continue considering multiple aspects of research and practice related to mathematics learning and teaching with English Learners. Our goals for the 2018 Working Group include: (1) sharing current perspectives on extant research related to mathematics and English learners, (2) understanding venues for dissemination of research on ELs, including novel outlets that connect research to practice, and (3) fostering new collaborations and supporting further connections among researchers.

COMPLEX CONNECTIONS: REIMAGINING UNITS COORDINATION

Beth Loveday MacDonald, Utah State University; Steven James Boyce, Portland State University; Jessica Heather Hunt, NCSU; Cameron Byerley, Colorado State University; Diana L. Moss, Utah State University

Students’ construction, coordination, and abstraction of units underlie success across multiple mathematics domains. Structures for coordinating units underscore notions of numbers as composite units (e.g., five is a unit of five and five units of one). In this working group, we seek to facilitate collaboration amongst researchers and educators concerned with composite unit formation and units coordination. The aim for this working group is two-fold: (1) to extend our research around units coordination to new grade levels; and (2) to collaborate with researchers who investigate students with learning differences in school settings to determine diverse students’ mathematics learning trajectories.

MODELS AND MODELING WORKING GROUP

Corey Brady, Vanderbilt University; Angeles Dominguez, ITESM, MX; Aran Glancy, University of Minnesota; Hyunyi Jung, Marquette University; Jeffrey A McLean, University of North Carolina at Chapel Hill

The Models and Modeling Working Group at PME-NA has provided a forum for discussing and collaborating on research projects fundamental to this area since the first PME-NA conference in 1978. We propose to convene this Working Group at PME-NA 40 with a dual purpose: (1) to build on discussions at PME-NA 37-39, extending collaborative research directions formulated at the Indianapolis meeting, and (2) to continue to invite newcomers to the Models and Modeling Perspective (MMP), giving them an introduction to this rich tradition in design research.

WORKING GROUP ON GENDER AND SEXUALITY IN MATHEMATICS EDUCATION: LINKING THE PAST TO THE FUTURE

Katrina Piatek-Jimenez,
Central Michigan University; Rebecca McGraw, University of Arizona; Lynda West, University of Nevada, Reno; Jennifer Hall, Monash University; Angie Hodge, Northern Arizona University; Elizabeth Ann Kersey, Purdue University; Laurie Rubel, Brooklyn College CUNY & University of Haifa; Kathleen Jablon Stoehr, Santa Clara University

After not having met for a number of years, the Gender and Sexuality in Mathematics Education Working Group will meet again this year with a new name, new members, and a new focus. During this Working Group, we will discuss current research being conducted on this topic and will identify themes for discussion and possible research collaborations. We plan to include a discussion about how research assumptions, such as language assuming that gender is binary, can affect research findings. All PME-NA attendees with an interest in gender and sexuality in mathematics education are invited to attend.

140. WORKING GROUP: CONCEPTIONS AND CONSEQUENCES OF WHAT WE CALL ARGUMENTATION, JUSTIFICATION, AND PROOF

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency D,E

Participan:

CONCEPTIONS AND CONSEQUENCES OF WHAT WE CALL ARGUMENTATION, JUSTIFICATION, AND PROOF AnnaMarie Conner, University of Georgia; Carlos Nicolas Gomez, Clemson University; Hyejin Park, University of Georgia; Jonathan Kyle Foster, University of Georgia; Yuling Zhuang, University of Georgia; Megan Staples, University of Connecticut; Michelle Cirillo, University of Delaware; Kristen Bieda, Michigan State University; Jill Newton, Purdue University

Argumentation, justification, and proof are conceptualized in many ways in mathematics education literature. The descriptions of these objects and processes are sometimes compatible or complementary; they can also be inconsistent or contradictory. Collaboration is needed to move toward highlighting connections and exploiting ways in which they may be used to address overarching research questions. The 2018 working group sessions will extend previous conversations into issues of teacher preparation with respect to argumentation, justification, and proof. The group will also discuss how issues of equity, social justice, and marginalized populations intersect with the teaching and learning of argumentation, justification, and proof.

141. WORKING GROUP: FORGING NEW PATHS THROUGH CRITICAL PERSPECTIVES ON DISABILITY AND MATHEMATICS EDUCATION

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency F

Participant:

FORGING NEW PATHS THROUGH CRITICAL PERSPECTIVES ON DISABILITY AND MATHEMATICS EDUCATION Amber Grace Candela, University of Missouri - St. Louis; Katherine E Lewis, University of Washington; Paulo Tan, University of Hawaii, Manoa; James Sheldon, University of Arizona; Kai Rands, National Coalition of Independent Scholars; Jessica Heather Hunt, NCSU

Research on mathematics and disabilities traditionally has been conducted within a special education paradigm, which often implicitly or explicitly adopts a deficit model of the learner. The deficit model locates the “problem” within the individual student rather than in the social, discursive, political, or structural context. Our working group is composed of researchers and educators who draw upon critical theories, such as Disability Studies in Education, Critical Race Theory, and DisCrit, in order to offer an alternative vision of mathematics education based around a different conceptualization of disability and learning differences.

142. WORKING GROUP: EMBODIED MATHEMATICAL IMAGINATION AND COGNITION (EMIC) WORKING GROUP

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Regency G

Participant:

EMBODIED MATHEMATICAL IMAGINATION AND COGNITION (EMIC) WORKING GROUP Erin Ottmar, Worcester Polytechnic Institute; Edward Melcer, Univ. of California, Santa Cruz; Dor Abrahamson, University of California, Berkeley; Mitchell J. Nathan, The University of Wisconsin - Madison; Emily Fyfe, Indiana University; Carmen Smith, University of Vermont

Embodied cognition is growing in theoretical importance and as a driving set of design principles for curriculum activities and technology innovations for mathematics education. The central aim of the EMIC Working Group is to attract engaged colleagues into a growing community of discourse around theoretical, technological, and methodological developments for advancing the study of embodied cognition for mathematics education. EMIC builds upon our prior working groups with a focus on how we can leverage emerging technologies to study embodied cognition and mathematics learning. We aim to develop new theories and extend frameworks and perspectives
143. WORKING GROUP: EXPLORING THE NATURE OF MATHEMATICAL MODELING IN THE EARLY GRADES

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A

Participant:

EXPLORING THE NATURE OF MATHEMATICAL MODELING IN THE EARLY GRADES Jennifer M. Suh, George Mason University; Kathleen Matson, George Mason University; Mary Alice Carlson, Montana State University; Rachel Levy, Harvey Mudd College; Megan Wickstrom, Montana State University; Amy Roth McDuffie, Washington State University; Spencer Jamieson, Fairfax County Schools; Erin Turner, University of Arizona; Padmanabhan Seshaiyer, George Mason University; Cynthia Oropesa Anhalt, The University of Arizona

This working group will focus on the research that deepens our understanding of early modeling. Our aim is to first explore the nature of mathematical modeling across the early grades and map out the learning pathways of mathematical modeling that can connect elementary to secondary mathematics education. Second, we will discuss efforts to design and implement professional development that introduces K-8 teachers to mathematical modeling. Our goal is to broaden the access of mathematical modeling to elementary grades and advance the field’s collective understanding of the interrelated processes of mathematical modeling in the elementary grades and beyond.

144. WORKING GROUP: WORKING TO UNDERSTAND MEDIATED FIELD EXPERIENCES AND STUDY THEIR IMPACT

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B

Participant:

WORKING TO UNDERSTAND MEDIATED FIELD EXPERIENCES AND STUDY THEIR IMPACT

Barbara A Swartz, McDaniel College; Esther Marie Billings, Grand Valley State University; Melinda Knapp, Oregon State University-Cascades; Rajeev K Virmani, Sonoma State University; Charlotte Sharpe, Syracuse University; Dawn Woods, Southern Methodist University; Sararose Lynch, Westminster College; Holly H Pinter, Western Carolina University

This group of mathematics teacher educators has been working to integrate preparation efforts by purposefully designing coursework around McDonald et al.’s (2013) learning cycle to include mediated field experiences. Our goals as a working group are to establish cross-cutting and essential features of these mediated field experiences and identify future research questions and ways to standardize data collection to create clear lines of investigation to explore the impacts of such experiences.

145. WORKING GROUP: MATHEMATICAL PLAY: ACROSS AGES, CONTEXT, AND CONTENT

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C

Participant:

MATHEMATICAL PLAY: ACROSS AGES, CONTEXT, AND CONTENT Caro Williams-Pierce, University at Albany, SUNY; David Plaxco, Clayton State University; Paul N. Reimer, AIMS Center for Math and Science Education; Amy Ellis, University of Georgia; Muhammed F. Dogan, Adiyaman University

Mathematical play has a fairly short history, with strong roots further back in time (e.g., Papert, Montessori), and understanding the role of mathematical play from early childhood to adulthood is, as yet, unmapped. This working group will provide a community space to explore and discuss mathematical play broadly, ranging from early childhood to undergraduate learners, with an emphasis on physical and digital interactions designed specifically to support mathematical play.

146. WORKING GROUP: DEVELOPING THEORY, RESEARCH, AND TOOLS FOR EFFECTIVE LAUNCHING

Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Teal Ballroom

Participant:

DEVELOPING THEORY, RESEARCH, AND TOOLS FOR EFFECTIVE LAUNCHING Rob Wieman, Rowan University; Jill A Perry, Rowan University; Andrew Tyniniski, Clemson University; Grace Kelemanik, Fostering Math Practices; Gloriana Gonzalez, University of Illinois at Urbana-Champaign; Aaron Trocki, Elon University; Jennifer Ann Eli, The University of Arizona

Launching cognitively demanding tasks is a much valued, but little understood, aspect of ambitious mathematics teaching. This working group supports the development of descriptions, theory, and tools to support teachers, teacher educators, and researchers in understanding and developing skill in launching. We will identify the purposes of effective launches, common challenges teachers face, and structures and skills that teachers use when launching. The working group will facilitate and support ongoing discussion and collaboration between researchers, teacher educators, and practitioners that will contribute to our knowledge of effective launches.
147. WORKING GROUP: DESIGNING AND RESEARCHING ONLINE PROFESSIONAL DEVELOPMENT
Working Groups
Working Group
10:30 to 12:00 pm
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participant:
DESIGNING AND RESEARCHING ONLINE PROFESSIONAL DEVELOPMENT Jeffrey Choppin, University of Rochester; Julie Amador, University of Idaho; Cynthia Callard, University of Rochester; Cynthia Carson, University of Rochester; Ryan Gillespie, University of Idaho
In this working group, we continue with previous efforts to consider design and research methodologies related to teacher learning in online professional development contexts. Year Two of this discussion group will combine whole-group and subgroup time to converse about: (a) the challenges of online professional learning experiences, (b) research tools, methods, and analyses, (c) the connections among different projects and studies, and (d) future collaborations. Given recent technological advances and demands to support teachers in various contexts, we contend that researching these online models, as well as other online models is important for the broader field of mathematics education.

148. LUNCH AND GRADUATE STUDENT MENTORING LUNCH 2
12:00 to 1:00 pm
Hyatt Regency: Floor 1st - Regency A,B,C
148-1. SATURDAY LUNCH
PMENA
Special Event
148-2. GRADUATE STUDENT MENTORING LUNCH 2
PMENA
Graduate Student Event
149. NATIONAL SCIENCE FOUNDATION EARLY CAREER PROPOSALS DISCUSSION
PMENA
Special Event
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Boardroom
Presider:
Karen Keene, North Carolina State University

150. GEOMETRY AND MEASUREMENT BRIEF RESEARCH REPORTS SESSION 3
Geometry and Measurement
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Crepe Myrtle
Participants:
EVALUATING GEOMETRIC DEFINITIONS Mark A Creager, University of Southern Indiana; Zulfiye Zeybek, Gaziosmanpasa University
Working with and on definitions has been called a critical part of doing geometry. However, several studies have noted the struggles that school-age children have with definitions. In this paper we describe challenge that we suggest has not been yet documented because of the level of mathematical thinking it requires. We studied how a group of sophisticated college-level mathematics students created and evaluated geometric definitions and noticed a glaring omission in their work. We discuss ways to fill in this gap in their understanding.

INVESTIGATING STUDENTS’ PROOF REASONING AS THEY TRANSITION FROM VERBAL PLANNING TO WRITTEN PROOF Michael Winer, Eastern Washington University; Michael Battista, The Ohio State University
This paper focuses on formal proofs that use triangle congruence postulates, which students construct in high school geometry. Examining student work with proofs in an clinical interview setting, we analyzed the transition from students verbally planning their proofs to writing their formal proofs using a two-column format. We found that much of the reasoning many students conveyed during the verbal planning of their proofs did not match the reasoning conveyed in their written proofs. We illustrate this finding by providing examples in which students’ verbal planning does not match the deductions that they wrote in their formal proof.

151. TEACHING AND CLASSROOM PRACTICE BRIEF RESEARCH REPORTS SESSION 5
Teaching and Classroom Practice
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Dogwood
Participants:
CARING, MALE AFRICAN AMERICANS, AND MATHEMATICS TEACHING AND LEARNING
Jason G. Hunter, DeKalb County School System; David Stinson, Georgia State University
Is this paper, the authors report on a qualitative study that explored the influence a “successful” African American male mathematics teacher had on three African American male high school students’ perceptions of teacher care. This critical ethnography study was guided by an intersection of an eclectic array of theoretical traditions, including care theory, critical race theory, and culturally relevant pedagogy. The study employed ethnographic methods during data collection; data analysis identified six overarching themes that the participants used to describe teacher care.
INVESTIGATING THE RELATIONSHIP BETWEEN THE ENACTED CURRICULUM AND TEACHER
CONCERNS IN HIGH SCHOOL MATHEMATICS
Ji-Won Son, University at Buffalo-The State University of New York; Jeri Diletti, University at Buffalo-The State University of New York
This study investigated the relationships among teacher concerns regarding the CCSSM, teachers’ intended curriculum and teachers’ enacted curriculum. Three high school teachers were intentionally selected as a focus group, based on their different levels of concern. Each teacher was observed during three different lessons on linear/non-linear functions. Pre- and post-observation interviews were conducted both before and after each lesson was taught. Findings suggest a complicated relationship exists between teacher concerns and their intended and enacted curriculum. Regarding teacher concerns, different factors seem to take account for the complicated relationship between teacher concerns and their enacted curricula.

152. CURRICULUM AND RELATED FACTORS BRIEF RESEARCH REPORTS SESSION 1
Curriculum and Related Factors
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Gardenia
Participants:
RE-LEARNING CURRICULUM THROUGH FOCAL EXPERIENCES TO CREATE SPACE FOR DIALOGIC MATHEMATICS Jennifer Kinser-Traut, New York University
Learning to teach mathematics is a complex endeavor. Particularly challenging is making sense of the various levels of curriculum (societal, technical, and enactment) and engaging in problem-solving, or dialogic, mathematics curriculum. This self-study examines how one early career teacher transformed her enactment of curriculum, through specific experiences during her first five years teaching science and mathematics. Narrative inquiry was used to examine past artifacts and experiences. The findings highlight the importance of specific focal experiences that support teachers throughout their first five years teaching to create space in the technical curriculum for enacting dialogic mathematics curriculum.

THE ROLE OF THE TWO-COLUMN PROOF IN THE GEOMETRY CLASSROOM Jeffrey Pair, California State University Long Beach; Rashmi Singh, Kent State University; Susanne Strachota, University of Wisconsin-Madison
Our research team surveyed members of the mathematics education community to gain insight into the community’s perceptions of the two-column proof. We asked participants to describe the value of the two-column proof and discuss whether they would be in favor of eliminating it from the high school curriculum. There was a wide-range of diversity in the responses and we present several themes that we observed. We found that about 36% of the respondents were definitely or probably in favor of eliminating the two-column proof, 42% were definitely or probably not in favor of eliminating it, while about 22% were unsure.

153. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 10
Preservice Teacher Education
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Magnolia
Participant:
REHEARSALS OF AMBITIOUS TEACHING IN IMMERSIVE CLASSROOM SIMULATION ACTIVITIES Carrie Lee, East Carolina University
Innovative technologies utilizing immersive classroom simulation activities (ICSA) allow PTs to rehearse instructional activities with student avatars. This study found that ICSAs provide opportunities to engage aspects of ambitious teaching such connecting reasoning and afford PTs with unique opportunities to position students as competent. Implications for ICSAs in scaling pedagogical change are discussed.

154. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORTS SESSION 9
Inservice Teacher Education/Professional Development
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Redbud A
Participants:
ONE DISTRICT’S SYSTEMIC APPROACH TO DETRACK HIGH SCHOOL MATHEMATICS Brian R Lawler, Kennesaw State University
I report initial findings in one district's effort to rehumanize mathematics experiences for students and teachers. Emphasis will be to describe a five(plus)-year project to shift mathematics instruction by working to redefine teacher's normative identities. I will identify an emerging three-year teacher curriculum, and tensions provoked by our aims.

TEACHER VIEWS OF USEFUL FEATURES OF MATHEMATICS PROFESSIONAL DEVELOPMENT AND HOW THE VIEWS INFLUENCED INSTRUCTION William Samuel Walker, Purdue University
This multiple-case study investigated what three high school teachers viewed as useful from a mathematics professional development (PD) program and how these views influenced their instructional practices. The teachers participated in PD that focused on using standards-based pedagogy
and mathematical tasks. The teachers commonly viewed mathematical tasks for use in the classroom and strategies for small group instruction as useful. Each of the PD features that teachers viewed as useful were enacted during instruction. These findings suggest that providers of PD for mathematics teachers should learn teachers’ views about the useful features of PD to improve outcomes.

155. TECHNOLOGY BRIEF RESEARCH REPORTS SESSION 7
Technology
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Redbud B
Participants:
TEACHER KNOWLEDGE FOR TECHNOLOGY IMPLEMENTATION Jaime Kautz, Ohio State University; Hea-Jin Lee, The Ohio State University, Lima; Kui Xie, The Ohio State University
This study is centered around professional development intended to improve teachers’ technological, pedagogical, and content knowledge for middle school mathematics. Seven asynchronous module work were analyzed to measure teachers’ beliefs about their ability to implement technology in the classroom and the alignment between teacher interaction with technology and their understanding of mathematics. Results suggest that 1) teachers were more efficacious teaching mathematics without technology than with it; 2) teachers’ beliefs about technology and their ability to implement it were generally positive and increased after professional development activities; 3) gaps in teacher knowledge and teachers’ ability to use technology were evident.

TECHNOLOGY INTEGRATION IN SECONDARY MATHEMATICS TEXTBOOKS Charity Cayton, East Carolina University; Milan F. Sherman, Drake University; Candace Walkington, Southern Methodist University; Alexandra Funsch, East Carolina University
In this session we will share results from an analysis of 20 high school textbooks, including integrated/non-integrated and conventional/investigative curricula, in reference to 1) how often each text integrates technology within tasks, and 2) the types of technologies that are included. We will discuss what these results indicate about the current state of curricular resources available to high school mathematics teachers regarding technology, as well as on-going analysis to characterize how technology is being used within these tasks.

156. STUDENT LEARNING AND RELATED FACTORS BRIEF RESEARCH REPORTS SESSION 6
Student Learning and Related Factors

Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Redbud C
Participants:

EXPLORING THE PHENOMENON OF PEDAGOGICAL EMPATHY Karina Uhing, University of Nebraska-Lincoln
Interactions between teachers and students are an essential part of learning in educational settings. In this study, I explore the phenomenon of pedagogical empathy, which is conceptualized as empathy that influences teaching practices. Specifically, I examine how mathematics graduate teaching assistants (GTAs) might express pedagogical empathy when providing feedback to student questions. Data was collected through interviews of current pre-calculus instructors in which participants were shown samples of student work and asked to respond to questions about that work. Preliminary analysis has revealed varying abilities of GTAs to express and attend to student emotion.

STUDENTS’ EXPERIENCES WITH LEARNER-CENTERED INSTRUCTIONAL STRATEGIES IN A LARGE-SCALE PRECALCULUS COURSE Brooke Outlaw, North Carolina State University; Karen Keene, North Carolina State University; Gregory Downing, North Carolina State University
In this phenomenological case study, we report results from qualitative research set in a large-size undergraduate mathematics classroom. We provide evidence that students perceived their participation in tasks where students work together to solve real life math problems involving precalculus concepts contributed to their learning. Students expressed positive attitudes with regards to the collaborative efforts in this math classroom, often different from a traditional math course. Additionally, other active learning components utilized in this course and study were considered useful and important by some of the students interviewed.

157. THEORY AND RESEARCH METHODS BRIEF RESEARCH REPORTS SESSION 3
Theory and Research Methods
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency D2,E2,H
Participants:

ADDRESSING TENSIONS IN MATHEMATICS EDUCATION THROUGH FORMATIVE INTERVENTION RESEARCH PARTNERSHIPS Charles Munter, University of Missouri; Cara Haines, University of Missouri; Rebecca Bruton, University of Missouri
This paper describes an approach to cultivating formative intervention research partnerships in mathematics with school districts in the U.S. state of Missouri by researching the diagnosis and
specification of problems as framed and experienced by those grappling daily with challenges related to learning and teaching mathematics. Through a mixed methods approach, we engage various stakeholders in identifying and describing important problems of practice, work to specify the inherent tensions that often exist in those challenges, and, by confronting those tensions, initiate a process of innovation rooted in the contexts in which students, teachers, leaders, and parents learn and work.

**UNDERSTANDING THE NATURE OF UNCERTAINTY IN PROBLEM SOLVING SITUATIONS**

Taren Going, Michigan State University; Merve Nur Kursav, Michigan State University; Yvonne E Slanger-Grant, Michigan State University; Kristen Bieda, Michigan State University; Alden Jack Edson, Michigan State University

Productive disciplinary engagement (PDE; Engle & Conant, 2002) describes classroom situations where students publicly engage in disciplinary practices. Researchers have argued that PDE is fostered when students engage in problematizing, where they grapple with genuine uncertainty about mathematical objects, among other characteristics. Building on work by Zaslavsky, this paper advances a framework that attempts to capture the nature of uncertainty about mathematical situations in classrooms. The framework supports efforts to measure and understand the nature of problematizing in school mathematics.

**158. TECHNOLOGY BRIEF RESEARCH REPORTS SESSION 6**

Technology Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency D,E

Participants:

La formulación y resolución de problemas en la reconstrucción de figuras mediante modelos dinámicos

Daniel Aurelio Aguilar-Magallón, Centro de Investigación y de Estudios Avanzados del IPN; William Enrique Poveda Fernández, Centro de Investigación y de Estudios Avanzados del IPN; Adrián Gómez-Arciga, Centro de Investigación y de Estudios Avanzados del IPN

Se reportan y analizan episodios de formulación de problemas relacionados con la construcción de configuraciones dinámicas durante un curso de maestría en educación matemática. ¿Cómo son las estrategias que exhiben profesores y futuros profesores en el proceso de construir representaciones dinámicas de la figura presente en un problema geométrico de demostración? Los resultados muestran que el uso de GeoGebra puede ser útil para motivar e involucrar a los profesores en diversos episodios de formulación y resolución de problemas. En este camino, algunas estrategias importantes fueron relajar las condiciones del problema y la visualización de lugares geométricos de puntos de intersección.

**TEACHERS’ IMPLEMENTATION OF VIRTUAL MANIPULATIVES AFTER PARTICIPATING IN PROFESSIONAL DEVELOPMENT**

Lindsay Reiten, University of Northern Colorado

This presentation focuses on why and how teachers implemented virtual manipulative (VM) tasks after participating in a professional development (PD) opportunity aimed at teaching with VMs. The structure of the three-phased PD as well as tools developed and introduced during the PD will be shared. After highlighting why and how teachers implemented VM tasks, discussion will focus on mediating factors that influenced teachers’ efforts to teach with VM tasks. Implications for supporting and preparing secondary mathematics teachers to teach with (not near) technology tools will also be discussed.

**159. MATHEMATICAL PROCESSES BRIEF RESEARCH REPORTS SESSION 4**

Mathematical Processes Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency F

Participants:

On how participation in a modeling competition occasions changes in undergraduate students’ self-efficacy regarding mathematical modeling

Jennifer Ann Czocher, Texas State University; Sindura Subanemy Kandasamy, Texas State University

Though scholars have long called for applications and modeling to be explicitly added to classroom agenda (Niss, Blum, & Galbraith, 2007), opportunities for undergraduates to engage in modeling to be explicitly added to classroom remain scarce. We share the efforts of a national organization (SIMIODE) to provide extra-curricular opportunities for undergraduate STEM majors to engage in authentic, open-ended modeling tasks using differential equations through a modeling competition. In this preliminary report, we document changes in twenty-one undergraduates’ self-efficacy regarding their own modeling competencies, develop hypotheses about what aspects of the competition occasioned those changes, and how these changes may benefit students.
Generalizing is widely considered to be essential to the learning and doing mathematics. Using design experiment methodology this study investigates middle school students’ construction of mathematical generalization when learning geometric transformations in a technology-intensive instructional environment. The study identified a wide range of mathematical generalizations students constructed in this particular learning ecology and the generalizing opportunities afforded by teacher interventions, technological tools, and mathematical tasks. It further supports the view that that mathematical generalizing is a socio-cognitive practice that is deeply shaped by mathematics tasks, social interactions, and tools available to learners.

160. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT BRIEF RESEARCH REPORTS SESSION 10
Inservice Teacher Education/Professional Development Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 1st - Regency G
Participants:
PREPARING ELEMENTARY MATHEMATICS SPECIALISTS (AS-SUBJECTS) AND RECONCEPTUALIZING TEACHER BELIEFS (AS-ENTANGLEMENT) Kayla Myers, Georgia State University
This project was designed to help Prospective Elementary Mathematics Specialists (PEMSs) negotiate their beliefs about mathematics teaching and learning amidst all of the other aspects of teaching, addressing the messiness of teacher beliefs while navigating their role as mathematics teacher and teacher leader. To do this, I take up poststructural theories of subjectivity to consider PEMSs as subjects whose beliefs about teaching and learning mathematics are always already entangled, impossible to think as separate or pre-existing. This reconceptualization gave PEMSs a space to address and navigate the tensions of teacher beliefs and their practice.

USING COACHING CYCLES TO TRANSFER AND SUSTAIN EFFECTIVE INSTRUCTIONAL PRACTICES Kristin E. Harbour, University of South Carolina; Stefanie D. Livers, Missouri State University
We illustrate a coaching cycle approach situated within a larger professional development design that focused on infusing high quality mathematics tasks and differentiation within inclusive elementary mathematics classrooms. Our design supported teams of general education and special education teachers with integrating tasks and differentiation strategies into co-taught mathematics lessons through reflective coaching sessions. This project yielded positive results in instructional practice and co-teaching collaborations.

161. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS BRIEF RESEARCH REPORTS SESSION 5
Early Algebra, Algebra, and Number Concepts Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A
Participants:
CONNECTIONS AMONG CURRICULUM, TASKS, AND LINGUISTICALLY DIVERSE SECONDARY STUDENTS’ UNDERSTANDINGS OF RATES OF CHANGE Lynda Wynn, San Diego State University; William Zahner, San Diego State University
We examine how two 9th grade integrated mathematics teachers from a linguistically diverse school introduced linear and exponential rates of change, and we describe how their students demonstrated learning on a written assessment and a set of clinical interviews. The teachers collaborated on some aspects of their lesson planning, but used different curriculum materials. We found evidence that students in these two classes learned different concepts. Our preliminary analysis, using Lobato et al.’s (2013) focusing framework, indicates that students' performance can be traced back to the teachers' use of particular curricularly-influenced tools in the instructional environment such as "ratio tables."

FUTURE MIDDLE GRADES TEACHERS’ INCREMENTAL ALIGNMENT OF KNOWLEDGE WITHIN THE MULTIPLICATIVE CONCEPTUAL FIELD Andrew Izsak, Tufts University; Sybilla Beckmann, University of Georgia
We report results generated through cycles of a number and operations content course offered to future middle grades mathematics teachers. A main feature of the course was using an explicit, quantitative definition for multiplication to connect a range of topics in the multiplicative conceptual field (Vergnaud, 1983, 1988). Results include a mathematical analysis of multiplication with the multiplicative conceptual field; and an examination of how students in these two classes learned different curriculum materials. We found evidence that students in these two classes learned different concepts. Our preliminary analysis, using Lobato et al.’s (2013) focusing framework, indicates that students' performance can be traced back to the teachers' use of particular curricularly-influenced tools in the instructional environment such as "ratio tables."

STUDENTS’ UNDERSTANDINGS OF RATES OF CHANGE Andrew Izsak, Tufts University; Sybilla Beckmann, University of Georgia
We examine how two 9th grade integrated mathematics teachers from a linguistically diverse school introduced linear and exponential rates of change, and we describe how their students demonstrated learning on a written assessment and a set of clinical interviews. The teachers collaborated on some aspects of their lesson planning, but used different curriculum materials. We found evidence that students in these two classes learned different concepts. Our preliminary analysis, using Lobato et al.’s (2013) focusing framework, indicates that students' performance can be traced back to the teachers' use of particular curricularly-influenced tools in the instructional environment such as "ratio tables."

DEEPENING K-8 PRESERVICE TEACHERS’
UNDERSTANDING OF MATHEMATICS AND MATHEMATICAL FEEDBACK VIA LETTER-WRITING James C. Willingham, James Madison University; Heidi Eisenreich, Georgia Southern University; Casey Hawthorne, Furman University; William W. DeLeeuw, Arizona State University

The purpose of this research was to explore the affordances of letter-writing exchanges for the development of preservice K-8 mathematics teachers’ understanding of mathematics and mathematical feedback processes. Analyzing formative feedback provided in letter-writing exchanges yielded interesting results. Findings indicated that exposure to different ways of thinking about a mathematical task were enough to elicit new ways of thinking among participants, that metacognitive awareness of the feedback cycle prompted changes in perception of the feedback given and received, and that improved mathematical understanding is an incremental construct that is not easily measured and is often hidden behind flawed written solutions.

PORTRAITURE OF ELEMENTARY PRESERVICE TEACHERS DURING A STEM CAMP EXPERIENCE Megan Burton, Auburn University; L. Octavia Tripp, Auburn University; Victoria Cardullo, Auburn University

Twenty-four preservice teachers planned, co-taught, observed peers, observed the elementary students, and participated in debriefing during a summer science, technology, engineering, and mathematics (STEM) field experience. Data from lesson plans, reflections, observations of students and peers created a holistic view of their perspectives on teaching and learning mathematics in a diverse setting, without the challenges that often occur in traditional field-based experiences. Using the portraiture method of inquiry, the complex dynamics of this experience are captured from multiple lenses.

163. TEACHING AND CLASSROOM PRACTICE BRIEF RESEARCH REPORTS SESSION 4
Teaching and Classroom Practice
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C

Participants:

ARGUMENTATION IN THE MATHEMATICS CLASSROOM: SOCIAL, SOCIOMATHEMATICAL, AND MATHEMATICAL ARGUMENTS Carlos Nicolas Gomez, Clemson University; Stacy Jones, Clemson University

We argue for the expansion of Krummheuer’s conceptualization of argumentation in the mathematics classroom. We use Toulmin’s deconstruction of arguments along with studies on social interactions (e.g. Goffman, 1959) to position argumentation as a larger social phenomenon. We provide examples from two lessons conducted by a first year secondary teacher to highlight three different types of arguments: (1) social arguments; (2) sociomathematical arguments; and (3) mathematical arguments. Compartmentalizing classroom arguments in this way provides researchers a way to examine the perpetuation of deficit narratives, construction of sociomathematical norms, and establishment of productive learning environments.

MULTILINGUAL PERSPECTIVES AS NEW OPPORTUNITIES FOR SEEING AND LEARNING MATHEMATICS Cristina Valencia Mazzanti, University of Georgia; Martha Alexsasht-Snider, University of Georgia

This research intends to offer multilingual perspectives of the languages in mathematics classrooms and how they can be conceptualized. Through our analysis of the multilingual perspectives of translanguaging and the teachers, children, and researchers in the study we present ways to identify and understand different language practices that emerge as young multilingual children experience and make sense of mathematics.

164. PRESERVICE TEACHER EDUCATION BRIEF RESEARCH REPORTS SESSION 11
Preservice Teacher Education
Brief Research Report Session
1:00 to 1:40 pm
Hyatt Regency: Floor 2nd - Think Tank @ NOMA

Participants:

FROM BATCHES TO PARTS: PROSPECTIVE TEACHERS’ REPRESENTATIONS FOR PROPORTIONAL RELATIONSHIPS Eric Siy, University of Georgia

In this report, I describe how using representations facilitated a shift in reasoning about proportional relationships in a content course for prospective middle school teachers. The prospective teachers initially approached proportional relationships and created representations from a multiple batches perspective. After some support, the teachers reasoned with a variable parts perspective and modified their representations accordingly.

PROSPECTIVE TEACHERS’ USE OF CHIP MODEL Nicole Marie Wessman-Enzinger, George Fox University; Eileen Murray, Montclair State University

Ten elementary and middle school prospective teachers (PTs) participated in clinical interviews where they modeled integer addition and subtraction number sentences with two-colored chips. The prospective teachers constructed various models using the chips that both matched and did not match the number sentences. Although the PTs sometimes created models that did not match the number sentences, some recognized these inconsistencies.
The results highlight spaces of struggle and accomplishments with using two-colored chips for certain integer number sentences. Implications of this study support facilitating PTs’ construction of models and leveraging their thinking in instruction.

165. SUPPORTING SECONDARY STUDENTS' PERSEVERANCE FOR SOLVING CHALLENGING MATHEMATICS TASKS
Student Learning and Related Factors
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Boardroom
Participant:
SUPPORTING SECONDARY STUDENTS' PERSEVERANCE FOR SOLVING CHALLENGING MATHEMATICS TASKS
Joseph DiNapoli, Montclair State University
Perseverance, or initiating and sustaining productive struggle in the face of obstacles, promotes making sense of mathematics. Yet, engaging in struggle can be grueling and is avoided for some students. I investigate the effect of scaffolding mathematics tasks on student perseverance. The results show how prompting secondary students to conceptualize a mathematical situation prior to problem-solving can encourage re-initiating and re-sustaining mathematically productive effort upon reaching an impasse. For learning mathematics with understanding, these findings suggest specific methods by which student perseverance in problem-solving can be supported.

166. USING INTERPRETIVE FRAMES TO INFORM SELECTIONS OF ARTIFACTS OF STUDENT THINKING
Inservice Teacher Education/Professional Development
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Crepe Myrtle
Participant:
USING INTERPRETIVE FRAMES TO INFORM SELECTIONS OF ARTIFACTS OF STUDENT THINKING
Raymond LaRochelle, San Diego State University; Lisa Lamb, San Diego State University; Susan Nickerson, San Diego State University
One important and prevalent tool used in teacher education is artifacts of student thinking. In this paper we add to the literature on artifact selection for professional development by discussing the affordances and constraints of different written artifacts of student thinking. Through a professional noticing assessment, we examine the interpretive frames that were invoked by 72 secondary teachers regarding 6 students’ written strategies to proportional reasoning tasks. We characterize different ways teachers might make sense of different artifacts of student thinking, and discuss for what purposes PD facilitators might select particular written solutions.

167. EXPANDING STUDENTS' CONTEXTUAL NEIGHBOURHOODS OF MEASUREMENT THROUGH DYNAMIC MEASUREMENT Technology
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Dogwood
Participant:
EXPANDING STUDENTS' CONTEXTUAL NEIGHBOURHOODS OF MEASUREMENT THROUGH DYNAMIC MEASUREMENT
Debasmita Basu, Montclair State University; Nicole Panorkou, Montclair State University
This study is part of a larger project exploring students’ thinking of Dynamic Measurement (DYME), an approach to area that engages students in dynamic experiences of measuring rectangular surfaces through sweeping lengths. This study evaluated the extent to which students could bridge the mathematical knowledge they gained from these dynamic experiences to other activities that are more static in nature. A classroom of third grade students participated in a design experiment centered on DYME. Data obtained from pre- and post-assessments administered suggest that students were able develop a connection between multiplication and area that could apply to solve static tasks.

168. ENTERING EQUATIONS: COMPARISON OF HANDWRITING RECOGNITION AND EQUATION EDITORS
Technology
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Gardenia
Participant:
ENTERING EQUATIONS: COMPARISON OF HANDWRITING RECOGNITION AND EQUATION EDITORS
Gabrielle Alexis Cayton-Hodges, Educational Testing Service; James Fife, Educational Testing Service
Once a novelty, Digitally-Based Assessments (DBA) have become commonplace. With mathematics, it is often a necessity to include items that require the student to input a mathematical formula, equation, or expression. Many of these responses cannot be input with a standard keyboard, but must use some type of equation entry. In this study, we compare ninth-graders’ entry of mathematical expressions using an equation editor versus using handwriting recognition on a tablet. While neither method is currently without flaws, we discuss the benefits and drawbacks of each as well as potential methods for improvement and the implications for mathematics assessment.
169. ESTRATEGIAS DE ALUMNOS MEXICANOS EN LA BÚSQUEDA DE ESTRUCTURA EN TAREAS DE EQUIVALENCIA/STRATEGIES USED BY MEXICAN STUDENTS IN SEEKING STRUCTURE ON EQUIVALENCE TASKS
Early Algebra, Algebra, and Number Concepts
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Magnolia
Participant:
ESTRATEGIAS DE ALUMNOS MEXICANOS EN LA BÚSQUEDA DE ESTRUCTURA EN TAREAS DE EQUIVALENCIA/STRATEGIES USED BY MEXICAN STUDENTS IN SEEKING STRUCTURE ON EQUIVALENCE TASKS
Cesar Martínez-Hernández, Universidad de Colima
Se presentan resultados preliminares sobre las estrategias de alumnos Mexicanos en la búsqueda de estructura en tareas de equivalencia. Los resultados corresponden al estudio piloto de una investigación sustentada en la estructura en aritmética como uno de los aspectos que caracterizan el pensamiento algebraico en edades tempranas

170. STATIC AND EMERGENT THINKING IN SPATIAL AND QUANTITATIVE COORDINATE SYSTEMS
Theory and Research Methods
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Redbud A
Participant:
STATIC AND EMERGENT THINKING IN SPATIAL AND QUANTITATIVE COORDINATE SYSTEMS
Teo Paoletti, Montclair State University; Hwa Young Lee, Texas State University; Hamilton L Hardison, Texas State University
In this theoretical report, we present a conceptual analysis of different ways students may reason about and interpret graphs within coordinate systems. Specifically, we describe two different uses of coordinate systems—spatial and quantitative—students might leverage and two ways of reasoning—static and emergent—students might engage in as they construct or interpret graphs. We characterize how a student may engage in each kind of reasoning in each use of coordinate system. We intend this paper to serve as a theoretical lens for future empirical studies examining students’ developing graphing understandings.

171. PROBABILITY AND INDEPENDENCE: A COMPARISON OF UNDERGRADUATES
Statistics and Probability
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Redbud B
Participant:
PROBABILITY AND INDEPENDENCE: A COMPARISON OF UNDERGRADUATES
Karen Virginia Zwanch, Virginia Tech
The purpose of this study is to develop a deeper understanding of undergraduate students’ reasoning regarding probability and probabilistic independence. Accordingly, three undergraduate students participated in clinical interviews, the results of which were analyzed using APOS theory. Each student was determined to conceptualize probability with different degrees of sophistication. Furthermore, students relied heavily on their intuitions when reasoning about independence. These results suggest a need for future research to refine the genetic decomposition outlining mental constructs that support probability and independence, and how students’ intuitions fit within this decomposition.

172. ANALYZING A DISCOURSE OF SCAFFOLDS FOR MATHEMATICS INSTRUCTION FOR AN ELL WITH LEARNING DISABILITIES
Mathematical Knowledge for Teaching
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Redbud C
Participant:
ANALYZING A DISCOURSE OF SCAFFOLDS FOR MATHEMATICS INSTRUCTION FOR AN ELL WITH LEARNING DISABILITIES
Qingli Lei, Purdue University; Yan Ping Xin, Purdue University; Patricia Morita-Mullaney, Purdue University; Ron Tzur, University of Colorado Denver
In this case study, we consider the usage of language — how teachers used and regulated their language when teaching English language learners (ELLs) with learning disabilities (LD) on mathematics multiplication problems. We focus on types of scaffold instruction of discourse moves to determine how to demonstrate what language helps ELLs with LD to build better multiplicative reasoning. Using the method of discourse analysis combined with linguistic corpus analysis, we find that more linguistic scaffolding and small group interactions are beneficial for ELLs with LD. In combination with kinesthetic scaffolding, they form an effective instructional method for both teachers and ELLs.

173. EXPANDING STUDENTS’ ROLE WHEN DOING PROOFS IN HIGH SCHOOL GEOMETRY
Teaching and Classroom Practice
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Regency D2,E2,H
Participant:
EXPANDING STUDENTS’ ROLE WHEN DOING
PROOFS IN HIGH SCHOOL GEOMETRY Patricio G Herbst, University of Michigan; Mollee Changshu Shultz, University of Michigan; Inah Ko, University of Michigan; Nicolas Boileau, University of Michigan; Ander Erickson, University of Washington Tacoma

We analyzed teachers’ responses to a multimedia survey of instructional practices in posing proof problems. Teachers described and rated for appropriateness three different ways of involving students, including one in which the teacher chooses the givens and the conclusion to prove, and two that expand the students’ role. While teachers recognized the former as normative, their ratings identified an alternative as more appropriate, having more positive value, and less negative value than the normative one. This alternative has students propose the givens or the conclusion to prove and allows the teacher to control the complexity of instruction by endorsing one proposal.

174. TEACHERS’ RESPONSES TO INSTANCES OF STUDENT MATHEMATICAL THINKING WITH VARIED POTENTIAL TO SUPPORT STUDENT LEARNING
Teaching and Classroom Practice
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Regency D,E

Participant:

TEACHERS’ RESPONSES TO INSTANCES OF STUDENT MATHEMATICAL THINKING WITH VARIED POTENTIAL TO SUPPORT STUDENT LEARNING
Shari L Stockero, Michigan Technological University; Ben Freeburn, Western Michigan University; Laura Van Zoest, Western Michigan University; Blake Peterson, Brigham Young University; Keith Rigby Leatham, Brigham Young University

We investigated teachers’ responses to a common set of varied-potential instances of student mathematical thinking to better understand how a teacher can shape meaningful mathematical discourse. Teacher responses were coded using a scheme that both disentangles and coordinates the teacher move, who it is directed to, and the degree to which student thinking is honored. Teachers tended to direct responses to the same student, use a limited number of moves, and explicitly incorporate students’ thinking. We consider the productivity of teacher responses in relation to frameworks related to the productive use of student mathematical thinking.

175. OPENING SPACE FOR CHANGE AND EMPOWERMENT THROUGH PHILOSOPHICAL AND STRUCTURAL CONTEMPLATION IN TEACHER PROFESSIONAL DEVELOPMENT
Inservice Teacher Education/Professional Development
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A

Participant:

OPENING SPACE FOR CHANGE AND EMPOWERMENT THROUGH PHILOSOPHICAL AND STRUCTURAL CONTEMPLATION IN TEACHER PROFESSIONAL DEVELOPMENT
David Matthew Bowers, Michigan State University

In this theoretical presentation and discussion, I examine the norms of teacher professional development with an eye towards modifying them to allow for genuine systemic change. I first argue that current norms restrict professional development practice to “pseudo-activity” which necessarily operates within rather than against larger societal structures. I then propose philosophical and structural contemplation of mathematics as an example of a currently non-normed practice that has the potential to effect substantive change.

176. COMPUTATIONAL AND INFERENTIAL ORIENTATIONS: LESSONS FROM OBSERVING UNDERGRADUATES READ MATHEMATICAL PROOFS
Mathematical Processes
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 1st - Regency G

Participant:

COMPUTATIONAL AND INFERENTIAL ORIENTATIONS: LESSONS FROM OBSERVING UNDERGRADUATES READ MATHEMATICAL PROOFS
Paul Christian Dawkins, Northern Illinois University; Dov Zazkis, Arizona State University

This paper presents findings from an assessment of university students’ moment-by-moment reading of mathematical proof. This method yields novel insights into the strategies students use to construct meaning for the equations in a proof text. We present evidence that novice readers constructed meanings for the equations using mathematical practices familiar from non-proof oriented courses – substituting and solving for variables – while more experienced readers drew upon practices native to proof-oriented mathematics – inferring properties of quantities. We refer to these as computational and inferential orientations, respectively. We interpret this mismatch of practices with reference to Systemic Functional Linguistics metafunctions.

177. REIMAGINING DEFINITIONS OF TEACHING MATHEMATICS FOR SOCIAL JUSTICE FOR PRESERVICE SECONDARY MATHEMATICS TEACHERS
Preservice Teacher Education
Research Report Session
1:50 to 2:30 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A

Participant:

REIMAGINING DEFINITIONS OF TEACHING MATHEMATICS FOR SOCIAL JUSTICE FOR PRESERVICE SECONDARY MATHEMATICS TEACHERS

REIMAGINING DEFINITIONS OF TEACHING MATHEMATICS FOR SOCIAL JUSTICE FOR PRESERVICE SECONDARY MATHEMATICS TEACHERS

Gabriela Elizabeth Vargas, University of Illinois at Urbana Champaign; Rochelle Gutierrez, University of Illinois at Urbana-Champaign

We investigate definitions and approaches that preservice secondary mathematics teachers develop about teaching mathematics for social justice while participating in an equity-based professional development program. We analyzed transcripts from seminar sessions of the program where participants discussed different forms of teaching mathematics for social justice. Participants described their possible teaching with what is seen in the literature while moving beyond in formulating other possible representations of teaching mathematics for social justice. These findings suggest that it may be necessary to further theorize our understanding of teaching mathematics for social justice so that representations include everyday practices beyond representations in curriculum.

178. SOCIAL JUSTICE DRIVEN STEM: ACHIEVING EQUITY GOALS THROUGH INTEGRATED MATHEMATICS EDUCATION

Frances K Harper, University of Tennessee; Deepa Deshpande, University of Tennessee, Knoxville

This study investigated how integrating social justice issues, STEM practices, and mathematics may support equity in mathematics education. We analyzed video of four lessons focused on inverse trigonometry and disability rights from a STEM-based geometry class. Using an established observation protocol, we identified themes related to access and participation in coherent and cognitively demanding mathematics, student voice, and opportunities to develop positive mathematics identity. Findings provide insights into project and lesson structures that support balancing mathematics and social justice goals across STEM projects and point to additional considerations of equity not fully captured by the existing observation protocol.

179. SPONTANEOUS GENERALIZATIONS THROUGH EXAMPLE-BASED REASONING IN A COLLABORATIVE SETTING

Katherine V Pauletti, New York University; Orit Zaslavsky, New York University

This study explores the progression from student justification to generalization in the course of example-based reasoning. Data was collected through group interviews with high school students who were working collaboratively on a task of determining connections between perimeter and area of tile shaped patterns. The task called for making and justifying conjectures regarding patterns of specific number of tiles. Our findings show that the task elicited collaborative example-based reasoning that evoked spontaneous generalizations about patterns of any number of tiles. The findings point to the importance of collaboration in generalizing, as well as the intuitive nature of generalizations.

180. PROFESSIONAL NOTICING IN COMPLEX MATHEMATICAL CONTEXTS: EXAMINING PRESERVICE TEACHERS' CHANGES IN PERFORMANCE

Molly H Fisher, University of Kentucky; Jonathan Norris Thomas, University of Kentucky; Cindy Jong, University of Kentucky; Edna O. Schack, Morehead State University; David Dueber, University of Kentucky

This paper examines the implementation of an instructional module on Preservice Elementary Teachers' (PSETs) professional noticing of children's mathematical thinking as defined by Jacobs, Lamb, and Philipp (2010). The module focuses on professional noticing skills through the content focus of early algebraic reasoning and uses complex video vignettes from whole class instruction in authentic elementary mathematics classrooms. It was found that two of the three components of professional noticing (attending and interpreting) showed statistically significant increases in a treatment group that did not occur in a comparison group. The deciding component remains a challenge that warrants further research.

181. SATURDAY AFTERNOON BREAK
182. SATURDAY POSTER SETUP
PMENA
Special Event
2:30 to 2:45 pm
Hyatt Regency: Floor 1st - Prefunction

183. TRANSFORMING TEACHERS’ KNOWLEDGE FOR TEACHING MATHEMATICS WITH TECHNOLOGIES THROUGH ONLINE KNOWLEDGE-BUILDING COMMUNITIES
PMENA
Plenary Session
2:45 to 4:15 pm
Hyatt Regency: Floor 1st - Regency A,B,C
Mathematics teacher educators are faced with designing teacher in-service professional development experiences for developing and transforming Technological Pedagogical Content Knowledge (TPACK) towards integrating digital technologies as mathematics learning tools. Online environments provide opportunities to a broad range of teachers, yet, the asynchronous nature presents communication and collaboration challenges. A researcher-conjectured, empirically-supported learning trajectory guides this online TPACK program for engaging teachers in knowledge-building communities. Three online technology education courses provide teachers with experiences as students, learning about the technologies while confronting challenges to their thinking about teaching with the technologies. The fourth course provides the teachers with key experiences through blended instruction. Through online explorations and discourses in their communities, they examine reform-based instructional strategies for teaching with technologies. Concurrently, they design, implement, analyze and reflect on their teaching experiences through their designed five-day unit in their mathematics classrooms. Four TPACK components reveal how this experience in knowledge-building communities transforms their TPACK.

Presider:
Margaret Niess, Oregon State University
Discussant:
Jeremy Roschelle, Digital Promise

184. POSTER SESSION 2 & HAPPY HOUR
4:30 to 5:30 pm
Hyatt Regency: Floor 2nd - Teal Ballroom

184-1. CURRICULUM AND RELATED FACTORS
POSTER SESSION 2
Curriculum and Related Factors
Poster Session
Participants:
AN INTERNATIONAL COMPARISON OF MKT AND EDUCATIVE CURRICULUM MATERIALS FOUND IN TEACHERS’ MANUALS
Matthew David Melville, University of Delaware
This study compares teachers’ manuals from the U.S. and Japan to determine the extent and the ways in which mathematical knowledge for teaching (MKT) is developed in teacher manuals from each country. This study also compares the extent to which the teachers’ manuals from the U.S. and Japan are educative.

CO-CONSTRUCTING STATEWIDE CURRICULUM FRAMEWORKS: PURPOSE AND PROCESSES
Michelle L Stephan, UNC Charlotte; Catherine Schwartz, East Carolina State University; Arren Duggan, UNC Greensboro
We describe a State-wide, research-practice partnership that convened Design Teams of teachers, district leaders and higher education professors to create K-5 and 6-8 State instructional frameworks. We describe the processes we used to ensure that all stakeholders were invited to design and enough resources were included so that all districts within a large state would be able to adapt the frameworks to their specific community. We also present preliminary findings from “framework rollout” meetings across the state that illuminate the ways in which instructional leaders anticipate challenges to plan professional development in their personal districts.

PERIODIC CONFUSION: EXAMINING TWO CONTEMPORARY TEXTBOOK UNITS ON TRIGONOMETRIC FUNCTIONS
Julien Corven, University of Delaware
The purpose of this study was to examine two textbook units on trigonometric functions to understand what opportunities to learn they provide to students. To fully understand how each text gave students opportunities to deeply learn trigonometry meant examining both the content and the intended cognitive demand of tasks. Over 950 student tasks from Pearson’s Algebra 2: Common Core and Key Curriculum Press’s Interactive Mathematics Program: Year 3 were coded on these two constructs. Analysis revealed important differences between the two texts in the opportunities to learn provided and potential shortcomings of both texts for students if enacted as intended.

PROJECT VERSUS PROBLEM BASED LEARNING: IS THERE A DIFFERENCE WITH CONCEPTUALIZATIONS?
Yashica Latimer, Clemson University
The purpose of this literature review is to examine project based and problem based learning as tools of instruction. The goal is to develop a conceptual knowledge of how both constructs are defined and implemented in classroom instruction. Empirical studies have been reviewed and analyzed in effort to determine similarities or differences in PBL instruction. Initial findings are leading to
misconstrued identities of the two concepts and interchangeability in the enactment.

TRENDS IN CROSS-NATIONAL COMPARATIVE EDUCATIONAL RESEARCH Hilary Tanck, Clemson University
International comparisons provide opportunities for generalizations and replications of educational policies and practices across different cultures. These types of studies have the potential highlight areas of strength and weakness and promote change within educational systems. This study examines literature from top tier journals to give a representation of the field’s work in the last 10 years.

USING TWITTER FROM AN ORGANIZATIONAL SENSEMAKING PERSPECTIVE TO SUPPORT STATEWIDE IMPLEMENTATION EFFORTS Lauren Naomi Baucom, University of North Carolina at Greensboro; Lisa Ashe, NC Dept of Instruction; Jared Webb, North Carolina A&T State University
For this proposed poster, we share how we have leveraged Twitter to support the statewide implementation of new mathematics standards. Using organizational sensemaking, we share an emerging framework for using social media to promote systemic coherence during implementation that goes beyond dissemination and communication to promote individual and collective learning.

184-2. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS POSTER SESSION 2
Early Algebra, Algebra, and Number Concepts Poster Session
Participants:
BORROW, TRADE, REGROUP, OR UNPACK?
INSTRUCTIONAL METAPHORS CURRICULAR RESOURCES INSTILL AS FOUNDATIONS FOR BASE-TEN NUMBER Julie Nurnberger-Haag, Kent State University; Anita Nicole Alexander, Lent State University
Extensive research has been conducted about how students develop ideas of base-ten number and operations with and without manipulatives. Yet, specific terms and ways that students physically move base-ten manipulative materials are just beginning to be recognized as metaphors worthy of investigation. This report reveals multiple metaphors elementary mathematics textbooks expressed in words as well as those metaphors students would be encouraged to physically enact with manipulatives. In light of a theoretical analysis of how each such metaphor represents mathematical concepts and procedures (Author, 2018), implications for future research on student learning are discussed.

EVOLUTION OF DEVELOPMENTAL STUDENTS’ MATHEMATICS BACKGROUND KNOWLEDGE Eyob Demeke, California State University, Los Angeles
In this poster, we report on the evolution of developmental students' mathematics background knowledge after a four-week long course that emphasized active learning. The research took place at a large Hispanic serving institution in the state of California. Students' progress or lack thereof was measured using a diagnostic test developed by the Mathematics Diagnostic Testing Project (MDTP). These students were initially considered not ready for college-level mathematics coursework and were subsequently enrolled, in a four-week summer course. We claim that the four-week program had a considerable impact on their mathematics knowledge.

HOW BENCHMARKS AFFECT THE NATURAL NUMBER BIAS AND STRATEGY USE IN FRACTION COMPARISON Andreas Obersteiner, Freiburg University of Education; Vijay Marupudi, University of Wisconsin-Madison; Martha Alibali, University of Wisconsin-Madison
People sometimes overextend natural number reasoning to fraction problems, yielding a "natural number bias". We investigated whether encouraging people to use benchmarks (reference numbers, such as ½) helps them activate fraction magnitudes and overcome a potential bias. Adults solved fraction comparison problems and reported strategies on a trial-by-trial basis. Overall, we found a reverse "smaller components-larger fraction" bias. Strategy use varied by problem type, suggesting that participants used strategies adaptively. Providing a tip about benchmarks had only a small effect. The study highlights variability in strategy use, which may account for diverse bias patterns in previous studies.

PRELIMINARY GENETIC DECOMPOSITION FOR QUADRATIC RELATIONSHIPS IN REAL WORLD CONTEXTS Tiffany LaCroix, Virginia Tech
This poster outlines a preliminary genetic decomposition of the mental constructions necessary for a student to conceptualize authentic quadratic relationships. The two concept strands of function and covariation, combined with Pape’s framework for reading comprehension, provide these necessary mental constructions. Combining the Object conceptions for function and covariation, and applying a MBA-justification reading approach suggests students have constructed a Schema conception for solving quadratic functions in real world contexts. This work is important because real world quadratic problems require students having sophisticated mental constructions for function, covariation, and being able to interpret the context language to find and justify solutions.

RELATIONSHIPS BETWEEN UNITS COORDINATION AND UNDERSTANDING
CALCULUS Steven James Boyce, Portland State University; Jeffrey A Grabhorn, Portland State University; Cameron Byerley, Colorado State University

We report on data from a 14-session paired-student constructivist teaching experiment investigating relationships between calculus students’ ways of coordinating units and their understandings of differential and integral calculus concepts. We describe our initial assessments of students’ units coordination, students’ reasoning during the teaching experiment activities, and conjectures of connections between the number of levels of units with which students assimilate and their reasoning about graphs.

184-3. INSERVICE TEACHER EDUCATION/PROFESSIONAL DEVELOPMENT POSTER SESSION 2

Inservice Teacher Education/Professional Development Poster Session

Participants:

ANALYZING ADJUNCT INSTRUCTOR’S ENGAGEMENT WITH A RESEARCH-BASED PRECALCULUS CURRICULUM Zareen Rahman, Montclair State University

Research points to a growing trend in higher education towards hiring part-time adjunct faculty (Mason, 2009; Curtis, 2014; Snyder & Dillow, 2015). This trend warrants research on adjunct instructors’ experiences (Kezar & Sam, 2013). I analyzed three adjunct instructors’ experiences as they implemented a research-based Precalculus curriculum. Using the case study methodology (Yin, 2009) I describe adjunct instructors’ engagement with the curriculum as they planned their instruction, enacted their lessons inside their classrooms, collaborated with their colleagues or reflected on their teaching experiences. Findings from this study have implications for designing professional developing programs for adjunct instructors.

COMPONENTS OF WHOLE-CLASS DISCUSSIONS IN ELEMENTARY MATHEMATICS CLASSROOMS Amy Hewitt, University of North Carolina at Greensboro

Due to the importance of whole-class discussions in mathematics classrooms, it is beneficial to understand the formats of discussion formats that can take place. Examination of 29 classroom observations revealed five components that help to characterize the formats of whole-class discussions: (a) the start of the discussion, (b) the presentation of student work, (c) the characteristics of student work shared, (d) how the mathematics was highlighted in the discussion, and (e) the end of the discussion. This work has implications for mathematics teacher educators.

EXPLORING ASIAN AMERICAN MATHEMATICS TEACHERS’ PERCEPTION AND IMPLEMENTATION OF CULTURALLY RELEVANT PEDAGOGY Min Jung Kim, Boston College

This study explores Asian American mathematics teachers’ experiences of the model minority myth and their perceptions and implementations of culturally relevant pedagogy through a multiple case study approach.

FIVE COMPONENTS TO CONSIDER WHEN CHARACTERIZING MATHEMATICS TEACHERS’ ACCESS TO PROFESSIONAL DEVELOPMENT Emily Lauren Bryant, University of North Carolina at Greensboro; Peter Holt Wilson, UNC-Greensboro; Beverly Vance, North Carolina Department of Public Instruction

In this poster session, we will share the development of a framework that identifies and describes key components of effective mathematics professional development. We will present the ways it can be used as an implementation measure, and the ways in which districts and schools can use the framework when adapting co-designed professional development resources for use in local contexts. Our hope is that this framework will support efforts to provide more equitable access to high quality mathematics professional development to teachers across the state.

INVESTIGATION INTO THE ROLE OF MATHEMATICS COACHES Brian Bowen, West Chester University

Identifying and implementing strategies to support teacher professional development is a critical challenge facing the mathematics education community. One approach to address this issue is the development of a cadre of school based mathematics coaches. This study looked to gain a better understanding of the role of mathematics coaches, specifically the ways in which they are prepared for their position and how they are utilized in their schools. Data was gathered from practicing mathematics coaches and superintendents.

NEW TEACHERS’ VISIONS OF HOW GROUPWORTHY TASKS CAN CONTRIBUTE TO CREATING EQUITABLE MATHEMATICS CLASSROOMS Kathleen Jablon Stoehr, Santa Clara University; Amy Olson, Duquesne University

The purpose of this study was to gain an understanding of how newly credentialed elementary teachers envision equitable mathematics teaching. The teachers attended a weeklong professional development course that provided in-depth tools and strategies for promoting equal-status participation in mathematics learning by providing groupworthy tasks for students from diverse ethnic, linguistic, socioeconomic, or academic achievement levels.
The underrepresentation of females in mathematics education has been widely studied and analyzed, but in mathematics education, women have been, on the surface, more visible. Multiple professional organizations for mathematics educators from across the globe were analyzed to determine the presence of women in leadership roles during their history, including organizations in the United States, Canada, South Africa, Japan, Europe, Australia, New Zealand, and sub-Saharan Africa. Additionally, recent conference proceedings for select organizations in these regions were analyzed to determine relative proportions of accepted female presenters and compared.

184-4. MATHEMATICAL KNOWLEDGE FOR TEACHING POSTER SESSION 2
Mathematical Knowledge for Teaching Poster Session
Participants:
A MULTIPLE CASE STUDY EXPLORING THE RELATIONSHIP BETWEEN MODEL-ELICITING ACTIVITIES AND PROSPECTIVE SECONDARY TEACHERS' MATHEMATICAL KNOWLEDGE FOR TEACHING ALGEBRA
Aline Abassian, University of Central Florida; Farshid Safi, University of Central Florida
This research study explores the question: what is the nature of the relationship between model-eliciting activities and prospective secondary teachers’ mathematical knowledge for teaching algebra topics? This question was examined using a multiple case research design. Data included recordings of prospective teachers exploring the tasks, participant artifacts, interviews, and written reflections. Results, limitations, and implications of the study will be discussed.

TASK DESIGN AND REVISION AS A VEHICLE FOR DEVELOPING MATHEMATICAL KNOWLEDGE FOR TEACHING TEACHERS Priya Vinata Prasad, University of Texas at San Antonio; Cody L Patterson, University of Texas at San Antonio; Raquel Vallines Mira, UNIVERSITY OF TEXAS - SAN ANTONIO; Su Liang, University of Texas, San Antonio
In this paper, four mathematics teacher educators describe the process of developing and using our own mathematical knowledge for teaching teachers in an elementary mathematics content course for prospective teachers. We conceptualize the process of designing and revising these tasks as a distinct form of mathematical knowledge for teaching, one that is specific to mathematics teacher educators. In this paper we share insights and reflections, obtained within the framework of our self-study, on how our mathematical knowledge for teaching teachers guided and was enriched by the design and revision of lessons on these three concepts.

184-5. MATHEMATICAL PROCESSES POSTER
SESSION 2
Mathematical Processes
Poster Session
Participants:

AN ANALYTIC FRAMEWORK FOR ASSESSING STUDENTS’ UNDERSTANDING OF PROOF COMPONENTS Kimberly Conner, University of Northern Iowa
This poster presents a framework, based on Stylianides’ (2007) definition of proof, that attends to multiple aspects of students’ work on proof tasks. I will also share coded examples of student work in order to illustrate the advantages of the framework. By attending to multiple aspects of students’ work, the researcher is able to identify what the student does understand and can do in regards to proof as well as identify areas of improvement for future instruction or interventions. The 9th grade students’ work was produced towards the end of an introduction-to-proof design research study.

COLLEGE ALGEBRA STUDENTS’ CONCEPT IMAGES OF PARABOLAS Monica Anthony, University of Maryland, College Park
This study documents the concept images of parabolas held by students in a college-level Algebra class, and identifies potential influences on students’ understandings.

MEASURE DEVELOPMENT: A FOCUS ON CONTENT VALIDITY Jonathan David Bostic, Bowling Green State University; Gabriel Matney, Bowling Green State University; Toni Ann Sondergeld, Drexel University; Gregory Stone, University of Toledo
The study’s purpose is to describe an aspect of the measure development process, focusing on developing strong content validity evidence. Measure development and validation processes are discussed and drawn upon experiences constructing problem-solving measures that address third, fourth, and fifth-grade mathematics content standards. Two outcomes for this work are: (1) sharing a model for future measure construction; (2) informing scholars about a new measure of children’s mathematics content, which adheres to best practices in measure development.

QUANTIFYING ANGULARITY: CIRCLES OPTIONAL Hamilton L. Hardison, Texas State University
Students challenges with angle measure are well documented at the elementary, middle, and undergraduate levels. Extant empirical research with undergraduates has shown that measuring angles using arc lengths is productive for students’ trigonometric understandings; however, this measurement process may not be appropriate or natural for all learners. Using data from a yearlong teaching experiment with ninth-grade students, we present two powerful quantifications of angularity involving extensive quantitative operations (e.g., iterating and partitioning). We argue these extensive quantifications are coherent, productive, and offer an alternative starting point for students’ early instruction in angle measure.

UNDERGRADUATE STUDENTS’ CONSTRUCTION OF GENERAL STATEMENTS Duane Graysay, Syracuse University
This presentation shares findings and conclusions from an empirical study of the approaches of undergraduate students to the construction of general statements. Qualitative, inductive methods were applied to the responses of mathematics majors and mathematics education majors during individual task-based interviews. Tasks prompted participants to develop descriptions of sets of objects that would satisfy a given set of properties. Findings describe the approaches in terms of ways that participants used specific cases, representative cases, and inductive and deductive reasoning to generalize, specialize, or deduce the characteristics of those sets.

184-6. PRESERVICE TEACHER EDUCATION POSTER SESSION 2
Preservice Teacher Education
Poster Session
Participants:

A RESEARCH EXPERIENCES FOR UNDERGRADUATES PROGRAM: PREPARING FUTURE RESEARCHERS IN STEM EDUCATION Molly H Fisher, University of Kentucky; Jennifer Wilhelm, University of Kentucky
Our Research Experiences for Undergraduates project exposes pre-service K-12 teachers to timely problems involving STEM teaching and learning. At this time, 23 undergraduate Fellows have fully completed the academic-year program. Research questions aimed to investigate the growth of the Fellows’ research skills as well as the impact on their future professional goals. We discovered significant growth in the Fellows’ confidence levels in studying, conducting, and analyzing research. Additionally, most of the Fellows still planned to work as a K-12 teacher, but the experience had helped them gain deep pedagogical knowledge and strategies that could be integrated into their future teaching.

ELEMENTARY PRE-SERVICE TEACHERS’ USE OF RESOURCES TO MAKE SENSE OF CURRICULAR PRESENTATIONS OF PROOF Taren Going, Michigan State University
My research is guided by the questions: 1) How do Elementary Pre-service Teachers (EPSTs) use resources from in-text explorations of the proving process as they make sense of written proofs? and 2) To what extent are there connections between...
how EPSTs interpret particular resources as they read proofs and how they use those resources as they prove? This poster will present findings from analysis grounded in data from interviews and written work of EPSTs as they engaged in making sense of two curricular presentations of proof.

ELEMENTARY PRESERVICE TEACHERS WHOLE-CLASS INSTRUCTIONAL DECISION MAKING
Lara K Dick, Bucknell University; Melissa Marie Soto, San Diego State University; Mollie Appelgate, Iowa State University; Dittika Gupta, Midwestern State University

Teacher focus on students’ mathematical thinking has been associated with high-quality instruction, thus the construct of professional noticing of students’ mathematical thinking has been utilized with teachers. For this study, preservice elementary teachers (PSTs) applied the professional noticing construct to their analysis of elementary student’s written work. The PSTs analyzed individual student’s work and then considered the student work as representative of a whole class to make an instructional decision. PSTs’ noticing was analyzed using a researcher developed scoring rubric. Preliminary results show that many PSTs’ made whole class instructional decisions by first focusing on individual students’ thinking.

ELICITING PERSONIFICATION TO STUDY PRE-SERVICE TEACHER BELIEFS
Robert Sigley, Texas State University; Muteb M. Alqahtani, State University of New York at Cortland

This paper reports about eliciting personification (Zazkis, 2015) by creating a character Math and describing their relationship with the character as a means to study pre-service teachers’ (PSTs) beliefs. At the end of the semester, the students were asked to revisit the assignment by describing a new character based on the math learned in class and by writing a dialogue to themselves. At the beginning of the semester, PSTs described math as having multiple personalities, out to hurt them, and having a relationship that fell apart. The math described at the end was more compassionate, welcoming, and easier to understand.

INSTRUCTIONAL STRATEGIES USED TO TEACH REASONING AND PROOF IN SECONDARY TEACHER EDUCATION PROGRAMS
Jia He, Augusta University; Tuyin An, Georgia Southern University

This study investigated instructional strategies used in mathematics and mathematics education courses to teach reasoning and proof in three universities. We developed a framework to capture instructional strategies which includes proof specific teaching strategies and general teaching strategies. We found variations in terms of the strategies used among three universities. We also noticed that more instructional strategies, both proof specific teaching strategies and general teaching strategies, were reported in mathematics courses than in mathematics education courses. Our work has implications for the current learning opportunities for future teachers.

PRESERVICE ELEMENTARY TEACHERS USE OF JOURNALS AS A MEANS OF REFLECTING ON PROFESSIONAL VISIONS OF MATHEMATICS INSTRUCTION
Ashley Whitehead, Appalachian State University

This session presents the preliminary results of a semester long study following 32 preservice elementary teachers throughout a senior mathematics methods course. The focus of the study is centered around the preservice teachers use of journaling as a means for reflecting on their past and present experiences with mathematics as well as discussing how they envision their future mathematics classrooms. Using qualitative data collected over six journals, themes were examined among all participants, and implications for mathematics education will be discussed.

PRESERVICE MATH TEACHERS’ PERCEPTIONS OF PRODUCTIVE STRUGGLE
Hope Marchionda, Western Kentucky University; Kanita Ducloix, Western Kentucky University; Natasha Gerstenschlager, Western Kentucky University; Janet Tassell, Western Kentucky University

This exploratory case study examined prospective elementary, middle grades, and secondary teachers’ perception of their struggles in a mathematics course for teachers while engaging in a problem-solving task. The researchers sought to determine (1) how prospective elementary, middle, and secondary teachers engage in productive struggle as they complete non-routine mathematical tasks and (2) how prospective teachers perceive and characterize their struggle during non-routine mathematical tasks. This presentation will include examples of each type of struggle that was identified as well as a discussion of the results and the possible implications on teaching prospective mathematics teachers and future research.

QUALITY RESEARCHES OF MATH WORD PROBLEM SOLVING INTERVENTION
Bingyu Liu, Purdue University

It is important to develop best practice for students to improve math performance. This literature review was conducted to evaluate the body of work using CEC quality indicators. The purpose of this review is to identify the quality of previous investigations of empirical single subject design studies published between 2013 and 2016 on mathematics word problems intervention for students with learning disabilities. There is limited research that evaluated the body of work using CEC quality indicator. This
study extended contribution by filled the two gaps that (a) evaluated studies using CEC quality indicator and (b) evaluated single subject studies.

TRANSFORMING LEARNING THEORY: A LENS TO LOOK AT MATHEMATICS COURSES FOR PREPARING FUTURE TEACHERS Kim Helene Johnson, West Chester University of Pennsylvania; Dana Olanoff, Widener University

Research has shown that prospective teachers (PTs) enter their mathematics content courses with procedural understandings of mathematics. Additionally, PTs often believe that they already know the elementary mathematics that they will need to teach. We suggest Transformative Learning Theory as a way for Mathematics Teacher Educators to help PTs move from shallow procedural understandings to the deeper conceptually-based understandings that they will need in their work as teachers. We describe a four-part cycle of Transformative Learning Theory: Disorienting Dilemma, Critical Reflection, Rational Discourse, Action.

WHAT DOES IT MEAN TO BE GOOD AT MATH: TOOLS FOR DISCOVERY Shannon P Sweeney, Northern Arizona University; Jennifer L. Ruef, University of Oregon; James C. Willingham, James Madison University

What does it mean to be "good at math?" Many prospective elementary teachers (PETs) suffer from fear of mathematics. Supporting their development of positive dispositions towards mathematics is thus important work. Knowing how PETs feel about math can inform this support. We developed and tested a suite three tools for eliciting such dispositions: (a) a personification of mathematics task (adapted from Zazkis, 2015), (b) a drawing protocol imaging someone who is "good at math," and (c) a semantic differential, which asks participants to assess twenty paired terms by marking a continuum between them (e.g., fast/accurate or ease/effort).

184-7. STATISTICS AND PROBABILITY POSTER SESSION 2
Statistics and Probability
Poster Session

Participants:

A FRAMEWORK FOR ANALYSIS OF AP STATISTICS TEXTBOOKS FOR INFERENCEAL REASONING Asli Mutlu, North Carolina State University; Hollylyrne S. Lee, NC State University

The relationship between the course and its textbook is complex. As a fundamental resource, Advanced Placement (AP) Statistics’ textbooks have the potential to shape the way the instructors teach and the students learn. Inferential reasoning is not only an ultimate learning goal of the AP Statistics course, its early introduction is also recommended by the Guidelines for Assessment and Instruction in Statistics Education (GAISE) report (Franklin et al., 2007). In this poster, we will describe a framework we have developed to answer the following: What is the nature and extent of inferential statistics concepts contained in AP Statistics textbooks?

ESTUDIO DE CASO DE UNA ENSEÑANZA DE LA ESTADÍSTICA BASADA EN LENGUAJE R: ESQUEMAS DE ACCIÓN Y DISCURSO Perla Marysol Ruiz-Arias, Center for Research and Advanced Studies (CINVESTAV- IPN, Mexico); Ana Isabel Sacristán, Center for Research and Advanced Studies (CINVESTAV- IPN, Mexico)

En este trabajo se analizan los esquemas de acción que una profesora de estadística de nivel universitario hace en sus clases basadas en el lenguaje de programación R. La profesora había diseñado una serie de actividades en R para promover el entendimiento de conceptos por parte de sus alumnos. Se observó su práctica en dos cursos de nivel universitario, complementándolo con entrevistas. Los resultados se analizaron cualitativamente usando el Enfoque Documental de lo Didáctico (Gueudet & Trouche, 2009). Se identificaron el uso de los lenguajes oral, estadístico y de programación, y la relación entre ellos, como principales esquemas de acción.

HIGH SCHOOL STATISTICS TEACHERS’ DEVELOPMENT OF KEY UNDERSTANDINGS OF HYPOTHESIS TESTING THROUGH SIMULATION Amber L Matuszewski, Middle Tennessee State University

My poster will describe the lesson plan design used for engaging a high school statistics teacher in tasks using simulations to conduct hypothesis testing and how the participant interacted with the tasks. Additionally, the results of how the tasks influenced the teacher’s content knowledge for hypothesis testing will be shared. The poster will highlight important elements to incorporate into professional development to help teachers foster a deeper understanding of hypothesis testing using technology to conduct simulations for inference.

184-8. STUDENT LEARNING AND RELATED FACTORS POSTER SESSION 2
Student Learning and Related Factors
Poster Session

Participants:

DEVELOPMENTAL DIFFERENCES IN LEARNING MATH BY EXAMPLE IN ELEMENTARY SCHOOL Julie Booth, Temple University

The purpose of the present study was to examine how prompting self-explanation of correct and incorrect examples impacts learning in in fourth vs. fifth grades on procedural and transfer items. Results from data collected in 27 26 real-world
classrooms indicate that while the worked-example assignments did have benefit for both fourth and fifth grade students, the pattern of results differed by grade. Fifth graders’ benefit manifested mostly in gains on transfer items, while fourth graders’ benefit was greater on the isomorphic procedural items. Grade level differences in how students approached and completed their assignments will also be discussed.

"EXPLICAME TU ESTRATEGIA": EMERGING BILINGUALS’ DEVELOPMENT OF MATHEMATICAL AGENCY IN PROBLEM SOLVING DISCUSSIONS Juanita Maria Silva, Texas State University; Gladys Helena Krause, The University of Texas at Austin; Luz Angelica Maldonado, Texas State University

Problem solving discussions with mathematical practices and positioning moves provided opportunities for children to engage in sense making and provide opportunities to take ownership of their mathematical thinking. This study explored how Latino/a emerging bilinguals exhibited mathematical agency when given an opportunity to engage in problem solving with peers and explain their thinking in English and Spanish during group discussions. We uncovered ways in which emerging bilinguals exhibited mathematical agency and how it increased over time. Findings suggest a need for further research on reform oriented mathematical practices that enable children to exhibit mathematical agency.

FACTORS THAT INFLUENCE STUDENT MATHEMATICAL DISPOSITIONS Meghan Riling, Boston University; Leslie Dietiker, Boston University; Kaitlyn Gibson, Boston University; Ildar Tukhtakhunov, Boston University; Ci Ren, Boston University

Why do secondary students in the US consistently and increasingly report a lack of interest in mathematics? This poster presents findings from an exploratory study of student disposition toward mathematics. We surveyed 275 students, grades 9 to 12, in 11 classes in three New England schools. Initial results indicate that students view teachers and the topics of study as the central factors influencing their enjoyment of mathematics class. Students who like math and those who do not reported some different class activity preferences. Identifying factors that influence secondary student mathematical dispositions can inform curriculum designers seeking to improve mathematical attitudes.

NEGOTIATING FRAMES IN AN INFORMAL MATH SPACE Katherine Carr Chapman, Vanderbilt University

This work addresses a call by Herbel-Eisenmann et al (2015) to provide more explicit empirical discussion in applications of Positioning Theory. Drawing on interactional analysis of a single pair of students within a single week of data collection at a math-focused knitting camp, initial findings suggest that 1) specific tools and constraints tend to re-Frame an interaction as being “school math”, and 2) student-initiated questions are more likely to subsume mathematics instrumentally into the current Frame.

STEM RETENTION FOR DEVELOPMENTAL MATHEMATICS STUDENTS: AFFECTIVE TRAITS AND A PEER-MENTORING INTERVENTION Edgar J Fuller, West Virginia University; Jessica Deshler, West Virginia University; Marjorie Darrah, West Virginia University

We present the results of a study of the impact of anxiety on students entering a developmental mathematics course at a research university over a two year period. We describe a peer-mentoring intervention and present outcomes from that project near the end of the two-year study. We find that anxiety inhibits course success, and that peer-mentoring supports course success but not necessarily STEM persistence over time.

STUDENT DISENGAGEMENT IN CALCULUS: IMPLICATIONS FOR MEASUREMENT AND QUANTITATIVE RESEARCH Daria Gerasimova, George Mason University; Margret Hjalmarson, George Mason University

Research has demonstrated that student engagement and disengagement with academic work predict learning outcomes. However, less attention has been paid to the reasons behind student disengagement. Nevertheless, understanding these reasons may help advance the knowledge of quantitative relationships. In this study, we investigated students’ reasons for disengagement in a Calculus classroom. Data sources included five interviews with students. Our analysis revealed three types of disengagement: disengagement potentially detrimental for student success in the course, alternative engagement, and potentially non-detrimental disengagement. The results suggest that the relationship between engagement and course success may differ depending on how and why students disengage.

YOUTH’S ENGAGEMENT AS MATHEMATICIANS IN AN AFTERSCHOOL MAKING PROGRAM Amber Simpson, Binghamton University; Alexandra Burris, Toledo Zoo; Adam Maltese, Indiana University

The presentation will focus on how youth were engaged in the eight mathematical practices outlined within the United States’ Common Core State Standards for Mathematics within an informal learning environment utilizing principles of making and engineering within the daily activities. Participants will watch short video clips, considering ways in which youths are engaged in
these practices differently than might be expected in a classroom setting.

184-9. TEACHING AND CLASSROOM PRACTICE POSTER SESSION 2
Teaching and Classroom Practice
Poster Session
Participants:
AN EXPLORATION IN DOING COLLABORATIVE UNSOLVED MATHEMATICS Cassondra M Gendron, University of Massachusetts - Dartmouth; Isaac T Nichols-Paez, Vanderbilt University; Corey Brady, Vanderbilt University
Over a two-week period, we explored what happened when unsolved mathematics (Collatz Conjecture) was given to a group of PhD and Masters students enrolled in a course that specifically focused on inquiry-based, collaborative, open-ended mathematics. The group studied patterns that arose when exploring the $3n+1$ problem. The group crafted illuminating representations, examined the problem using modular arithmetic, and explored what happened when the initial number, n, was negative. These explorations both recapitulated the work of Lagarias and went off in its own directions. This work describes the processes and products.
CONTEXTUAL PROBLEMS AS CONCEPTUAL ANCHORS?: A STUDY OF TWO CLASSROOMS Luke Reinke, UNC Charlotte; Rukiye Ayan, Middle East Technical University; Amanda R. Casto, UNC Charlotte; Michelle L Stephan, UNC Charlotte
Research has shown contextual problem-solving experiences can be used as anchors for understanding mathematical ideas. The purpose of this multiple case study is to gain insight into the ways teachers leverage the contextual nature of problems toward developing students’ understanding of mathematics. Data, collected from observations of two seventh grade mathematics classrooms over the course of six weeks, were analyzed to understand how contextual references support students' conceptual understanding. Our findings highlight the different ways teachers and students make contextual references during mathematical discourse, as well as the purposes or benefits of each in developing students’ understanding of mathematics.
DEVELOPING METHODS TO IMPLEMENT EMBODIED GAME DESIGN FOR MOBILE LEARNING TECHNOLOGIES IN STEM CLASSROOMS Taylyn Hulse, Worcester Polytechnic Institute; Avery Harrison, Worcester Polytechnic Institute; Ivon Arroyo, Worcester Polytechnic Institute; Erin Ottmar, Worcester Polytechnic Institute
Extending evidence that shows student learning, motivation, and computational thinking are increased through technology-supported classrooms, game-based curricula, and embodied learning, we propose a pedagogical method that invites students to not only play games but to also create their own math games. We propose the Embodied Game Design framework as a classroom activity and preliminary method for analyzing students’ higher-level thinking and problem-solving in STEM classrooms. To achieve this goal, our team has tested the effectiveness of two instructional designs and created the Wearable Learning Cloud Platform (WLCP), which together provide the structure and tools needed to implement into any classroom.
DIFFERENTIATING MATH GAMES: MEETING THE NEEDS OF ALL STUDENTS Diana Tang-En Chang, University of North Georgia
This study focuses on differentiating math games as an instructional strategy to meet the varying academic needs of students. I use the situated learning theory as a lens to examine the participation that occurs while students play differentiated math games in small groups of two to four. The study was situated in a first-grade classroom of a small rural school, where the majority of students were African American. In this study, I found that differentiation within math games provided students the opportunity to engage in fun activities while solving math problems that were appropriately leveled.
EXAMINING THE SOCIAL ASPECTS OF GREENHOUSE EFFECT THROUGH MATHEMATICAL MODELING Debasmita Basu, Montclair State University; Nicole Panorkou, Montclair State University
For years researchers have emphasized the role of mathematics to develop students' awareness about social justice issues, such as unemployment rate, racial profiling, and gender bias. This study focuses on the environmental topic of greenhouse effect for engaging students with issues of social injustice through mathematics. In this poster, we present the modeling tasks we developed in the agent-based modeling tool NetLogo and present our initial findings from a whole class design experiment with middle-school students. We discuss how the task design may help students develop an awareness about the greenhouse effect and develop their mathematical thinking of covariation relationships.
PROBLEM POSING AND STUDENT ENGAGEMENT IN A UNIVERSITY DEVELOPMENTAL MATHEMATICS COURSE John Sevier, Appalachian State University and University of North Carolina at Charlotte; Anthony Fernandes, UNC Charlotte
The number of students entering college underprepared to pursue their major is increasing. This study examines the impact of engaging these developmental mathematics students with personalization in problem posing. The study will
also examine the change in the students' attitudes, beliefs, and motivation in mathematics. This poster will discuss preliminary findings of students' problem posing and its impact on their motivation and interest in developmental mathematics course.

SECONDARY STRINGS: MATH TALKS IN HIGH SCHOOL Rob Wieman, Rowan University; Jill A Perry, Rowan University

The secondary teacher-leaders we work with are excited about integrating problem solving, discourse and sense-making into their classrooms; however, they struggle to find ways to do so with their current curriculum. Through their work with elementary teachers, they have become excited about the potential of strings to engage their students in reasoning and argumentation and have begun to develop secondary strings. This poster will share some examples of secondary strings, as well as ongoing questions about their design and implementation, and what knowledge teachers need in order to plan and enact them.

TEACHER DECISION MAKING IN INSTRUCTIONAL SITUATIONS IN ALGEBRA AND GEOMETRY: DO TEACHERS FOLLOW INSTRUCTIONAL NORMS? Emanuele Bardelli, University of Michigan; Patricio G Herbst, University of Michigan

This paper reports preliminary results from a nationally-representative study of the instructional decisions of experienced secondary mathematics teachers. Using multimedia scenarios of classroom instruction, teachers engaged with different instructional decisions in both geometry and algebra 1 lessons. The results suggest that experienced geometry teachers were likely to act in ways that followed an instructional script, while experienced Algebra teachers seem less likely to do so. These results add nuance to the notion that the instructional scripts are cultural, supporting prior claims that the teaching of mathematics is subject-specific.

TEACHING NORMS FOR THE ORDER OF MULTIPLICATION IN THIRD GRADE Karl Wesley Kosko, Kent State University

Numerous different recommendations are advocated for the order that operands and factors should be introduced for instruction of multiplication in third grade. Many of these recommendations vary considerably between researchers, textbooks, and curricular resources. However, it is unclear what sequence current third grade teachers are introducing multiplication operands. The present study reports on 49 third grade teachers' reported rankings. Findings reveal that there is large variance in reported order, but also a very clear norm in the order multiplication operands are currently introduced.

THE RELATIONSHIP BETWEEN NOVICE TEACHERS' EFFICACY AND STUDENTS' OPPORTUNITIES FOR DISCOURSE Diane Catheine Hunter, North Carolina State University; Temple A. Walkowiak, North Carolina State University; Teomara Rutherford, North Carolina State University

This study focused on novice, elementary grades, teachers' efficacy in relation to the opportunities for discourse during their mathematics lessons. There were 118 second-year teachers that participated in the study. Multiple regression analyses were utilized to assess if mathematics teaching efficacy significantly predicted mathematical discourse, controlling for teachers’ high school GPA and SAT scores. Grade band (K-2 and 3-5) was examined as a potential moderator. Results indicate that MTOE, or beliefs about ability to impact student outcomes, is a significant predictor of opportunities for discourse within the mathematics lessons. The moderation of grade band was not statistically significant.

DRAWING A PICTURE OF PRACTICE-BASED TEACHER COMPETENCY FOR DISCURSIVE MATHEMATICS PEDAGOGY Dong Joong Kim, Korea University; Sang-Ho Choi, Korea University; Younhee Lee, Pennsylvania State University; Woong Lim, University of New Mexico

Discursive capacity is a relatively unknown pedagogical demand in mathematics education. As the basis for studying discursive capacity, we investigated the nature and kinds of mathematical discourse for teaching (MDT) by examining lessons of Korean master teachers in which discourse was the primary mode of teaching school mathematics. We argue that a teacher’s discursive competency resides in the process of sequential but not exhaustive phases of practicing MDT: first, establishing relationships and norms in the classroom community; second, launching a lesson with various discursive strategies to elicit student thinking; and third, facilitating problem-solving with patterns of discursive practice.

184-10. TECHNOLOGY POSTER SESSION 2

Technology
Poster Session
Participants:
CALCULUS II STUDENTS’ DEFINITIONS OF FUNCTION: ATTENTION TO CORRESPONDEANCE Samuel Douglas Reed, Middle Tennessee State University; Sister Cecilia Anne Wanner, Middle Tennessee State University; Nina G Bailey, UNCC; Candice M Quinn, Middle Tennessee State University; Jennifer N. Lovett, Middle Tennessee State University; Allison McCulloch, University of North Carolina at Charlotte; Milan F. Sherman, Drake University
This poster describes a large scale study of calculus II students’ understanding of function. Students utilized an applet designed to problematize common misconceptions of function to answer the following question: How do students change their definition of function after engaging with the applet? Findings related to their pre and post definitions will be presented.

DEVELOPMENT OF THE COMPOSITE UNIT IN ADDITIVE PROBLEM SOLVING OF A STUDENT WITH MATHEMATICS DIFFICULTY IN A COMPUTER-BASED LEARNING ENVIRONMENT
Soo Jung Kim, Purdue University; Signe Kastberg, Purdue University; Yan Ping Xin, Purdue University
Our study explores the learning path and the role of affect by looking at a child with mathematics difficulty in computer-based learning related to developing the composite unit. We analyzed pre-and post-tests, videotaped tutoring sessions, and field notes. Our findings show that, through the interaction with a computer tutoring program, our participant exhibited the use of the composite unit consistent with Steffe’s idea although she needed more support for developing the composite of tens. Her affect actively interacted with her learning process by functioning as a reward system and a message to her reflect on her previous behaviors.

INNOVATIVE METHOD TO COMBAT MATHEMATICS ANXIETY: SEEKING HELP IN VIRTUAL SPACE Hochieh Lin, The Ohio State University; Theodore Chao, The Ohio State University; Dustin James Auble, Ohio State University; Chengzhi Tan, The Ohio State University
Utilizing a designed-based methodology, we investigates how elementary and middle school students could use technology to seek help in doing math tasks. Through a cycle of three design experiments, participants interacted with one another both virtually and physically as they engaged in mathematics problems. After the intervention, participants were interviewed to share their experiences and perceptions of help-seeking in school. This pilot study opens the way for future research investigating creating an equitable learning technology platform to facilitate classroom interactions and discussions in which ALL students participate with confidence.

LEARNING TO NOTICE AND NAME STRENGTHS WITH LESSONSKETCH Nicole Bannister, Clemson University; Crystal A Kalinec, University of Texas at San Antonio; Sandra Crespo, Michigan State University; Diana Bowen, University of Maryland; Lorraine Jacques, Clemson University
An enduring challenge for mathematics teacher educators is developing course experiences that provide PTs with accessible entry points for learning strengths-based practices. Recent advances in technology-based teaching methods suggest that the LessonSketch (LS) platform is a promising medium for this work. We analyzed what PTs noticed and named about students’ strengths in a LS experience before and after a strengths-based intervention, and the quality and quantity of the claims and evidence in PTs noticing statements. We found statistically significant increases in quality and quantity, which provides empirical backing for a digital experience that meaningfully approximates PTs’ learning of strengths-based practice.

ORIENTATION OF PEDAGOGY WHEN EXPLOITING CAS TECHNOLOGY IN THE DEVELOPMENT OF MATHEMATICAL KNOWLEDGE Candace Terry, Middle Tennessee State University
The purpose of this study was to understand (a) how high school mathematics teachers use symbolic CAS tools to instruct students to develop mathematical understandings, (b) how teachers adjusted or aligned curriculum in new ways, and (c) why these teachers were motivated to change their focus. Technology integration to instruction is both inevitable and expected yet CAS’ incorporation into classrooms has been slow and non-existent in most cases, despite its availability for over 25 years. This study contributes evidence of functional usage of the technology and a testimony to regard CAS as an essential tool in learning mathematics.

SHEARING IN IMMERSIVE SPATIAL DISPLAYS: PLANE AND SOLID FIGURES Camden Glenn Bock, UNIVERSITY OF MAINE; Justin Dimmel, University of Maine
We ask: How do the affordances of immersive spatial displays allow pre-service elementary teachers to reason about relationships between plane and solid figures? Immersive spatial displays allow learners to interact with solid mathematical figures in their ‘native’ dimension, explore parameters that grow without bound, and directly interact with figures. A pilot study found that pre-service teachers might draw connections between plane and solid figures when exploring shearing in immersive spatial displays (Bock & Dimmel, 2017). In an ongoing study, participants work in small groups to explore the shearing of plane and solid virtual manipulatives.

184-11. THEORY AND RESEARCH METHODS POSTER SESSION 2
Theory and Research Methods
Poster Session
Participants:
COMPETING VIEWS ON PREPARING MATHEMATICS TEACHERS FOR CHANGE
Samuel Otten, University of Missouri; Charles Munter, University of Missouri; Zandra de Araujo, University of Missouri; Corey Webel, University of Missouri;
This poster provides a theory-based distinction between two approaches to teacher preparation and different views on how preparation carries forward into teachers’ early career classrooms. The agent-of-change approach is based on the notion that without a clear vision of a different kind of mathematics education, teachers will not look for or be prepared to act on opportunities for challenging and disrupting the status quo. The incremental approach builds upon conventional practices by identifying aspects that can be positive while also raising small-scale critiques and providing specific recommendations to address those critiques. Study designs to investigate these approaches are presented.

 USING ENGINEERING CONTEXTS TO TEACH MATHEMATICS Premkumar Pugalenthi, University of North Carolina at Charlotte; Michelle L Stephan, UNC Charlotte; David Pugalee, UNC Charlotte

The purpose of this study is to contribute to the ongoing dialogue regarding the efficacy of genuine STEM integration. Our goal is to explore the feasibility of using engineering contexts to teach mathematics and develop a conceptual framework for genuine STEM integration. The instructional sequences were designed to encourage students to switch back and forth between the engineering context and the mathematics embedded within that context. Separate emphasis was intentionally placed on mathematics and engineering instructional sequences because, goal of mathematician and engineer are different and hence learning outcomes of mathematics and engineering are going to be different as well.

184. DISSERTATION: FUSION OF VISION AND TOUCH IN AUGMENTED REALITY PRESENTATION
PMENA
Special Event
7:00 to 9:00 am
Hyatt Regency: Floor 1st - Prefunction

185. SCALING CONTINUOUS COVARIATION: SUPPORTING MIDDLE SCHOOL STUDENTS’ ALGEBRAIC REASONING
Amy Ellis, University of Georgia; Robert Ely, University of Idaho; Brandon K Singleton, University of Georgia; Halil Ibrahim Tasova, University of Georgia

Middle school is an important time for introducing functions, but many students struggle to understand functions as relationships between dependent quantities. We report on the influence of Scaling Continuous Covariation in fostering productive ideas about graphs and rates of change. Scaling Continuous Covariation entails the ability to imagine a re-scaling to any increment for x and coordinate that scaling with associated values for y. We present findings from a teaching experiment and report on how Scaling Continuous Covariation supported three ideas: (a) sense making about graphs, (b) forming constant rates of change, and (c) understanding constantly-changing rates of change.

186. DJ AND DANCING
PMENA
Special Event
8:30 to 10:30 pm
Hyatt Regency: Floor 1st - Regency A,B,C

187. SPECIAL EVENT
10:30 to 12:00 pm
Hyatt Regency: Floor 1st - Crepe Myrtle

188. SUNDAY MORNING COFFEE
PMENA
191. EARLY ALGEBRA, ALGEBRA, AND NUMBER CONCEPTS BRIEF RESEARCH REPORTS SESSION 6
Early Algebra, Algebra, and Number Concepts
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Magnolia

Participants:

EXPLORING FACTORS RELATED TO HIGH SCHOOLERS’ ALGEBRA ACHIEVEMENT: A REVIEW OF DISSERTATIONS USING HSLS:09 DATA Sheree Taisha Sharpe, University of New Hampshire; Dalton Marsh, University of New Hampshire

The difficulty that students demonstrate when it comes to learning algebra in secondary school has been long documented and researched. The authors conducted a research synthesis of the literature that uses data from the High School Longitudinal Study of 2009 with a focus on algebra achievement. We’ve summarized the results of 13 dissertations across 2 outcome variables (9th and 11th grade algebra achievement). We employed the optimal resource theory (ORT) as a research framework to inform best-practices for improving student outcomes. Our findings show that malleable factors at the student-, teacher-, school-, and parent-level were related to algebra achievement.


This study investigated the differences in conceptions of variable among the groups of students labeled as having mathematics difficulties (MD) and typical mathematics achievement (TMA). Results revealed little evidence of differences between MD and LMA students’ conceptual understandings. That students labeled as MD and TMA can have similar levels of sophistication of conceptions of variables suggests that current measures of achievement provide an incomplete picture of students’ understandings of algebra, and also disproportionately disadvantage those labeled as low-achieving. The theoretical framework for this study was based upon a learning trajectory (LT) of levels of sophistication of students’ conceptions of variable.

192. STUDENT UNDERSTANDING OF THE GENERAL BINARY OPERATION CONCEPT
Mathematical Processes
Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud A
Participant:

STUDENT UNDERSTANDING OF THE GENERAL BINARY OPERATION CONCEPT Kathleen Melhuish, Texas State University; Michael Duane Hicks, Texas State University

In this paper, we address the variety of ways in which students conceive of binary operations and the metaphors they might leverage when working with binary operations in several contexts. We use open-ended surveys paired with interviews to qualitatively explore student’s conceptions of binary operation. Through this analysis, we identified three central metaphors (function, arithmetic, and structure), as well as a number of attributes related to binary operation that students perceive as critical. This work has implications for our treatment of binary operation in advanced mathematics, and the messages we send about operation in the K-12 setting.

193. WHERE’S THE MATH? A STUDY OF COACH-TEACHER TALK DURING MODELING AND CO-TEACHING
Inservice Teacher Education/Professional Development Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud B
Participant:

WHERE’S THE MATH? A STUDY OF COACH-TEACHER TALK DURING MODELING AND CO-TEACHING Evthokia Stephanie Saclarides, University of Alabama at Tuscaloosa; Sarah Lubinski, Indiana University at Bloomington

This study explores how two instructional coaches enacted modeling and co-teaching cycles with five elementary teachers during mathematics instruction. A content analysis of the coach-teacher talk from 11 planning meetings and 23 lessons reveals that the coaches and teachers seldom engaged in mathematical conversations. Instead, they primarily had low-depth discussions about curriculum, other instructional materials, and assessment. Implications for school districts with instructional
coaching models are discussed.

194. GEOMETRY AND MEASUREMENT BRIEF RESEARCH REPORTS SESSION 4
Geometry and Measurement
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Redbud C
Participant:

INVESTIGATING VOLUME AS BASE TIMES HEIGHT THROUGH DYNAMIC TASK DESIGN
Nicole Panorkou, Montclair State University; Debasmita Basu, Montclair State University; Madhavi Vishnubhotla, Montclair State University
This study aims to engage students in dynamic tasks of extruding surfaces on a certain height and reasoning about volume as a continuous quantity that depends on the size of the base and the height of extrusion, an approach we call as Dynamic Measurement for Volume (DYME-V). In this paper we describe our efforts for designing tasks for DYME-V and present data from a design experiment with one pair of fifth grade students. The data show that DYME-V has the potential to help students visualize a) volume as a continuous structure and b) the multiplicative relationship of base times height.

195. THEORY AND RESEARCH METHODS BRIEF RESEARCH REPORTS SESSION 4
Theory and Research Methods
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency D2,E2,H
Participants:

CHALLENGING THE STIGMA OF A SMALL N: EXPERIENCES OF STUDENTS OF COLOR IN CALCULUS 1 Jess Ellis Hagman, Colorado State University; Vincent Basile, Colorado State University; Bailey K. Fosdick, Colorado State University; Daniel Birmingham, Colorado State University
Students of color are underrepresented in undergraduate mathematics classes, and their experiences are often ignored in studies drawing on large data sets or are inferred based on the experiences of other populations. This exclusion and misrepresentation of students of color is often attributed to methodological limitations. We reexamine the data studied for a previous analysis attending to student race and ethnicity rather than to gender. This paper argues for a reframing of how we value papers with a small n, and what this value indicates about our value of the students making up the small samples.

NETWORKING THEORIES TO DESIGN A FULLY ONLINE ASSESSMENT OF STUDENTS' COVARIATIONAL REASONING Heather Lynn Johnson, University of Colorado Denver; Jeremiah Kalir, University of Colorado Denver; Gary A Olson, University of Colorado Denver; Amber Gardner, CU Denver; Amy Smith, CU Denver; Xin Wang, RMC Research
Networking theories of different grain sizes, we designed a fully online assessment of students' covariational reasoning. With this assessment, we intend to produce a viable means of measuring students' mathematical thinking using methods other than clinical, task-based interviews. The assessment is fully online, and readily accessible across different types of devices. We outline design aspects across and within the assessment items and discuss three theoretically based design principles underlying the design of the assessment. Through this research, we contribute to the development of new theoretical approaches to investigate and assess complexities of students' mathematical reasoning.

196. TEACHERS' ANALYSIS OF STUDENT THINKING IN A TEACHING MATHEMATICS WITH TECHNOLOGY MASSIVE OPEN ONLINE COURSE
Technology
Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency D,E
Participant:

TEACHERS' ANALYSIS OF STUDENT THINKING IN A TEACHING MATHEMATICS WITH TECHNOLOGY MASSIVE OPEN ONLINE COURSE Karen Hollebrands, North Carolina State University; Gemma Foust Mojica, NC State University; Brooke Outlaw, North Carolina State University
The research study examined the ways participants analyzed students’ mathematical thinking in a massive online open course focused on teaching mathematics with technology. Across units, participants’ posts showed increased attention to student thinking and less focus on issues related to technology.

197. MATHEMATICAL KNOWLEDGE FOR TEACHING BRIEF RESEARCH REPORTS SESSION 4
Mathematical Knowledge for Teaching
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency F
Participants:

IN-SERVICE TEACHERS' ABILITIES TO MAKE SENSE OF FIXED NUMBER OF VARIABLE SIZED PARTS TASKS Chandra Hawley Orrill, UMass Dartmouth; John Millett, University of Massachusetts Dartmouth
In this study, we interviewed 32 practicing middle grades teachers to determine whether they were able to invoke reasoning about a fixed number of
variable-sized parts in a proportional situation. To this end, we presented them with a sample student response to an item that relied on such reasoning to determine whether teachers understood the approach and whether they thought it was appropriate. Findings suggest that teachers who did not invoke this reasoning were unable to make sense of the student's reasoning, thus limiting their ability to make sense of students' work.

INVESTIGATING HOW A MEASUREMENT PERSPECTIVE CHANGES PRE-SERVICE TEACHERS’ INTERPRETATIONS OF FRACTIONS Muteb M. Alqahtani, State University of New York at Cortland; Arthur B. Powell, Rutgers University-Newark

Theoretical and empirical revisions of our common practices of teaching fractions are needed. This study investigates how re-examining fractions from a measurement perspective influences pre-service teachers’ (PSTs) interpretations of fractions. Sixty-seven PSTs engaged in re-examining fractions from a measurement perspective during a 15-week semester and completed pre- and post-tests that assess their interpretations of fractions represented in discrete and continuous models. Findings show statistically significant increase in PSTs’ scores, specifically on questions that used continuous models. This study shifts investigating fractions learning from an exclusive focus on the partitioning perspective to the measurement approach and highlights its affordances.

198. STATISTICS AND PROBABILITY BRIEF RESEARCH REPORTS SESSION 2
Statistics and Probability
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 1st - Regency G

Participants:

MIDDLE-SCHOOLERS’ CONSTRUCTION OF PROBABILISTIC VOCABULARY Kelly Patrick Findley, Florida State University; Sebnem Atabas, Florida State University

Our research investigates the probabilistic reasoning of middle-school students making sense of sample space, distribution, and long-run likelihood. Eight students in a 3-week summer class on probability participated in games and activities that focused on concepts from the Common Core State Standards for grades 6-8. These activities utilized both concrete and simulated environments. Through engagement with the games and activities, we captured seeds of probabilistic reasoning that emerged with one student in particular, Evan, and took note of the vocabulary he and the class created to make sense of seemingly paradoxical situations. Implications for instruction on probability are briefly discussed.

NIVELES DE LECTURA DE GRÁFICAS ESTADÍSTICAS POR PROFESORAS EN FORMACIÓN DE PREESCOLAR José Antonio Orta Amaro, Escuela Nacional para Maestras de Jardines de Niños; David Alfonso Paez, CONACyT-Universidad Autónoma de Aguascalientes; José Antonio Altamirano Abad, Escuela Nacional para Maestras de Jardines de Niños

Se expone una exploración sobre lectura de gráficas por profesoras en formación de nivel preescolar, además, se pretende identificar las nociones que tienen de valor representativo de un conjunto de datos. Para ello, se les proporcionó una gráfica para que contestaran un conjunto de preguntas. El análisis da cuenta de los niveles de lectura que hacen las participantes, pueden recuperar información explícita de la gráfica, sin embargo cuando deben integrar y combinar datos muestran dificultades. Los resultados encontrados pueden ser utilizados para mejorar la formación de las futuras docentes y reducir brechas en el aprendizaje de la estadística para preescolar.

199. CURRICULUM AND RELATED FACTORS BRIEF RESEARCH REPORTS SESSION 2
Curriculum and Related Factors
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA A

Participants:

THIRD GRADE TEXTBOOKS’ MODELS FOR MULTIPLICATION & DIVISION Karl Wesley Kosko, Kent State University; Rashmi Singh, Kent State University

Multiplication and division are important topics that are formally introduced in third grade. Visual models and representations are key scaffolds for facilitating the teaching and learning of these topics, but there is little research on the prevalence of these models in classrooms. The present study examined six U.S. textbooks and found that three quarters of independent practice and homework tasks did not incorporate visual models. Additionally, textbooks vary significantly regarding which specific models are incorporated.

USING A NEXT-GEN “AGILE CURRICULUM” TOOL TO STRENGTHEN WEAK RATIO REASONING Jere Confrey, North Carolina State University; Michael Belcher, North Carolina State University; William McGowan, North Carolina State University; Meetal Shah, North Carolina State University

Our digital learning system (DLS) scaffolds curricular coherence, supporting assembly and iterative improvement of diversely-resourced curricula. An implementation-based design study on effects of a DLS (learning map of big ideas and learning trajectories, local ratio curriculum unit, and...
The in-the-moment noticing of the novice mathematics teacher

Michael Jarry-Shore, Stanford University

This study examined both the extent to which four novice teachers noticed students' mathematical thinking in-the-moment, as well as the types of knowledge they drew upon to support them with this noticing. Findings indicate that these novice teachers relied most on knowledge they developed in their classrooms (e.g., knowledge of their students and of the lessons in which students took part) to support their in-the-moment noticing. These findings support calls for teachers to come to view their classrooms as rich sources of knowledge that can continually support their growth and development as teaching professionals.

202. STUDENT LEARNING AND RELATED FACTORS
BRIEF RESEARCH REPORTS SESSION 7
Student Learning and Related Factors
Brief Research Report Session
8:30 to 9:10 am
Hyatt Regency: Floor 2nd - Think Tank @ NOMA

Participants:

DOES TEACHER FEEDBACK ON HOMEWORK IMPROVE STUDENT MATHEMATICS ACHIEVEMENT BETTER THAN ONLINE COMPUTER FEEDBACK? Ji-Won Son, University at Buffalo-The State University of New York; Amir Mahmood, University at Buffalo-The State University of New York

This study examined the effects of four types of feedback on eighth grade students’ achievement in mathematics: no feedback, effort-based teacher feedback on paper-and-pencil-based homework, ability-based teacher feedback on paper-and-pencil-based homework, and online programmed feedback on computer-based homework. A total of 59 students from an inner-city school district in New York participated in the study. A repeated measures experimental design was employed to minimize the between group variability. Analysis of results revealed that although effort-based feedback appeared to be a variable of interest, there was statistically insignificant relationship between the effect of different type of feedback and student achievement.

PROVIDING STUDENTS CORRECT VS. INCORRECT CALCULUS EXAMPLES Jeneva Clark, University of Tennessee, Knoxville; Jo Ann Cady, University of Tennessee, Knoxville; Ji-Won Son, University at Buffalo-The State University of New York

Are there differences in learning when calculus learners analyze correct or incorrect work samples? Do students perceive the exercise differently? Results suggest that when students analyze incorrect
work samples, they are less likely to repeat the errors they have seen. Results also suggest that students perceive correct work samples as more beneficial to learning than incorrect work samples. However, both correct and incorrect work samples were found to challenge students' thinking and promote student independence.

203. PERSPECTIVES ON THE NATURE OF MATHEMATICS AND RESEARCH
PMENA
Plenary Session
9:15 to 10:45 am
Hyatt Regency: Floor 1st - Regency A,B,C
Presiders:
Anderson Norton, Virginia Tech
Julie Sarama, Denver University

204. SUNDAY MORNING BREAK
PMENA
Special Event
10:45 to 11:00 am
Hyatt Regency: Floor 1st - Prefunction

205. BOXED LUNCHES AVAILABLE
PMENA
Special Event
10:45 to 12:30 pm
Hyatt Regency: Floor 1st - Prefunction

206. WORKING GROUP: DEVELOPING A RESEARCH AGENDA OF K-8 TEACHERS’ IMPLEMENTATION OF DIGITAL CURRICULA
Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Boardroom
Participant:
DEVELOPING A RESEARCH AGENDA OF K-8 TEACHERS’ IMPLEMENTATION OF DIGITAL CURRICULA Shannon Driskell, University of Dayton; Steve Rhine, Pacific University; Rachel Harrington, Western Oregon University
The purpose of this working group is to understand how teachers are implementing digital curricula to teach elementary mathematics, to explore best teaching practices for using digital curricula, and to understand how students are learning from digital curricula. We propose a working group on digital curricula that focuses on the themes of: access, equity, and empowerment; data generation/use; mathematical content; motivation and mindset; and nurturing NCTM Mathematics Teaching Practices and Common Core State Standards for Mathematical Practices.

207. WORKING GROUP: MATHEMATICAL MAKING IN IMMERSIVE VIRTUAL ENVIRONMENTS
Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Crepe Myrtle
Participant:
MATHEMATICAL MAKING IN IMMERSIVE VIRTUAL ENVIRONMENTS WORKING GROUP Justin Dimmel, University of Maine; Megan Nickels, University of Central Florida; Craig Cullen, Illinois State University; Camden Glenn Bock, UNIVERSITY OF MAIN 
Our working group will bring mathematics education researchers together to explore how immersive spatial display technologies (e.g., room scale virtual reality) can be used for the teaching and learning of mathematics. The sessions will provide participants with the opportunity to explore a range of virtual worlds, including mathematics-specifics environments that were designed by session organizers. Participants will work together to plan research studies, discuss instructional activities, and design virtual environments. Our group aims to look ahead to a time in the near future and anticipate the research, design, and development that can guide how these technologies will be integrated into schools.

208. WORKING GROUP: SPECIAL EDUCATION AND MATHEMATICS WORKING GROUP
Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Dogwood
Participant:
SPECIAL EDUCATION AND MATHEMATICS WORKING GROUP Yan Ping Xin, Purdue University; Jessica Heather Hunt, NCSU; Helen Thouless, UCL Institute of Education; Ron Tzur, University of Colorado Denver
This Working Group will continue the conversation started since PME-NA-34, with a goal to move forward the teaching and learning of mathematics involving students with learning disabilities or difficulties in mathematics (LDM). This Working Group is rooted in following premises: (1) students with LDM are capable of and need to develop conceptual understanding of mathematics, and (2) special education as well as inclusive classroom instruction need to transition toward this focus. Participants will continue (a) the collaborative research agenda for the group, and (b) the dissemination effort through publications that reflect the cross-disciplinary collaborative work of this international group.

209. WORKING GROUP: ADDRESSING EQUITY AND DIVERSITY ISSUES IN MATHEMATICS EDUCATION: LOOKING BACK AND LOOKING AHEAD
Working Groups
Working Group
11:00 to 12:30 pm
Embracing the theme of this year’s meeting, we seek as a community to embrace the history of mathematics education research/PMENA, and the promise of the future of mathematics education by continuing on the reestablished purpose of this group and supporting the development of new directions for equity-oriented research working groups. The sessions will focus on regrouping attendees interested in equity, generating and brainstorming new subtopics and potential projects, and working to establish standalone working groups dedicated to furthering research on equity. The purpose being to encourage a move away from “big-tent” equity thinking and toward more productive working collectives.

210. WORKING GROUP: MATHEMATICS TEACHER EDUCATORS’ INQUIRY INTO THEIR PRACTICE: UNPACKING METHODOLOGIES FOR PROFESSIONAL AND PERSONAL GROWTH

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Magnolia

Participant:
MATHEMATICS TEACHER EDUCATORS’ INQUIRY INTO THEIR PRACTICE: UNPACKING METHODOLOGIES FOR PROFESSIONAL AND PERSONAL GROWTH Elizabeth Suazo-Flores, Purdue University; Signe Kastberg, Purdue University; Jennifer Ward, Kennesaw State University; Dana Christine Cox, Miami University; Olive Chapman, University of Calgary

In this working group, we introduce narrative inquiry, self-study, and autoethnography as methodologies that focus on the study of the self. Through posing research questions and creation of research texts from existing field texts, participants will explore these methodologies. Field texts used will be videos, personal journals, and transcripts of conversations that the leaders of the working group and Melva Grant have constructed in their different research studies. The creation of a nurturing space to conduct and review research using these methodologies will be promoted in this working group.

211. WORKING GROUP: THE MATHEMATICS EDUCATION OF ENGLISH LEARNERS

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Redbud A

Participant:
THE MATHEMATICS EDUCATION OF ENGLISH LEARNERS Zandra de Araujo, University of Missouri; William Zahner, San Diego State University; Sarah A Roberts, University of California, Santa Barbara; Craig Willey, Indiana University, IUPUI

This Working Group builds on the work of Working Groups in 2015 and 2016. We will continue considering multiple aspects of research and practice related to mathematics learning and teaching with English Learners. Our goals for the 2018 Working Group include: (1) sharing current perspectives on extant research related to mathematics and English learners, (2) understanding venues for dissemination of research on ELs, including novel outlets that connect research to practice, and (3) fostering new collaborations and supporting further connections among researchers.

212. WORKING GROUP: COMPLEX CONNECTIONS: REIMAGINING UNITS COORDINATION

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Redbud B

Participant:
COMPLEX CONNECTIONS: REIMAGINING UNITS COORDINATION Beth Loveday MacDonald, Utah State University; Steven James Boyce, Portland State University; Jessica Heather Hunt, NCSU; Cameron Byerley, Colorado State University; Diana L. Moss, Utah State University

Students’ construction, coordination, and abstraction of units underlie success across multiple mathematics domains. Structures for coordinating units underscore notions of numbers as composite units (e.g., five is a unit of five and five units of one). In this working group, we seek to facilitate collaboration amongst researchers and educators concerned with composite unit formation and units coordination. The aim for this working group is two-fold: (1) to extend our research around units coordination to new grade levels; and (2) to collaborate with researchers who investigate students with learning differences in school settings to determine diverse students’ mathematics learning trajectories.

213. WORKING GROUP: MODELS AND MODELING WORKING GROUP

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Redbud C

Participant:
MODELS AND MODELING WORKING GROUP
Corey Brady, Vanderbilt University; Angeles Dominguez, ITCHEM, MX; Aran Glancy, University of Minnesota; Hyunyi Jung, Marquette University; Jeffrey A McLean, University of North Carolina at Chapel Hill

The Models and Modeling Working Group at PME-NA has provided a forum for discussing and collaborating on research projects fundamental to this area since the first PME-NA conference in 1978. We propose to convene this Working Group at PME-NA 40 with a dual purpose: (1) to build on discussions at PME-NA 37-39, extending collaborative research directions formulated at the Indianapolis meeting, and (2) to continue to invite newcomers to the Models and Modeling Perspective (MMP), giving them an introduction to this rich tradition in design research.

214. WORKING GROUP: GENDER AND SEXUALITY IN MATHEMATICS EDUCATION: LINKING THE PAST TO THE FUTURE

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Regency D2,E2,H

Participant:

WORKING GROUP ON GENDER AND SEXUALITY IN MATHEMATICS EDUCATION: LINKING THE PAST TO THE FUTURE
Katrina Piatek-Jimenez, Central Michigan University; Rebecca McGraw, University of Arizona; Lynda Wiest, University of Nevada, Reno; Jennifer Hall, Monash University; Angie Hodge, Northern Arizona University; Elizabeth Ann Kersey, Purdue University; Laurie Rubel, Brooklyn College CUNY & University of Haifa; Kathleen Jablon Stoehr, Santa Clara University

After not having met for a number of years, the Gender and Sexuality in Mathematics Education Working Group will meet again this year with a new name, new members, and a new focus. During this Working Group, we will discuss current research being conducted on this topic and will identify themes for discussion and possible research collaborations. We plan to include a discussion about how research assumptions, such as language assuming that gender is binary, can affect research findings. All PME-NA attendees with an interest in gender and sexuality in mathematics education are invited to attend.

215. WORKING GROUP: CONCEPTIONS AND CONSEQUENCES OF WHAT WE CALL ARGUMENTATION, JUSTIFICATION, AND PROOF

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Regency D,E

Participant:

CONCEPTIONS AND CONSEQUENCES OF WHAT WE CALL ARGUMENTATION, JUSTIFICATION, AND PROOF

Kristen Bieda, Michigan State University; Jill Newton, Purdue University; AnnaMarie Conner, University of Georgia; Carlos Nicolas Gomez, Clemson University; Hyejin Park, University of Georgia; Jonathan Kyle Foster, University of Georgia; Yuling Zhuang, University of Georgia; Megan Staples, University of Connecticut; Michelle Cirillo, University of Delaware; Kristen Bieda, Michigan State University; Jill Newton, Purdue University

Argumentation, justification, and proof are conceptualized in many ways in mathematics education literature. The descriptions of these objects and processes are sometimes compatible or complementary; they can also be inconsistent or contradictory. Collaboration is needed to move toward highlighting connections and exploiting ways in which they may be used to address overarching research questions. The 2018 working group sessions will extend previous conversations into issues of teacher preparation with respect to argumentation, justification, and proof. The group will also discuss how issues of equity, social justice, and marginalized populations intersect with the teaching and learning of argumentation, justification, and proof.

216. WORKING GROUP: FORGING NEW PATHS THROUGH CRITICAL PERSPECTIVES ON DISABILITY AND MATHEMATICS EDUCATION

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Regency F

Participant:

FORGING NEW PATHS THROUGH CRITICAL PERSPECTIVES ON DISABILITY AND MATHEMATICS EDUCATION
Amber Grace Candela, University of Missouri - St. Louis; Katherine E Lewis, University of Washington; Paulo Tan, University of Hawaii, Manoa; James Sheldon, University of Arizona; Kai Rand, National Coalition of Independent Scholars; Jessica Heather Hunt, NCSU

Research on mathematics and disabilities traditionally has been conducted within a special education paradigm, which often implicitly or explicitly adopts a deficit model of the learner. The deficit model locates the “problem” within the individual student rather than in the social, discursive, political, or structural context. Our working group is composed of researchers and educators who draw upon critical theories, such as Disability Studies in Education, Critical Race Theory, and DisCrit, in order to offer an alternative vision of mathematics education based around a different conceptualization of disability and learning differences.

217. WORKING GROUP: EMBODIED MATHEMATICAL IMAGINATION AND
COGNITION (EMIC) WORKING GROUP
Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 1st - Regency G
Participant:
EMBODIED MATHEMATICAL IMAGINATION AND COGNITION (EMIC) WORKING GROUP Erin Ottmar, Worcester Polytechnic Institute; Edward Melcer, Univ. of California, Santa Cruz; Dor Abrahamson, University of California, Berkeley; Mitchell J. Nathan, The University of Wisconsin - Madison; Emily Fyfe, Indiana University; Carmen Smith, University of Vermont

Embodied cognition is growing in theoretical importance and as a driving set of design principles for curriculum activities and technology innovations for mathematics education. The central aim of the EMIC Working Group is to attract engaged colleagues into a growing community of discourse around theoretical, technological, and methodological developments for advancing the study of embodied cognition for mathematics education. EMIC builds upon our prior working groups with a focus on how we can leverage emerging technologies to study embodied cognition and mathematics learning. We aim to develop new theories and extend frameworks and perspectives from which collaboration and activities can emerge.

219. WORKING GROUP: WORKING TO UNDERSTAND MEDIATED FIELD EXPERIENCES AND STUDY THEIR IMPACT
Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA B
Participant:
WORKING TO UNDERSTAND MEDIATED FIELD EXPERIENCES AND STUDY THEIR IMPACT Barbara A Swartz, McDaniel College; Esther Marie Billings, Grand Valley State University; Melinda Knapp, Oregon State University-Cascades; Rajeev K Virmani, Sonoma State University; Charlotte Sharpe, Syracuse University; Dawn Woods, Southern Methodist University; Sararose Lynch, Westminster College; Holly H Pinter, Western Carolina University

This group of mathematics teacher educators has been working to integrate preparation efforts by purposefully designing coursework around McDonald et al.’s (2013) learning cycle to include mediated field experiences. Our goals as a working group are to establish cross-cutting and essential features of these mediated field experiences and identify future research questions and ways to standardize data collection to create clear lines of investigation to explore the impacts of such experiences.

220. WORKING GROUP: MATHEMATICAL PLAY: ACROSS AGES, CONTEXT, AND CONTENT
Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 2nd - Studio 220 @ NOMA C
Participant:
MATHEMATICAL PLAY: ACROSS AGES, CONTEXT, AND CONTENT Caro Williams-Pierce, University at Albany, SUNY; David Plaxco, Clayton State University; Paul N. Reimer, AIMS Center for Math and Science Education; Amy Ellis, University of Georgia; Muhammed F. Dogan, Adiyaman University

Mathematical play has a fairly short history, with strong roots further back in time (e.g., Papert, Montessori), and understanding the role of mathematical play from early childhood to adulthood is, as yet, unmapped. This working group will provide a community space to explore and discuss mathematical play broadly, ranging from early childhood to undergraduate learners, with an emphasis on physical and digital interactions designed specifically to support mathematical play.
221. WORKING GROUP: DEVELOPING THEORY, RESEARCH, AND TOOLS FOR EFFECTIVE LAUNCHING

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 2nd - Teal Ballroom
Participant:

DEVELOPING THEORY, RESEARCH, AND TOOLS FOR EFFECTIVE LAUNCHING
Rob Wieman, Rowan University; Jill A Perry, Rowan University; Andrew Tyminski, Clemson University; Grace Kelemanik, Fostering Math Practices; Gloriana Gonzalez, University of Illinois at Urbana-Champaign; Aaron Trocki, Elon University; Jennifer Ann Eli, The University of Arizona

Launching cognitively demanding tasks is a much valued, but little understood, aspect of ambitious mathematics teaching. This working group supports the development of descriptions, theory, and tools to support teachers, teacher educators, and researchers in understanding and developing skill in launching. We will identify the purposes of effective launches, common challenges teachers face, and structures and skills that teachers use when launching. The working group will facilitate and support ongoing discussion and collaboration between researchers, teacher educators, and practitioners that will contribute to our knowledge of effective launches.

222. WORKING GROUP: DESIGNING AND RESEARCHING ONLINE PROFESSIONAL DEVELOPMENT

Working Groups
Working Group
11:00 to 12:30 pm
Hyatt Regency: Floor 2nd - Think Tank @ NOMA
Participant:

DESIGNING AND RESEARCHING ONLINE PROFESSIONAL DEVELOPMENT
Jeffrey Choppin, University of Rochester; Julie Amador, University of Idaho; Cynthia Callard, University of Rochester; Cynthia Carson, University of Rochester; Ryan Gillespie, University of Idaho

In this working group, we continue with previous efforts to consider design and research methodologies related to teacher learning in online professional development contexts. Year Two of this discussion group will combine whole-group and subgroup time to converse about: (a) the challenges of online professional learning experiences, (b) research tools, methods, and analyses, (c) the connections among different projects and studies, and (d) future collaborations. Given recent technological advances and demands to support teachers in various contexts, we contend that researching these online models, as well as other online models is important for the broader field of
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