

NCTM Research Conference Program

San Diego, California

April 1 – 3, 2019

Monday Apr 01, 2019 5:30 PM -7:00 PM

#1. What is the Responsibility of the Mathematics Education Research Community to Address Local, National and Global Issues?

Opening Session

Deborah Loewenberg Ball, Na'ilah Suad Nasir, Kathryn B. Chval

A central pillar of our work as mathematics education researchers is addressing issues of equity. This work is complicated by the multiple definitions of equity used in mathematics education and the many different ways these issues show up within our institutions, as well as in our local communities, nationally, and globally. As a community, what is our collective responsibility for confronting these issues? How can our research deliberately work to address these challenges?

Room 33ABC

Tuesday Apr 02, 2019 8:30 AM -9:45 AM

#2. Research Reports Session 2

Exploring Volume Measurement Dynamically

Nicole Panorkou

This paper describes our efforts for exploring students' thinking of Dynamic Measurement for Volume (DYME-V), an approach to volume measurement that engages students in dynamic experiences of extruding surfaces to create 3-D objects and assists students in reasoning about volume as a continuous quantity that depends on the size of the surface being extruded and the height of the extrusion.

Promoting Young Children's Spatial Visualization through Defining Practices

Megan Wongkamalasai

Recent studies have demonstrated that children's descriptions and transformations of space support reasoning about space and early math skills. These are promising findings. Yet, we still know little about how to develop spatial language and reasoning skills so they can serve as foundations to broader conceptual understandings and mathematical practices. This study looks at how to support grade one children in developing spatial visualization and concepts through defining invariant patterns.

Room 29A

#3. Research Reports Session 3

Explicit Vs. Implicit Teaching Concerning Strategies for Problem Solving

Yelena Portnov Neeman, Miriam Amit

Children who control strategies can direct their own learning and knowledge. For this goal we designed a 6-month learning program that consisted of four strategies for math problem solving: Working backwards, Recursion, Proof by Contradiction and Trial and Error. Explicit vs. Implicit Teaching were tested on 119 young talented students. Results showed that young students can learn complex strategies and that explicit teaching produced greater ability to control strategies in the short and long term.

Postulating Two Types of Mathematical Concepts and How They Develop

Martin Simon

The term "mathematical concept" is commonly used in the mathematics education research community. However, use of the term lacks both precision and shared meaning. Our research program has used teaching-experiment methodology to explore the nature of mathematical concepts and how they develop. Here, I specify two types of mathematical concepts, one involving mathematical relationships and one involving arithmetic operations, and discuss the differences in how these concepts are constructed.

Room 29B

#4. Research Reports Session 4

Elementary Teachers' Use of Digital Instructional Resources in 4 Countries

Janine Remillard

This research report examines teachers' purposes for working with digital resources in their mathematics instruction. Through an empirical, qualitative, cross-cultural analysis of interviews with 40 elementary school teachers from four educational contexts: Sweden, Finland, the US, and Belgium, we explore how teachers use digital resources for instructional and professional purposes and consider the possible opportunities for and challenges to transformation of teaching and learning.

Room 29C

#5. Research Reports Session 5

Computer Generated Dynamic Graphic Organizer's Effect on Learning Outcomes

Michael Rugh, Mary Margaret Capraro, Robert Capraro

A Dynamic Interactive Mathematical Expressions (DIME) map system was used to analyze a physics textbook chapter and produce a DIME map. This map acted as an alternative to traditional graphic organizers in helping high school students (n=16) learn new math intensive material. The students in the experimental group outperformed the control group on attitude and knowledge. Females in the experimental group outperformed control group females by an even greater amount. Implications are discussed.

Investigating Student Thought via Scratch Work for a Large-Scale Assessment

Meggan Hass

Large-scale assessments are ubiquitous in U.S. public K-12 education. However, it is possible that more information about student thinking might be obtained from these assessments than a final submitted answer on a computerized assessment suggests. The current study examines scratch work produced by students on constructed response summative assessment items targeting multiplication and division. Several implications for both education and assessment professionals are discussed.

Room 29D

#6. Research Reports Session 6

One University's Story on Teacher Preparation in Elementary Mathematics

Casedy Thomas

This multi-case study examines how three elementary mathematics methods instructors in the same teacher education program provide their teacher candidates (TCs) with learning opportunities. The findings suggest that the instructors' values and teaching philosophies influence the content that TCs have the opportunity to learn and the nature of the TCs' opportunities to learn (OTL). The three assertions unpack similarities in OTL, differences in OTL, and perceived purpose of the methods courses.

What's in a name? A study of mathematics teachers' implicit bias

Yasemin Copur-Gencturk, Joe Cimpian, Ian Thacker, Sarah Theule Lubienski

Mathematics teachers can significantly affect students' perceptions of their mathematical ability and future career choices. In this experiment (N=390), mathematics teachers evaluated 18 mathematical solutions to which gender- and race-specific names were randomly assigned. Teachers displayed no detectable bias when assessing the correctness of students' solutions; however, they perceived White students' ability to be higher, especially relative to Black and Latina girls.

Room 30AB

#7. Research Reports Session 7

Professional Learning Community: Mathematicians and Writers

Doris Santarone, Angel Abney, Sandra Webb

In this session, we discuss a professional learning community (PLC) designed to provide K-2 teachers with resources for an integrated approach to math instruction involving conceptual understanding through the use of children's literature, manipulatives, and writing. After participating in the PLC, teachers saw an increase in student learning outcomes and became intentional about connecting all of the components of an integrated lesson, but misconceptions were revealed through the process.

Using Number Talks to Support the Development of a Math-Talk Community

Dawn Woods

Number Talks encourage students to solve and talk about strategies and may support the development of math-talk community. To this end, this case study investigated how 5 teachers enacted Number Talks before and after ongoing professional development that leveraged cycles of exploration, preparation, enactment, and analysis of enactment. Findings suggest that Number Talks may be used as a tool to support teachers in creating opportunities for their students to use math-talk during instruction.

Room 30C

#9. Making Mathematics Connections Visible through Problem Solving and Dialogue

Discussion Session

Martha Koch, Christine Suurtamm

Research, curriculum standards, and guidelines for effective teaching prompt teachers to make connections among mathematics concepts and processes. This session focuses on the complexity inherent in making these connections. Participants will examine problem solving as a way to identify and connect concepts and processes; consider how educators negotiate connections they have made as they collaborate with others; and provide feedback on early findings from a research project about this topic.

Room 31AB

Tuesday Apr 02, 2019 8:30 AM -9:45 AM

#11. Examining Students' Opportunities to Engage with Mathematics in High School

Research Symposium

Amanda Jansen, Kelly Curtis, Kwaku Edusei, James Middleton, Gabriel Tarr.

Discussant: **Gerald Goldin**

How are opportunities to engage with mathematics constructed by high school teachers and students? During this symposium, we will present three studies from a project in which we investigate how students' opportunities to engage with mathematics can unfold as they are constructed in high school classrooms. Our data for these studies consist of observations of classroom instruction and interviews with teachers and students from year one of the project, which is set in two states.

Room 32A

Tuesday Apr 02, 2019 10:00 AM -11:15 AM

#13. Research Reports Session 13

A framework for analyzing secondary students' covariational reasoning

Laurie Cavey, Michele Carney, Jason Libberton, Kylee Souders, Tatia Totorica

Analysis of students' work on the well-known bottle filling task yielded a revised framework for coding covariational reasoning and revealed that younger secondary students can reason at higher levels than their academic language might indicate. Results also revealed that bottle shape may influence the level of reasoning students exhibit, individual students can reason at different levels while completing a single task, and conflating varying quantities with time can impact student success.

Quantitative Reasoning among Linguistically Diverse Middle School Students

William Zahner, Hee-Joon Kim, Teresa Lara-Meloy

We developed and refined a coding scheme for characterizing quantitative reasoning (QR) during problem solving discussions among 12 groups of linguistically diverse 7th grade students including English Learners (ELs). Half of the groups used dynamic representational technology (DRT) while the others used paper and pencil activities. With this coding scheme we examined patterns of QR during the groups' discussions, and characterized the affordances of DRT for fostering QR among ELs and non-ELs.

Room 29A

#14. Research Reports Session 14

A Study to Examine Preservice Teachers' Understanding of the Quadrilaterals

Pavneet Bharaj, Dionne Cross Francis

This descriptive study investigated the ways in which preservice teachers' engagement in developing constructions improved knowledge of the properties of quadrilaterals. Findings emphasize the need for integrating both visual and applied aspect of the geometric ideas as well as asking students to justify each step of the construction and transitioning from empirical proof-schemes to analytic proof-schemes to develop conceptual knowledge. Implications for teacher education are discussed.

Using Learning Progressions to Design and Assess Geometry Curricula

Michael Battista

This presentation discusses how a research-based Learning Progression was used to design, and study learning in, an online dynamic geometry curriculum. It illustrates how interpreting assessments in terms of LP provides critically important added insight to their interpretation. Field-tests (38 teachers, 2100 students) suggest that the LP-based curriculum was very effective, but, consistent with previous research, fully achieving property-based reasoning about shapes is difficult for students.

Room 29B

#15. Research Reports Session 15

Empowering Students in Learning Proof: Balancing Agency and Authority

Jeffrey Pair, Sarah Bleiler-Baxter, Samuel Reed

In this paper, we present an investigation into how an instructor uses her authority to empower students as legitimate proof producers. Empowerment is viewed through a situated lens, as an dance of agency accounting for relationships of disciplinary authority and student agency. We analyzed transcripts from three classroom episodes in a transition-to-proofs course and identified instances when the instructor leveraged her authority to support students' engagement in the dance of agency.

The Role of the Two-Column Proof in the High School Geometry Classroom

Jeffrey Pair, Rashmi Singh, Susanne Strachota

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.

Room 29C

#16. Research Reports Session 16

Pre-Service Teachers' Knowledge Resources for Arguments and Representations

Rachel Francom

Integration across math and science is emphasized in elementary STEM teacher education programs. A point of overlap, ubiquitous in both math and science standards, is a focus on learning and teaching through 1) developing arguments and 2) using various modalities of representations. In this study we used audio data from pre-service teachers' discussions of hypothetical teaching scenarios and analyzed productive resources of arguments and representations and patterns of occurrence.

Teachers Eliciting Students' Mathematical Arguments

John Francisco

There is a need for more studies on how mathematics teachers can promote students' mathematical arguments in teaching. This study reports on the experiences of middle school mathematics teachers in a research project where they had the opportunity to lead research sessions on students' development of mathematical ideas. The results show that teachers can engage in effective practices, but also face challenges in trying to influence students' mathematical thinking.

Room 29D

#17. Research Reports Session 17

Mathematics Teachers' Use of Social Justice to Design for Equity

Deena Khalil, Angel Miles Nash

To increase minoritized students' interest in science, technology, engineering, and mathematics careers, we partnered with teachers and STEM professionals of color to establish a federally-funded, blended community of practice. Our project engaged middle school mathematics teachers and students in engineering design tasks by including social justice throughout the design thinking process. Our proposal describes teachers' mindsets and reflection on their journey to become equity-oriented.

“It Just Got Real” - Backing into Social Justice

Eva Thanheiser, Mathew Felton-Koestler, Courtney Koestler, Jennie Osa, Brenda Rosencrans

The purpose of this project/paper is to explore PTs experiences in a course focused on teaching mathematics for social justice. Our research question was: How do PTs react to real world problems in general, and a backdoor task in particular? We found that while PTs experienced discomfort with the context of racial inequality, they felt it was a powerful experience in making the mathematics more real and added a depth of meaning to the context when explored from a mathematical perspective.

Room 30AB

#18. Research Reports Session 18

Discovering Square Roots: Productive Struggle in Middle School Mathematics

Cindy Cattey, Cody Patterson

Using videos and transcripts from a lesson on square roots and follow-up conversations with students and teachers, we analyze factors that can facilitate episodes of productive struggle, including student and teacher dispositions, task features, and classroom conditions. We highlight choices and task features that honored student autonomy and maintained students' engagement in, and success with, the lesson. We also discuss students' equitable access to the mathematics of the lesson.

Inservice Teachers' Distinctions Between Quadratic and Exponential Growth

Madhavi Vishnubhotla, Teo Paoletti

Our aim was to investigate how teachers may leverage covariational reasoning to distinguish between quadratic and exponential growth. We present relevant constructs pertaining to teachers' covariational reasoning and describe one task we used in clinical interviews with four teachers. We present findings from clinical interviews examining how teachers' leveraged (or did not leverage) covariational reasoning as they addressed this task to differentiate between quadratic and exponential growth.

Room 30C

#19. Common Methodological Errors in JRME Submission

Invited Session

Jinfa Cai, Jeff Shih, Susan Empson, Marcy Wood

This session will discuss the main methodological errors that appear in JRME submissions. We will show examples of each kind of error and discuss how to correct the issue. Errors to be discussed include problems with validity and reliability; insufficient detail in data collection and analysis; and lack of connectivity across the problem for study, theoretical framework, and methods.

Room 30DE

#20. Mathematical Authority: Gateway to High Quality Classroom Discourse

Discussion Session

Patrick Sullivan, Whitney Evans

A group of secondary mathematics teachers participated in an extensive professional development focused on improving the quality of their classroom discourse. While their espoused beliefs about teaching and student learning were consistent with elements of high quality classroom discourse most struggled to realize the fruits of high quality classroom discourse. A qualitative analysis of teaching episodes suggest that aspects related to mathematical authority may be the culprit.

Room 31AB

Tuesday Apr 02, 2019 10:00 AM -11:15 AM

#21. Preservice Teachers [Re] Learning the Meaning of Multiplication of Fraction

Discussion Session

Mary Gichobi

The context in which preservice teachers (PSTs) learn the mathematical knowledge for teaching fractions in elementary classroom is still less obvious. This session describes the extent to which PSTs' representations of fraction demonstrated conceptual [mis]understanding when provided with opportunities to experience reform-based mathematics instruction in a content course. We will examine types of errors that PSTs made as they represented multiplication of fractions using visual models. Join us!

Room 31C

#22. Differentiating Instruction in Mathematics Education

Research Symposium

Amy Hackenberg, Jessica Hunt, Robin Jones, Beth MacDonald, Juanita Silva, Allison Roxburgh

Differentiating instruction (DI) is a pedagogical approach to manage classroom diversity in which teachers proactively plan to adapt curricula and teaching methods to address individual students' needs in an effort to maximize learning for all. Although DI is critical in fulfilling visions of equitable classrooms, it has been studied very little in Mathematics Education. Teams from three different research programs will present how they understand DI and the challenges associated with it.

Room 32A

Tuesday Apr 02, 2019 11:30 AM -12:45 PM

#24. Research Reports Session 24

Developing Measures of Mathematical Proficiency in a Learning Technology

Taylyn Hulse, Avery Harrison, Daniel Manzo, Erin Ottmar, Katharine Sawrey

As a field, we need to break away from correctness-based assessment and design more formative measures that help students learn and succeed by measuring the entire learning process in real time. Utilizing clickstream data from a dynamic mathematics learning technology, we explore algebraic problem-solving in high school and college populations. This work aims to tease apart components of mathematical proficiency more efficiently and at a deeper level than traditional summative assessment.

Development of Diagnostic Assessments in Probability for Middle Graders

Hollylynn Lee

The research shared in this report illustrates how an iterative process to item development that involves expert review and cognitive lab interviews with students can be used to collect evidence of validity for assessment items. Analysis of students' reasoning was also used to expand a model for identifying conceptions and misconceptions about probability. Participants will discuss the model and how several items can be used to diagnose students' probabilistic reasoning.

Room 29A

#25. Research Reports Session 25

Grounded in common sense?: Examining contextual references in a ratio unit

Luke Reinke, Rukiye Ayan, Amanda Casto, Michelle Stephan

Teachers are urged to ground students' mathematical understanding to their common sense using problems set in experientially real contexts. By analyzing the implementation of a context-rich ratio unit, we identify a particular type of contextual reference teachers and researchers can listen for to assess whether students' use of formal representations is genuinely grounded in the context. We conclude that in this case, the intended grounding did not occur, despite many standards-based practices.

Reasoning with ratios: As composed units or as multiplicative comparisons?

Fetiye Aydeniz

A teaching experiment consisted of 12 45-minute episodes with two pairs of pre-service teachers (PSTs) was conducted to examine how PSTs reason distributively and proportionally, and to investigate relationships between PSTs' distributive reasoning and proportional reasoning. The presenter will share findings from three teaching episodes in which two of the PSTs worked on a specific problem context requires to reason with ratios as a multiplicative comparison.

Room 29B

#26. Research Reports Session 26

Discourse that Empowers Self in the Learning of Mathematics

Olive Chapman

This study investigated what and how specific features of whole-class discourse can support and promote students' development of productive mathematical identity. Participants were an exemplary elementary teacher and her class in a public elementary school. Findings provide a classroom-based perspective of learner-focused discourse involving reflection on self with examples of four categories of self-reflection, teacher's actions to facilitate them, and connections to mathematical identity.

Elementary Teachers' Math Anxiety and Implications for Self-Evaluation

Molly Kearns, Erin Hone

This session explores elementary teachers' abilities to self-evaluate their math teaching practices in relation to their levels of math anxiety, as well as other demographic factors. Teachers from 40 states participated in a survey examining math anxiety, NCTM Teaching Practices, and beliefs. Findings were then compared to teaching practices within three case studies in North Carolina. We identify those math practices which are most difficult for teachers to self-reflect on and execute.

Room 29C

#27. Research Reports Session 27

Improving Children's Fraction Understanding through the Use of Number Line

Meghna Soni, Yukari Okamoto

Fractions are a stumbling block for many students. This study assessed the effect of two different number line interventions to improve 4th graders' understanding of fractions. One used an electronic game Motion Math, while the other used a paper-and-pencil number line method. Results showed that both number line interventions were effective in improving participants' fraction knowledge. This suggests number line is a useful tool for teaching fractions regardless of other features or format.

Intervention for Improving Struggling 5th-Graders' Fractions Achievement

Madhavi Jayanthi, Russell Gersten, Karen Karp, Robin Schumacher

Findings from an impact evaluation of a fractions intervention for 5th-grade struggling students will be shared. The session will highlight key features of the intervention, such as the focus on grade-level standards as well as relevant foundational fractions content, use of the number line and concrete manipulatives for representing fractions, opportunities for problem solving, and providing explanations for mathematical solutions.

Room 29D

#28. Research Reports Session 28

Connecting Mathematical Knowledge and Dispositions with Pedagogical Skills

Meghan Shaughnessy, Timothy Boerst

We examined the connection between preservice teachers' (PSTs) skills in eliciting and interpreting student thinking and their mathematical knowledge and dispositions. PSTs better probed student understanding (and interpreted understanding) when they had high knowledge of the mathematical situation and preference for the approach compared to situations in which their knowledge and preference was low. Knowledge and preference did not appear to impact eliciting the student's process.

Synthesizing Measures of K12 Students' Math Knowledge

Jonathan Bostic, Michele Carney, Erin Krupa, Jeff Shih

The purpose of this presentation is to present a narrative on quantitative measurement of students' content knowledge outcomes as well as to share how this narrative is ripe for equity scholars' expertise. This presentation outlines some viable directions for validation work with measures of students' content knowledge and suggestions for collaborative work across measurement and equity scholars.

Room 30AB

#29. Research Reports Session 29

Integer Problem Types and Their Relationship to Children's Thinking

Lisa Lamb, Jessica Bishop, Randolph Philipp, Ian Whitacre

Through analyses of 160 integers problem-solving interviews of students in grades 2, 4, 7, and 11, we have identified five ways of integers reasoning and three problem types. Each problem type evokes or has the potential to evoke a particular way of reasoning. Session attendees will learn about the problem types, ways of reasoning that each evokes, implications of this research, and the chain of inquiry from which this work builds.

Properties of Equality and Operations: How Do 3rd Graders Think?

Seanyelle Yagi, Fay Zenigami

This qualitative study focused on 3rd grade students' use of the properties of equality and operations to gain insight into their interpretation of the equal sign and relational thinking. The curriculum implemented in the class was grounded in a general to specific perspective. Initial findings indicate students' relational view of the equal sign through their use of the properties of equality and operations and supported them in thinking relationally about equivalent expressions.

Room 30C

#30. ICME, International Perspectives, and Opportunities

Invited Session

Gail Burrill

International Congress on Mathematics Education (ICME) serves as an international forum to promote reflection, collaboration and the exchange and dissemination of ideas on the teaching and learning of mathematics from primary to university level across a diverse research areas. In 2020 ICME-14 will be held in Shanghai China. Come find out about the opportunities that have grown from past ICME congresses and the opportunities for ICME-14.

Room 30DE

#31. Mathematical Modeling With Cultural and Community Contexts in Grades 3-5

Discussion Session

Mary Foote, Julia Aguirre, Amy Roth McDuffie, Erin Turner

This session will examine the role of using cultural/community contexts in mathematical modeling tasks for grades 3-5. Cultural and community-based modeling tasks serve as a vehicle to increase student engagement and mathematics learning. Participants will engage with modeling tasks and then examine evidence from classroom implementations with specific attention to mathematics concepts/skills, cultural connections, and engagement in the modeling cycle.

Room 31AB

#32. Enhancing Elementary Mathematics Instruction: A U.S.-China Collaboration

Research Symposium

Meixia Ding, Tia Larese, Maryann Milewski, Danielle Murray, Jennifer Seidman

Discussant: **Jinfa Cai**

This symposium contains three papers resulted from a five-year NSF project that aims to enhance elementary mathematics instruction through a U.S.-China collaboration. What do teachers experience during the collaboration process? What do they learn from their international peers? And what challenges may they encounter? The best answers may come from teachers themselves who are inside practitioners. The three action research papers in this symposium will share findings from teacher perspectives.

Room 31C

#33. Researching Synchronous Online Content-Focused Mathematics Coaching

Research Symposium

Julie Amador, Cyndi Carson, Ryan Gillespie Discussant: **Rebekah Elliott**

The three papers in this symposium unite around synchronous online professional development, namely content-focused coaching, for rural middle school mathematics teachers. The first paper details our online content-focused coaching model. The second paper focuses on the analysis of meetings that occurred between the coach and mathematics teacher. The third paper focuses on our analysis of lesson implementation on video. The intent is to describe the online coaching model and data analysis.

Room 32A

#35. Research Reports Session 35

How a MOOC for Educators Can Make a Large Impact

Hollylynne Lee, Christina Azmy, Heather Barker, Gemma Mojica

This report shares an effort to provide wide-scale online professional development to improve the teaching of statistics. We share design principles and learning opportunities in a massive open online course that served 1,744 educators from 2015-2017. We will illustrate how we used multiple data sources to discern how educators engaged in the course, impacts on participants' perspectives about statistics and teaching statistics, and their self-reports of changes to practice.

Transforming Teachers' Understandings About Distribution

Susan Peters

We report results from a PD program designed to deepen teachers' statistical understandings. Results from data analyzed using a transformative learning theory framework reveal that critically reflecting on activities such as growing samples and engaging in rational discourse to consider multiple perspectives while working on activities broadened teachers' perspectives about distribution. This study identifies factors associated with deepening teachers' statistical understandings in refined ways.

Room 29A

#36. Research Reports Session 36

A Model for Teacher Candidate Attentiveness to Student Thinking

Michele Carney, Laurie Cavey, Tatia Totorica

We are developing an inventory to assess teacher candidates' attentiveness to secondary students' quantitative reasoning. Part of our design process involves gathering qualitative responses to constructed-response items and then analyzing the constructed-response data to build an operational model for attentiveness. This model may be useful to others seeking to develop this practice in teacher candidates.

Critical Embodied Noticing

Elizabeth Mendoza, Victoria Hand

Mathematics education research has become increasingly interested in mathematics teacher noticing as it relates to the reproduction of racialized and gendered ideologies. Teacher noticing may be a point of entry to examine, critique, and then expand towards the disruption of these dominant ideologies. This paper reports on an approach to noticing that is enhanced by women of color feminist epistemologies, and results in a critical embodied noticing praxis.

Room 29B

#37. Research Reports Session 37

Operationalizing Evaluative Listening-to-Question in Mathematics Teaching

Eloise Kuehnert, Colleen Eddy, Sarah Pratt

This case study focused on the evaluative listening practices of four eighth-grade mathematics teachers who participated in an algebra professional development. Listening-to-question was defined as the enactment of teachers listening to students followed by teacher questions in response to students' mathematical thinking. Classroom observations provide empirical evidence to support six different enactments of evaluative listening-to-question ranging from directive to responsive orientations.

Preservice Mathematics Teachers' Lesson Launch Considerations

Julie Amador

To support preservice teachers to learn to launch a lesson, they engaged in a four-part process of analyzing mathematics curriculum, planning a lesson based on the materials, demonstrating their visualization of enactment through an animation, and reflecting on the process. We present a case study of one focal pair to describe their decision making with respect to curricular adaptations, and specifically the introductory launch portion of the lesson.

Room 29C

#38. Research Reports Session 38

Examining Teacher Learning through Shifts in Teachers' Enacted Identity

Jen Munson

Teacher learning involves shifts in teachers' participation in the classroom community of practice, though both instructional practices and identity. I propose that teacher identity is visible during teaching through enacted identity. I explore this construct through qualitative video analysis of three elementary mathematics teachers' interactions with students, pre- and post-professional development on productive discourse. Analysis revealed four shared shifts in teachers' enacted identity.

The Impact of Professional Identity on Quality of Mathematics Instruction

Courtney Flessner, Jinqing Liu, Kemol Lloyd, Pavneet Bharaj

This study investigates how elementary teachers perceive their identity as mathematics teacher and in what ways this perception impacts their quality of math instruction. Seven elementary teachers were coached and interviewed for data collection. The findings revealed the multifaceted nature of identity was effective in teachers' professional identity which seems to impact the quality of their math instruction. Implications and suggestions for future research are discussed.

Room 29D

#39. Research Reports Session 39

Examining Domains of Teacher Knowledge in a Lesson Study Experience

Evrin Erbilgin

This study aimed to investigate what domains of teacher knowledge the elementary preservice teachers discussed about and focused on as they engaged in lesson study as part of a Methods of Teaching Mathematics course. Didactic-Mathematical Knowledge model was used as the teacher knowledge framework. Data sources included group reports and discussions. Data analysis revealed that the lesson study experience engaged preservice teachers in discussions about didactical domains of teacher knowledge.

Room 30AB

#40. Research Reports Session 40

Does Disability Matter in Mathematics Education Research? A Research Review

Rachel Lambert, Paulo Tan

We present the findings of a research review of articles (N=2405) published between 2013-2017 comparing research on students with disabilities with research on students without disabilities, in terms of methodologies, participants and theoretical frameworks. Using Critical Disability Studies, we discuss the implications of the differences we found, and question the exclusion of students with disabilities from mathematics education, both at the classroom and the research level.

Key Indicators of Mathematically Responsive Classrooms

Jessica Bishop, Hamilton Hardison, Julia Przybyla-Kuchek

Responsiveness to students' mathematical thinking -- the extent to which student ideas are present, attended to, and taken up as the basis for instruction -- is an important component of classroom interactions. We analyzed the responsiveness of whole-class mathematics discussions in 40 fractions lessons across 10 middle-grades classrooms. We present an analysis of trends in our data, key indicators that differentiated responsiveness across classrooms, and potential implications of our analysis.

Room 30C

#41. Detracking in Action: Stories, Opportunities, and Challenges

Invited Session

A Systemic Approach to Change: Transforming Mathematics Education

Abi Leaf, Bryan Meyer, Brian Lawler

In 2013, the mathematics teachers and leadership at Escondido Union High School District (EUHSD) in California began a concerted effort to create mathematics experiences that use and build on the strengths of students and teachers. They began working to remedy the ways district structures and practices of teaching mathematics have underserved students, predominantly those of color. EUHSD viewed their work as changing a complex system, rather than fixing a disconnected collection of discrete parts. Change at a systemic level is a difficult, long-term process. Learn about EUHSD's positive results.

Detracking to Support Equity: The San Francisco Story

Angela Torres, Lizzy Hull Barnes

San Francisco Unified School District (SFUSD) planned and implemented an effort to detrack mathematics by creating heterogeneous math classes in which all students make sense of rigorous mathematics in ways that are creative, interactive, and relevant. The positive impact of detracking has been significant. Learn about the work and the impact.

Room 30DE

#42. Learning from each other: A conversation around extending 30 years of CGI

Discussion Session

Susan Empson, Megan Franke, Victoria Jacobs

Since the 1989 publication of the original Cognitively Guided Instruction (CGI) study, much has changed in the field-theoretically, methodologically, and in terms of priorities and general commitments. We will showcase a variety of current research related to CGI to serve as a case that will support a broader conversation around research on teaching and learning mathematics that centers children's thinking. Affordances and challenges as well as productive future directions will be considered.

Room 31AB

#43. ~~The impact of simulation features on the learning MKT~~ (cancelled)

Discussion Session

Timothy Boerst, Erin Pfaff

Room 31C

#44. Middle Grades and High School Students Three-Dimensional Reasoning

Research Symposium

Erik Tillema, Jeffrey Barrett, Hwa Young Lee

The majority of research on three-dimensional spatial reasoning has been conducted with Pre-K to 5th grade students. This symposium will extend that work by presenting results from three research projects that collectively worked with 6th through 10th grade students in advanced mathematical settings. We will examine how students used rotation and translation of two-dimensional structures to produce and organize three-dimensional space, identifying key differences in student reasoning.

Room 32A

#46. Research Reports Session 46

Mathematics for Democracy?

Mary Candace Raygoza

How do math teachers think about the role of math education in preparing students to participate in a democracy? This investigation draws on a nationwide survey of math teachers, as well as interviews with teachers who reported teaching about economic inequality (e.g. distribution of wealth). This study reveals that how math teachers approach teaching about inequality is shaped by how they think about the kind of mathematician and the kind of informed civic actor they hope students will become.

Rehumanizing mathematics: historical and cultural recontextualization

Roxanne Moore, David Slavit

NCTM's 2018 volume of the APME series, Rehumanizing Mathematics for Black, Indigenous and Latinx Students, addresses humanization as it applies to mathematics education. By rehumanizing teaching practices but not mathematics itself, we fail to demonstrate the inherent humanity of mathematics. We advocate for rehumanizing mathematics through the historical and cultural recontextualization of content. We provide two examples for how high school mathematics teachers might enact this perspective.

Room 29A

#47. Research Reports Session 47

Students' Mathematical Capabilities in Mediated Field Experiences

Tonya Wilson, Charlotte Sharpe

This research explores ways to support preservice teachers to develop productive views of students' mathematical capabilities within teacher education programs. The study results echoed existing research that the ways in which teachers frame the source of student difficulties relates to their views on how best to support their learning. The findings suggest teacher educators should assess and offer targeted supports for preservice teachers based on their initial views of student capabilities.

The Predictive Relationship Between an Algebraic Readiness Universal Screener and Algebra I Outcomes

Elizabeth Adams, Leanne Ketterlin Geller

This study examines the empirical relationship between an algebraic reasoning universal screener for middle school students and students' performance on a state standardized test and Algebra I end-of-course (EOC) test using a series of hierarchical linear models. Results indicate that scores on the screener positively related to both tests, but were much better predictors of students' Algebra I EOC scores, supporting that the universal screener is a viable tool for identifying students in middle

Room 29B

#48. Research Reports Session 48

Framing a task as both construction and proof: How do teachers manage?

Amanda Milewski, Emanuele Bardelli, Patricio Herbst

Students commonly fail to see connections between proof and construction problems (Schoenfeld, 1989) and might benefit from experiences that combine construction and proof (Chazan, 1995). In this paper, we explore how a group of experienced secondary geometry teachers planned a lesson for engaging students in both formulating conjectures about construction and proving them. We report how the canonical ways of interacting with diagrams across these situations created tensions for teachers.

Preservice Teachers' Representational Fluency and Functional Reasoning

Nigar Altindis, Nicole Fonger

This research explores how preservice teachers' representational fluency and functional thinking are related to the rate of change of quadratic function within a real-life context. This study contributes to our understanding of how to better support PTs in their mathematical reasoning as a starting point for their later work with students. The findings suggest that although PTs create, interpret and connect representations, they had challenges in identifying the functional relationship.

Room 29C

#49. Research Reports Session 49

Additive Reasoning as Disabler of Fraction Reasoning: Where is Disability?

Jessica Hunt, Kristi Martin, Blain Patterson

This paper examines the results of a teaching experiment of one student with learning disabilities (LD). Using the framework of units coordination, we analyzed how he worked on tasks involving both whole numbers and fractions. We determined that he was operating on two levels of units with whole numbers, but only one level of units with fractions. This limited his ability to operate multiplicatively with fractions. However, his identified LD did not.

Beyond Correctness: Strategy Use in Multiplicative Reasoning Performance

Caroline Eby, Robert Nathenson

We use results from a large-scale assessment of multiplicative reasoning to explore relationships between problem-solving accuracy, strategy sophistication, and item difficulty. The strength of the correlation between accuracy and sophistication increased with item difficulty, and prior sophistication was a significant predictor of accuracy across grades, item difficulty, and time. Our results highlight the importance of attending to sophistication in assessment of student performance.

Room 29D

#50. Research Reports Session 50

A Participatory Approach to Mathematics Teacher Noticing

Victoria Hand, Elizabeth Mendoza, Elizabeth van Es

Missing from current approaches to mathematics teacher education are the voices of communities for whom inequitable mathematical instruction is most consequential. We follow researchers in teacher education who call for teacher learning organized around participatory approaches that involve members of communities directly in research. We report on a research project that involves math teachers, community youth leaders and university personnel in a participatory approach to teacher noticing.

Room 30AB

#52. But What About Equity? Examining Equity as a Collective Professional Responsibility

Invited Session

Sylvia Celedon-Pattichis, Imani Goffney, Stacy Boote, Gregory Larnell, Lisa Lunney Borden, Joshua Males, Susan Peters

We often hear from mathematics education researchers that they struggle to understand how an equity lens can apply to their work. In this panel, we will explore some of these questions and offer ideas about how an equity lens might be brought to such work. This will also be an opportunity for the research community to ask questions about their own work and how it might contribute to the collective professional responsibility we all share. We invite you to this important discussion where we will hope to start a dialogue about our collective professional responsibility to address equity and justice in our work as mathematics educators.

Room 30DE

#53. Components of Professional Development that Lead to Change in Teaching

Discussion Session

Nicole Garcia, Jillian Mortimer, Erin Pfaff, Kristen Pynes, Meghan Shaughnessy

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 effect classroom level change.

Room 31AB**#54. Mixed Methods Research Synthesis: Addressing Complexity in Math Education**

Discussion Session

Lilian Chimuma

This discussion session addresses one of the most recent approaches to research synthesis, mixed methods research synthesis, and its usability in informing evidence-based practices in the teaching and learning of mathematics. This session will illustrate the process of synthesizing existing evidence using a defined protocol (45 minutes), then engage participants in group exercises based on their interests and backgrounds (15 minutes) and conclude with a question and answer session (15 minutes).

Room 31C**#55. Math Instructional Supports and Assessments for Students Learning English**

Research Symposium

Johannah Nikula, Johannah Nikula, Rebecca Bergey, Kyle Schultz, William Zahner

This symposium will present four studies with complementary perspectives on mathematical instructional supports and assessments for students who are concurrently learning English while learning mathematics. Focusing on this student population, the studies investigate how to support student learning of key middle grades and high school mathematics content. The presentation will highlight similarities and differences in approaches and findings across studies.

Room 32A

Poster Session and Reception

Ballroom 20D

Poster #	Poster ID, Title
#57	106 - Shaping Preservice Teachers' Conceptions of STEM Through Collaboration (Rupe, Bartels)
#58	122 - Polya's Problem Solving Method and Student Attitudes Towards Mathematics (Schuster)
#59	127 - Promoting Mathematical Practices for Students with Autism Spectrum Disorder (Cox)
#60	132 - The Mindset Disconnect in Mathematics Teaching (Sun)
#61	133 - Opportunity to Learn: Geometry and Mathematics Textbooks (Hatziminadakis)
#62	153 - Peer Advising in a STEM Summer Camp as Early Field Experience (Quander, Redl, Trujillo, Uppal)
#63	168 - Impact of a professional learning math pilot for Early Childhood Educators (Gamino, Russell, Rizo)
#64	176 - Pre-Service Teachers' Beliefs and Growth Mindset Assessments (Waid, Velamur)
#65	177 - The Quality of Elementary Mathematics Activities on Teachers Pay Teachers (Dick, Wismer, Shapiro, Sawyer)
#66	193 - Greenhouse effect: An Issue of Social Justice through Mathematical Lens (Basu, Panorkou)
#67	206 - Follow Up Moves in Whole-Class Discussions About Fractions (Foxworthy)
#68	211 - "A Simple Yes or No?": How Word Problem Design Affects Student Sense-Making (Kirkland)
#69	232 - The Effect of Math Instructional Coaching on Instruction (Turan, Almager, Sayilir)
#70	233 - The Detailed Analysis of the Middle Grade Math Teachers Lesson Practice (Turan, Matteson)
#71	244 - Filling the Gap: The STEM Enrichment by Design (STEMed) Project (Lopez, Rodriguez)
#72	248 - Student Perceived Opportunities to Learn in Testing Oriented Classrooms (Chavez)
#73	260 - Eliciting Prospective Secondary Teachers' MKT through Modeling Activities (Abassian, Safi)
#74	262 - The Use of CODAP as an Instrument for Exploratory Data Analysis (Barker)
#75	263 - Teaching word problems informed by learning trajectory in China and the US (Kimmins, Seat, Frideczky, Winters)
#76	273 - Expanding Dispositions by Using Integrated STEM Unit in Elementary Methods (Maiorca, Benken)
#77	281 - Categorizing Students' Classroom Experiences with Cluster Analysis (Tarr, Middleton)
#78	301 - Support middle school students in problem-posing: A personalized approach (Wang)

Poster #	Poster Title
#79	302 - Mathematical Modeling from the Practitioners' Perspective (Alhammouri)
#80	322 - Mathematics Task Demands in Small Group Learning Environments (Gordon, Hamm)
#81	324 - Mathematical Reasoning and Modeling: A Way to Change Teacher Knowledge (Choi, Hwang, Jensen, Meiners, Wu)
#82	334 - Teachers' Uses of Instructional Strategies and Organization of Students (Cudd, Williams)
#83	338 - Choose Your Words Wisely: Supporting Students as Mathematicians (Curtis)
#84	346 - Productive Struggle: Creating and Resolving Uncertainty with DGE Tasks (Jairam)
#85	355 - Students' perceptions of ambitious mathematics instruction (Gonzales)
#86	356 - Examining Relationships Among Mathematics Knowledge for Teaching Skills (Flores, Wang, Yi, Zeng)
#87	357 - Elementary Preservice Teachers' Identification of Problem-Solving Tasks (Morrisey, Popovic, Kartal)
#88	362 - Relating Beliefs and Practices in Equitable and Ambitious Math Teaching (Boston, Parke, Badertscher, Thomas-Browne)
#89	363 - Empowering Girls, One STEM Camp at a Time (Vela, Bevan, Caldwell, R. Capraro, M. Capraro)
#90	376 - Teachers' Use of Insider Knowledge when Noticing Children's Thinking (Jessup, Pynes)
#91	378 - A Strategy for Addressing Elementary Pre-Service Teachers' Math Anxiety (Karunakaran)
#92	380 - Measuring PSTs' Geometry Knowledge for Teaching 2D shapes: A Validity Study (Yi, Flores, Lee, Wang)
#93	386 - Making Rigorous Mathematics Instruction Accessible to Diverse Learners (Moeller, McLeod, Duncan, Hitchcock)
#94	388 - Elementary Pre-Service Teachers' Math Narratives: A Look Over Twenty Years (Goldsmith-Markey, Janine Remillard)
#95	391 - Using a STEM club to support beginning teachers in math and science methods (Brown, Fadigan)
#96	394 - Parents' Influence on Latina Girls' Mathematics Identities (Guzman)
#97	398 - Co-constructing Conceptual Neighborhoods: A Working Metaphor (Nichols)
#98	400 - Researching mathematics for pre-service elementary teachers: A reflection (Nguyen, Otto, Marlow)
#99	402 - Unbounded Shearing: A Design-Based Study of an Immersive Environment (Bock, Dimmel)
#100	404 - A Learning Assistant Program and Becoming a Mathematics Teacher (Fernandez)
#101	411 - Characteristics of Preschoolers' Evolving Mathematical Knowledge (Shumway, Reeder)
#102	412 - Japanese Junior High School Teachers' Planning Practices (Melville, Corey)
#103	419 - Advancing the Mathematics Equity Agenda Through Digital Game-Based Learning (Pope)
#104	423 - Values or Frequency in Secondary Mathematics Classrooms In Hawai'i (Moore)

#120. Research Reports Session 120

Exploring coordinates using coding

Erell Feb Germia, Nicole Panorkou

In this paper, we report findings from a design experiment investigating how sixth grade students reason about coordinates while working on a Scratch programming task we designed and implemented from our integrated mathematics and coding curriculum. By engaging with our task, students were able to form advanced generalizations about coordinates and coordinate plane avoiding some of the difficulties reported by previous studies.

Learning from Dialogic Online Mathematics Videos

Joanne Lobato

Online math videos for student learning are abundant; yet they are surprisingly uniform in their expository mode of presentation and their emphasis on procedural skill. In response, we created videos that feature student dialogue, complex problem solving, and mathematical meaning. In this session, we present part of a learning trajectory for a pair of Grade 9 students who engaged over time with a set of 8 dialogic video lessons on geometric-algebraic connections with parabolas.

Room 29A

#121. Research Reports Session 121

Impact of Electronic Notebooks on Teacher Educator Instructional Decisions

Heather Gallivan

Technology plays a major role in mathematics instruction, including when developing students' written communication skills. New electronic notebook technology has the potential to support MTEs in using journal writing with PSTs. This study explores (1) the benefits and challenges faced by two MTEs when using electronic notebooks related to their planning, instruction, and formative assessment practices; (2) how the MTEs adjust their practices to address the challenges faced over two semesters.

Sketchnotes: A Communication Tool to Strengthen Research and Practice Links

Nicole Fonger

Effective communication among researchers and practitioners is essential to advance the field, yet tools and theories are limited. This report aims to address this gap by introducing sketchnotes—a communication tool that combines visual and textual representations of ideas. This theoretical report draws on theories of learning with multiple representations to argue for the effectiveness of sketchnotes. Implications for the use of sketchnotes, and future research directions are discussed.

Room 29B

#122. Research Reports Session 122

Using Pitfalls to Support Middle School Mathematical Discussion and Equity

Kathleen D'Silva

This study examined the handling of mathematical stumbles and errors (pitfalls) by three grade 7 teachers as they used a pitfalls-enriched curriculum. Using Hufferd-Ackles et al.'s (2004) math-talk framework as a lens, results indicate that some faced a conflict between what they saw as important in maintaining student trust (i.e., validation of correct answers) and giving time and attention to pitfalls. A teacher who celebrated pitfalls in class saw it lead to more equitable student engagement.

Who is Math? Drawings and texts tell stories of healing from math trauma

Jennifer Ruef, James Chris Willingham

Many Elementary Teachers suffer from mathematics anxiety. How can Mathematics Teacher Educators (MTEs) help preservice teachers recognize and heal from the trauma of feeling "bad at math?" Working from Zazkis' (2015) task, three MTEs developed, tested, and analyzed by in their methods classes. Early results show promise for the positive impact of drawings and script writing that personify WHO math is to you, beginning conversations with how you want your relationship with math to work.

Room 29C

#123. Research Reports Session 123

Addressing the Computer Science & Math Debate with a Catalyzing Change Lens

Jeremy Zelkowski

The NCTM (2018) just released Catalyzing Change in High School Mathematics: Initiating Critical Conversations-This proposal intends to do so! The NCTM reports that in 2017, nearly 30 states accepted a Computer Science (CS) course in lieu of a mathematics credit for graduation requirements from high school (HS)-a change from 2013 when only 12 states permitted such action. Our session will focus on engaging participants in difficult and critical conversations regarding teacher preparation.

Teachers dealing with non-standard student solutions to linear equations

Amanda Milewski, Daniel Chazan, Patricio Herbst

A national sample of 523 algebra teachers responded to four multimedia scenarios, in which a student presented a non-standard solution to a linear equation at the board. The analysis of teachers' responses to the prompt "what action would you take in this situation and why" revealed that teachers attend to factors beyond mathematical correctness of the solution. In particular, the pattern of teachers' responses suggest there are preferences for some non-standard solution over others.

Room 29D

#124. Research Reports Session 124

Design Features of Digital Math Games through the Lens of ACAT

Patricia Moyer-Packenham, Jill Ashby, Emma Bullock, Kristy Litster, Allison Roxburgh

The purpose of this study was to examine how design features in 12 digital math games influenced children's learning. The participants were 193 children in Grades 2-6. Children completed pre- and post-tests, and interacted with digital math games. The analysis revealed significant gains for 9 of the 12 digital games. There were six prominent categories of design features that supported children's learning: feedback, unlimited attempts, tutorials, constraints, progressive levels, and efficiency.

Digital Math Games: Affect, Vocabulary, and Strategy Influences on Learning

Kristy Litster, Jill Ashby, Patricia Moyer-Packenham, Allison Roxburgh

This study examined how Affect, Math Vocabulary, and Strategy influenced children's learning from digital math games. Recognition of in-game math impacted children's learning for most games. Children's positive affect toward the games and sophisticated strategies during game-play influenced learning in about half of the games. Unique game affordances and personal attributes children brought to the game-playing experience (prior knowledge, gamification, perseverance) help explain these findings.

Room 30AB

#126. MET Grant Research: Second Grade Urban Students' Sense of Fraction Magnitude; and Infusing History into Mathematics Instruction

Invited Session

Ralph Connelly, Mathematics Education Trust Board

This session will highlight research-related grants from NCTM's Mathematics Education Trust, and present an overview of research conducted by 2018-2019 MET awardees: Arthur Powell and Kendell V. Ali (PreK-6 Classroom Research Grant; Ji-Won Son and Winston Martey (7-12 Classroom Research Grant)

Second Grade Urban Students' Sense of Fraction Magnitude

Arthur Powell, Kendell Ali

Infusing History into Mathematics Instruction

Ji-Won Son, Winston Martey

Room 30DE

#128. Math-as-Discourse & SciFi Futures: Perspectives on MTs' Prep for SJ

Research Symposium

Trevor Warburton, Jose Gutiérrez, Sara Rezvi

In this symposium we offer three perspectives on the preparation of mathematics teachers to teach for social justice. Taken together these perspectives critique and expose the overwhelming presence of Whiteness and neoliberalism in US mathematics education, while also presenting possibilities for disruption to promote social justice with students. We suggest resources and strategies to improve the preparation of mathematics teachers to teach for social justice.

Room 31C

#129. Equity in K-12 Mathematics Education: Highlights from a National Survey

Research Symposium

Kristen Malzahn, Evelyn Gordon, Courtney Plumley

This symposium addresses equity in mathematics education in the U.S. Data from a nationally representative sample of mathematics teachers and schools suggest disparities in the distribution of the teacher workforce, mathematics professional development opportunities and experiences, and the nature of instruction. Statistical analyses show variation in the allocation of these areas by class- and school-level factors historically associated with differences in students' educational opportunities.

Room 32A

#130. NCTM President's Session: Researchers as Advocates for Mathematics Teaching and Learning

Invited Session

Robert Q. Berry, III

Our work as researchers has the potential to significantly support and impact advocacy efforts. For example, collaboration between researchers, teachers, and communities can create a sense of collective efficacy to shift practices, revise policies and transform mathematics teaching and learning. This collaborative interactive session will focus on 'How we can use our collective efficacy to advocate with research and for research supportive of mathematics teaching and learning for each and every student?'

Room 33ABC

#131. Learning, Identity, and Power in a Collaborative World

Plenary Session

Jennifer Langer-Osuna

Students negotiate who they are and can become when doing mathematics together. This talk will focus on student identity in the context of collaborative classrooms. With ever-increasing needs for people to solve complex problems together across social difference, mathematics educators have a unique responsibility to support a generation of diverse collaborative young mathematicians. Our field's increased interest in inclusive discourse-oriented classrooms and collaborative learning offers educators new opportunities to support student understanding, as well as address key issues of identity and power.

Room 33ABC

#132. Research Reports Session 132

Embracing change agency: Practical lessons from secondary classrooms

Miriam Gates, Eden Badertscher, Una MacDowell, Sarah Sword

We will report on a collective case study of the outcome of two-year professional learning community (PLC) focused on the intersection of mathematics and equity. The goal of the PLC was to support teachers to take practical steps as change agents in their own classrooms and schools. The focus of the shared analysis will be the practical implications of the teachers' experience of change agency. In discussion, we will describe our change agent model and the results of our analysis.

Opportunities for Student Agency in Math Lessons with/out Interactive Sims

Sebnem Atabas, Jennifer Schellinger, Ian Whitacre

We investigated the social and socio-mathematical norms within a middle-school math classroom, comparing lessons involving computer simulations (sims) versus non-sim lessons. In sim lessons, students often exhibited conceptual agency (e.g., sharing ideas, making conjectures, creating rules, developing strategies). In non-sim lessons, students tended to exhibit disciplinary agency (e.g., recalling facts, performing standard procedures). We discuss implications for educators and researchers.

Room 29A

#133. Research Reports Session 133

Modeling as a Mean of Fostering Creativity and Multicultural Equity

Miriam Amit, Talya Gilat

We present the impact of modelling practice on the creativity of 92 young talented students in a multicultural classroom. A modelling teaching unit was developed and implemented in the "Kidumatica" math club, engaging students in authentic model eliciting activities (MEA). Qualitative analysis of products and journals revealed that MEA can bridge cross-cultural differences, as well as facilitate students' creativity, as manifested in the number and variety of their mathematical models.

Prospective Teachers' Development of Knowledge of Mathematical Modeling

Wenmin Zhao

This study examined the evolution of 20 secondary prospective teachers' (PTs') understanding of mathematical modeling throughout a four-session modeling module within a teaching methods course. Data from pre- and post-questionnaires and written reflections were analyzed qualitatively to build a learning trajectory of their conceptions of modeling. The results show that PTs developed a more sophisticated understanding of modeling and changed their perceptions toward modeling.

Room 29B

#134. Research Reports Session 134

The Moderating Effect of Student-teacher Relationship on Math Learning

Raymond Flores, William Lan

Using an international database, this study examined the moderating effect of student-teacher relationship (STR) on the relationship between high school students' values and their effort. Results showed that greater utility value and intrinsic value, lower cost, and better STR were associated with more effort. Also, a better STR can decrease the positive effect of utility value on effort, promote the positive effect of intrinsic value on effort, and reduce the negative effect of cost on effort.

What can mathematics teacher educators do to develop their knowledge bases?

Priya Prasad, Su Liang, Cody Patterson, Raquel Vallines Mira

In this paper, four mathematics teacher educators describe the process of using task design and revision to develop our own knowledge bases for teaching prospective teachers in an elementary mathematics content course. We contend that this process can be used as a form of self-directed professional development for MTEs who have not developed a robust knowledge base for teaching prospective teachers in their own graduate preparation.

Room 29C

#135. Research Reports Session 135

Making Sense of Teachers' Varied Responses to Representations of Practice

Kara Jackson, Nicholas Kochmanski, Hannah Nieman

How mathematics teachers engage with representations of practice (e.g., student learning data, video-records) varies, and with better and worse outcomes in terms of improving teaching. In this report, we present a qualitative analysis of variation in middle-grades math teachers' responses to survey data from students regarding their experiences of classroom discussion. We specify aspects of teachers' current perspectives on teaching and learning that explain, in part, the variation.

Room 29D

#136. Research Reports Session 136

A Fraction Sense Intervention for Struggling Middle School Math Students

Nancy Dyson, Nancy Jordan

Fractions are foundational for learning algebra, thus representing a crucial component of middle school mathematics. But fractions are problematic for many children, especially those with learning difficulties and disabilities. We examined the efficacy of a fraction sense intervention that is centered on a number line and explicitly incorporates instructional principles from the science of learning. The intervention was found to be effective for small groups of four and for larger groups of 14.

Diagnosing Reasoning to Measure Future Teachers' Facility with Fractions

Ibrahim Olmez, Andrew Izsak

Recent research has showed the existence of three latent classes in a nationwide sample based on psychometric analysis of survey responses. The present study sought to better understand the three latent classes by interviewing 8 future teachers and comparing to what extent characteristics based on the three classes were associated with reasoning evidenced during interviews. The psychometric and qualitative analyses provided consistent results about the reasoning of the teachers on fractions.

Room 30AB

#138. Sharing Research with Classroom Teachers: Writing for *MTLT*

Invited Session

Angela Barlow, Thomasenia Adams

MTLT is NCTM's soon-to-be-launched digital-first journal. Aimed at supporting the teaching and learning of mathematics in grades PreK-12, *MTLT* represents a venue for connecting research to classroom practice. In this session, we will provide insights into publishing your research in a teacher-friendly format. Specific attention will be given to writing for *MTLT* and utilizing digital enhancements for supporting the reader's engagement.

Room 30DE**#139. Making Sense of Identity and Sense of Belonging in Mathematics**

Discussion Session

Nancy Kress, Monica Campbell

The terms 'mathematics identity,' 'identity as a doer of mathematics,' and 'sense of belonging in mathematics' represent closely related but distinct ideas. This session shares an analysis of the ways these terms have been used in mathematics education research to date. We will engage participants in discussion to develop more nuanced understandings of the meanings of and interactions among these terms. Finally, we consider the role each concept plays in people's experiences of mathematics.

Room 31AB**#140. Exploring Dynamic Learning Technologies for Experiencing Algebraic Notation**

Discussion Session

Katharine Sawrey, Taylyn Hulse, Erin Ottmar

This session introduces a computer application designed to support student understandings of algebraic notation through perceptual learning techniques. The application is a stand-alone canvas and also gamified with progressively challenging activities. We will review the application, its theoretical underpinnings, and preliminary efficacy data from a middle school intervention. Bring personal devices to try the application. We invite questions/feedback before study implementation in 2019.

Room 31C**#141. Examining Classroom-Based Professional Learning Models**

Research Symposium

Linda Davenport, Jill Board, Lynsey Gibbons, Catherine Lewis, J Michael ShaughnessyDiscussant: **Linda Davenport**

There is an urgent need to strengthen mathematics teaching and learning in ways that build access and identity for all students. This session focuses on three professional learning models-Lesson Study, Math Studio, and Learning Labs-and their impact on teacher learning, teacher practice, and student learning. What features do they share? In what ways are they different? How might these models be productively situated in classrooms, schools and districts to maximize the learning of all students?

Room 32A

#142. Linking Research and Practice: Productive Struggle for All Students Using Differentiated Instruction

Invited Session

Katherine Lewis, Jessica Hunt, Sararose Lynch

Come experience how you can create a classroom experience that engages all students in productive struggle using differentiated instruction. Consider strategies outlined in 'Productive Struggle for All: Differentiated Instruction' that create access to mathematics while maintaining the cognitive demand of a rich platform task. We invite researchers and educators to come work together to develop ways to improve practice.

Room 33ABC**#143. Research Reports Session 143**

K-8 Mathematics Teachers' Beliefs About Mathematical Aptitude

Yasemin Copur-Gencturk, Caroline Ebby, David Quinn, Ian Thacker

This study investigates teachers' beliefs about mathematical aptitude and gendered attributions of mathematical ability. An analysis of data from 434 K-8 teachers indicated that teachers did not see mathematical aptitude and students' gender-specific mathematical ability as two different constructs. Findings also suggest that teachers who were more experienced, who worked with students at risk seem to hold beliefs that could impede their students' career paths.

Teacher Views of Non-Cognitive Traits Key to Success in 8th Grade Algebra

Kirk Walters, Ryan Eisner, David Gorsky, Nick Sorensen

Using data from focus groups and an experimental profile activity, this study identifies skills and qualities middle school teachers deem essential to success in 8th grade algebra, especially for academically average students. Set in three large districts, the study found that teachers privilege non-cognitive factors of persistence and motivation over grades and test scores, especially for students who were academically average in 7th grade.

Room 29A**#144. Research Reports Session 144**

MTEs Learning through Lesson Study: A Community of Practice Perspective

Mollie Appelgate, Lara Dick, Dittika Gupta, Melissa Soto

In this paper we analyze early-career mathematics teacher educators' (MTEs') learning during the process of lesson study using Wenger's (1998) social theory of learning through communities of practice. Our findings show how MTE learning evolved over the course of the lesson study, demonstrating lesson study was a rich professional development activity for MTEs.

What Online Resources are Elementary Mathematics Teachers Using?

Lara Dick, Amanda Sawyer, Emily Shapiro, Tabitha Wismer

As a result of the availability of unsanctioned websites such as Pinterest and Teachers Pay Teachers, teachers have access to a vast number of mathematics resources. However, there is limited research on how elementary teachers make decisions about what online resources to implement in their classrooms. We share results of a 2018 survey of 601 elementary teachers from across the US detailing their search and choice habits. We also discuss differences between factors such as years of experience.

Room 29B

#145. Research Reports Session 145

Developing Math Teacher-Leaders in Rural Schools: A Year-long PD Experience

Katie Anderson-Pence

The purpose of this study was to examine the impact of a year-long partnership between university faculty and rural school districts. The goals of this project were to increase rural elementary and secondary teachers' understanding of math pedagogy, extend their math content knowledge, strengthen their confidence in teaching math, and improve student achievement. Pre-post assessments reveal that the project had a positive impact on teachers' pedagogical knowledge and confidence in teaching math.

Studying the Sustained Impacts of Professional Development

Courtney Plumley, Philippa Hoover, Kristen Malzahn

Much is known about professional development, including its effective elements as well as the best methods for researching and reporting its impacts. However, little has been studied related to its long-term impacts. In our session, we outline a rationale for studying sustained impacts of professional development and share our experiences and findings doing so a year after teachers completed their participation with our project PD.

Room 29C

#146. Research Reports Session 146

Identifying the Differential Impact of an Individualized Coaching Approach

Dionne Cross Francis

The study described in this paper present results of an examination of the influence of three approaches to mathematics professional development (PD) for elementary teachers focused on improving their mathematical knowledge for teaching (MKT) and quality of instruction (MQI). Results suggest that initiatives designed to influence teacher change should attend not only to the cognitive (i.e. MKT), but also the also the affective (emotions) and psychological (e.g., efficacy) dimensions of teaching.

Using Rehearsal to Grow Shared Expertise in a Community of Teacher Leaders

Susan Nickerson, Meredith Vaughn

We explore the use of rehearsals with practicing secondary mathematics and science master teachers (MTs). Our use of rehearsals with MTs acknowledged and drew on the expertise of the teachers. We engage MTs in rehearsals for the purpose of creating specifications of best practices and principles. We will explore two questions. How do these rehearsals differ from intentions and enactments of rehearsals with pre-service novice teachers (NTs)? What might MTs learn from engaging in this experience?

Room 29D

#147. Research Reports Session 147

The Effects of Informal Learning on Student Interest in STEM Fields

Ali Bicer, Yujin Lee

The purpose of the present study was to investigate the effects of a two-week long STEM summer camp on students' mathematics, science, and engineering career interest. As indicated by pre- and post-intervention surveys, there was a statistically significant ($p < .05$) increase in students' interest in mathematics, science, and engineering careers. The results for this study suggest that informal STEM instruction in a summer camp may have the potential to increase students' interest in STEM career.

Room 30AB

#149. Writing *MTE* Manuscripts: Using the Writing Tool to Guide the Communication of Your Ideas

Invited Session

Karen Hollebrands

In this workshop-style session, *Mathematics Teacher Educator (MTE)* Editorial Board Members will engage the audience in discussing the Writing Tool and providing suggestions about how it can be used to communicate your ideas. Potential authors and reviewers will learn more about expectations for publishing in *MTE* and the variety of manuscript types that are appropriate.

Room 30DE**#150. The Arc of Learning Framework: Building Learning Over Time**

Discussion Session

Alden Edson, Elizabeth Phillips, Yvonne Slinger-Grant

Rather than emphasizing student learning as passively watching and imitating a set of isolated skills, the Arc of Learning framework highlights ways that student learning can evolve from informal knowledge to more sophisticated reasoning over time. It provides a tool for characterizing deeply grounded and connected learning, both in terms of practice and research. Participants will become familiar with the Arc of Learning by interacting with examples from a problem-centered curriculum.

Room 31AB**#151. Syllabus Subject to Change; or Transforming Assessment with Specs Grading**

Discussion Session

C David Walters

Specifications grading offers great potential for college instructors who want an assessment system aligned with Principles to Actions. In this discussion session, participants will learn more about specs grading and see several examples of its implementations. Participants will also examine a pilot study about student engagement in courses that use specifications grading. Finally, participants will spend time generating ideas for how to implement aspects of specs grading in their own courses.

Room 31C**#152. Mathematical Engagement IS Fundamentally an Equity Issue**

Research Symposium

Eden Badertscher, Melissa Boston, Miriam Gates Discussant: **Joi Spencer**

Connections between professional learning opportunities and student and teacher outcomes are difficult to come by. However, in our work, which focuses explicitly at the intersection of mathematics and racial equity, we are seeing some dramatic connections between growth in teacher beliefs, how teachers engage in doing mathematics and how they teach mathematics, to how students experience their mathematics classroom, particularly around factors research shows are critical for learning.

Room 32A

Wednesday Apr 03, 2019

1:30 PM -2:45 PM

#153. Linking Research and Practice: Strategies for Building Caring Relationships in Math Classrooms

Invited Session

Lead Speaker: **Jessica Hunsdon, Dan Battey, Rebecca Neal**

Experiences with learning mathematics can produce positive emotions, but they also can generate anxiety, inadequacy, and embarrassment for many students. In focusing on learning, we often overlook relational dimensions of mathematics instruction. The session will support elementary teachers in identifying ways students are framed behaviorally, emotionally, and intellectually in mathematics, examining classroom interactions, and strategizing ways to build strong relationships with underserved students.

Room 33ABC

Wednesday Apr 03, 2019

3:00 PM -4:15 PM

#154. Research Reports Session 154

Exploring Gravity Through Mathematics

Nicole Panorkou, Debasmita Basu

We provide an example from our integrated math and science curriculum where students explore the mathematical relationships underlying various science phenomena. We present the tasks we designed for exploring the covariation relationships that underlie the concept of gravity and discuss the generalizations students made as they interacted with those tasks.

The Use of Task Templates to Guide Design Activity

Tenille Cannon

Teachers participate in design activity in part by selecting and sequencing mathematical tasks. This study explores how prospective secondary mathematics teachers (PMTs) use task templates to guide their emerging task work as novice participants in teaching as a design activity. Additionally, it looks at how one PMTs' use of learning goals resulted in a qualitatively different approach to selecting and sequencing tasks.

Room 29A

#155. Research Reports Session 155

Secondary Mathematics Teachers' Descriptions of Mathematical Practices

Lynda Wynn

How do secondary mathematics teachers describe the mathematical practices? In this qualitative study, eleven mathematics teachers in two linguistically diverse high schools were asked to plan, teach, and debrief a lesson. In planning (and debriefing) interviews, the teachers were asked which mathematical practices students will (or did) engage in during the lesson. At times, the teachers used the standard phrasing of the SMPs with varied meanings, pointing to the potential for miscommunication.

Teacher-Designed Mathematical Modeling Routines for Secondary Classrooms

Rebekah Elliott, Melinda Knapp

Research on two teacher-designed and enacted modeling routines for secondary classrooms document the tensions that emerge as activity systems of school mathematics and modeling instruction were coordinated. Analysis revealed that teachers modified routines in productive and less productive ways to attend to students' tendency toward traditional school mathematics. Productive modifications show that tensions across activity systems were opportunities for expansive teacher and student learning.

Room 29B

#156. Research Reports Session 156

Change in Pre-service Teachers' Conceptions of Mathematics Teaching

Ozgul Kartal, Wade Tillet

This study focused on whether a math methods course can change Preservice Teachers' (PTs) conceptions of math teaching in alignment with the most recent standards/practices. We developed a conception survey to examine PTs' conceptions of math teaching through a methods course. The results showed that PTs (n=68) came to our course with conceptions that math is best taught through a traditional teacher-centered approach; and their conceptions significantly changed to a reform-based approach.

Teachers' Shifting Perceptions of the Standards for Mathematical Practice

Jon Davis, Amanda Seiwel

We examined the perspectives regarding the Standards for Mathematical Practice (SMP) of teachers using different mathematics textbooks over a period of 2-3 years. Teachers using delivery mechanism curriculum types were more likely to engage in passive offloading of SMP to their textbooks and to consider the SMP as unconnected from learning content than teachers using thinking device curriculum types. Teachers across both curriculum types shifted towards more adaptive uses of their textbooks.

Room 29C

#157. Research Reports Session 157

Examining the 12th-grade Mathematics NAEP: Validity Considerations for ELLs

Cristina Runnalls

As diversity in the U.S. grows, assessments must adapt to student differences in many domains. One of these domains is language, especially relevant for English language learners. While major efforts have been made to develop fair and valid large-scale assessments, challenges remain. This work examines recent 12th-grade mathematics NAEP questions for content validity, with a focus on the intersections of linguistic complexity and mathematical content. Implications of the results are discussed.

Impact of Professional Development for Math Teachers of English Learners

Pamela Buffington, Josephine Louie, Jill Neumayer DePiper, Johannah Nikula

Many mathematics teachers are not consistently provided training for how to support students who are English Learners to meet content standards. This presentation will discuss results from a project that developed and studied a teacher professional development program designed to build middle grades teachers' mathematical knowledge for teaching related to the use of visual representations to support the mathematical reasoning and communication of English Learners.

Room 29D

#158. Research Reports Session 158

Gender Difference on Spatial Visualization (STEM vs non-STEM)

Yujin Lee, Ali Bicer, Robert Capraro, Mary Margaret Capraro, Jihyun Park

In the present study, researchers examined the gender difference on spatial visualization between STEM and non-STEM undergraduate majors. The findings showed that the gender difference on spatial visualization in STEM was larger than the gender difference on spatial visualization in non-STEM. In addition, male students' spatial visualization ability was higher than female students' spatial visualization in both STEM and non-STEM majors.

Interactional Pathways to Shared Intellectual Authority During Group Work

Jennifer Langer-Osuna, Rosa Chavez, Emma Gargroetzi, Jen Munson, Immanuel Williams

We offer an innovative analysis of the interactional pathways students take during collaborative mathematics problem-solving that lead to shared intellectual authority. We examine 13 small group videos in a fourth-grade classroom wherein collaboration was a core practice. We found that students routinely achieved and maintained shared intellectual authority. Yet, to do so, they often first contested social authority, suggesting that disruptions to group dynamics foster dialogic possibilities.

Room 30AB

#160. Research in Math Education and STEM: Panel Discussion

Invited Session

Margret Hjalmarson, Jodi Asbell-Clarke, Melissa S. Gresalfi

New research and research opportunities exist which require collaboration between mathematics educators and other STEM faculty. These include computer science, computational thinking and/or possibly other STEM areas, including the + C.

Room 30DE

#162. Refreshing High School Curricula with Mathematics-News-Snapshots

Discussion Session

Nitsa Movshovitz-Hadar

A longitudinal research and development study of interweaving mathematics news snapshots in the ordinary teaching of high school mathematics as a vehicle to cope with the challenge of exposing high school students to contemporary mathematics without harming their progress in learning the ordinary curriculum will be discussed. The discussion will be followed by a call for collaboration with U.S. researchers on extending this study to American schools.

Room 31C

#163. Collaborating to Improve the Preparation of Secondary Mathematics Teachers

Research Symposium

Lisa Amick, Dana Franz, Alyson Lischka, Julie McNamara, Wendy Smith, Marilyn Strutchens Discussant: **Brian Lawler, W Gary Martin**

Five research teams made up of mathematicians, mathematics educators, and K-12 personnel have been working to address specific secondary mathematics teacher preparation challenges using a networked improvement community design, rapidly prototyping, testing, and refining improvement strategies. Researchers in this session will discuss these efforts in relationship to the AMTE Standards, allow time for participant interactions, and discuss future research plans.

Room 32A

#164. Linking Research and Practice: Inverse Functions: Why Switch the Variables?

Invited Session

Dawn Teuscher, Kylie Palsky, Charlie Palfreyman,

Most textbooks introduce inverse functions by having students switch the variables. In this session, we will explore the questions: Why do we teach students to switch the variables to find an inverse function and how might this be confusing for students? We will discuss common misconceptions that students may develop when they use the technique of switching the variables. We will also discuss ways of teaching inverse functions with meaning that allow students to make sense of inverse functions.

Room 33ABC