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Investigating Fifth-Grade Students' Conceptions of Fractions on the Number Line

Conference Paper · April 2016

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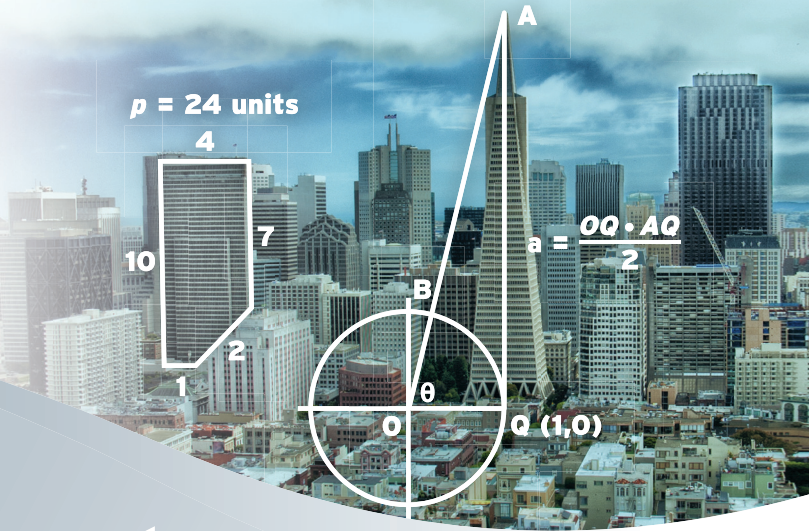


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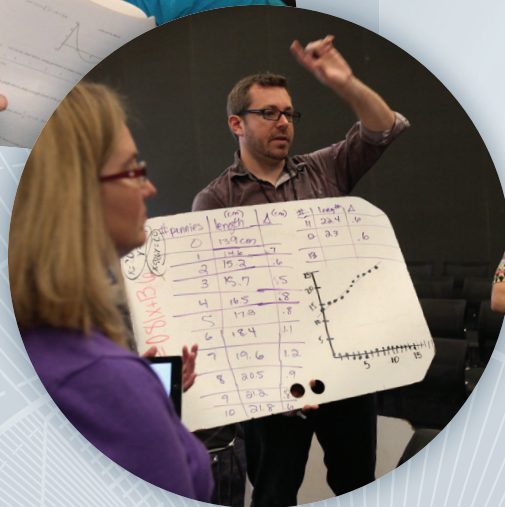
PREMIER MATH EDUCATION RESEARCH EVENT

2016 NCTM RESEARCH CONFERENCE

April 11-13 • San Francisco



Program Book



nctm.org/researchconf

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Announcements

- The Research Conference will be held at the Moscone Center, West Building.
- Registration will be held on the Third Level, Moscone West Building. **Registration is required for attendance, and badges must be worn for all sessions.**
 - o Monday, 4:00 p.m.–7:00 p.m.
 - o Tuesday, 7:30 a.m.–3:00 p.m.
- On Wednesday, the Research Conference is open to all registered attendees of the NCTM Annual Meeting and the NCSM Annual Conference. Badges from these conferences will be required for attendance for all sessions on Wednesday.
- A light reception will be held on Tuesday evening on the Third Level Lobby, Moscone Center, West Building from 4:45 p.m. to 6:00 p.m.
- Research Posters Sessions will take place on the Third Level Lobby, Moscone Center, West Building
 - o 5:00 p.m.–6:00 p.m. on Tuesday
- The Call for Proposals for the 2017 NCTM Research Conference will be available online by early June 2016.
- The NCTM Bookstore will be open on Wednesday 10:00 a.m. – 7:00 p.m in the Exhibit Hall D, North building, Moscone Center.

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Invited Sessions

Opening Session

Cynthia W. Langrall

JRME: A Tale of Unicorns, Mastodons, and Ants (Session 1)

Monday, April 11, 5:30 PM-7:00 PM

Moscone West, 3001/3003/3005

Access, Equity, Identity and Agency (Session 1.5)

Tuesday, April 12, 7:30 a.m. – 8:20 a.m.

Moscone West, 3001/3003/3005

Graduate Student, Junior Faculty, and Researcher Mentoring Session (Session 36)

Tuesday, April 12, 10:00 a.m. – 11:15 a.m.

Moscone West, 3002

Teacher Development in Statistics Education: A Critical Examination of How Teachers' Experiences Impact Their Knowledge, Beliefs, and Practices for Teaching Statistics (Session 39)

Tuesday, April 12, 10:00 a.m. – 11:15 a.m.

Moscone West, 3006

Writing for the NCTM School Journals: Publishing Your Research in Teacher-Friendly Articles and Linking Research and Practice Awards (Session 40)

Tuesday, April 12, 10:00 a.m. – 11:15 a.m.

Moscone West, 3000

"Power Concedes Nothing without a Demand": Challenging the Pervasive Deficit Discourse about Children in Mathematics Education (Session 60)

Tuesday, April 12, 1:15 p.m. – 2:30 p.m.

Moscone West, 3006

The Role of Theoretical Frameworks in Research Dissemination: JRME Editorial Panel Session (Session 65)

Tuesday, April 12, 1:15 p.m. – 2:30 p.m.

Moscone West, 3000

Approaching Intersecting Challenges: Mathematics Remediation at Four-Year Universities and Mathematics Identity as a Lens on Inequitable Access (Session 83)

Tuesday, April 12, 3:30 p.m. – 4:45 p.m.

Moscone West, 3006

Mathematics Education Research, Policy, and the National Science Foundation (Session 90)

Tuesday, April 12, 3:30 p.m. – 4:45 p.m.

Moscone West, 3016

Expanding Horizons in K – 3 Geometry and Spatial Thinking: The Implementation and Results of a New Curriculum and PD Model (Session 148)

Wednesday, April 13, 8:30 a.m. – 9:45 a.m.

Moscone West, 3006

What is STEM Education? (Session 156)

Wednesday, April 13, 8:30 a.m. – 9:45 a.m.

Moscone West, 3008

Writing *Mathematics Teacher Educator* Manuscripts That Avoid Common Mistakes Aspiring Authors Make (Session 157)

Wednesday, April 13, 8:30 a.m. – 9:45 a.m.

Moscone West, 3000

Plenary Session

Brent Davis

How Research into Second-Language learning Might Be Useful to Mathematics Educators (Session 158)

Wednesday, April 13, 10:00 AM – 11:30 AM

Moscone West, 3001/3003/3005

MET Grants Support Classroom Research (Session 177)

Wednesday, April 13, 1:15 p.m. – 2:30 p.m.

Moscone West, 3009

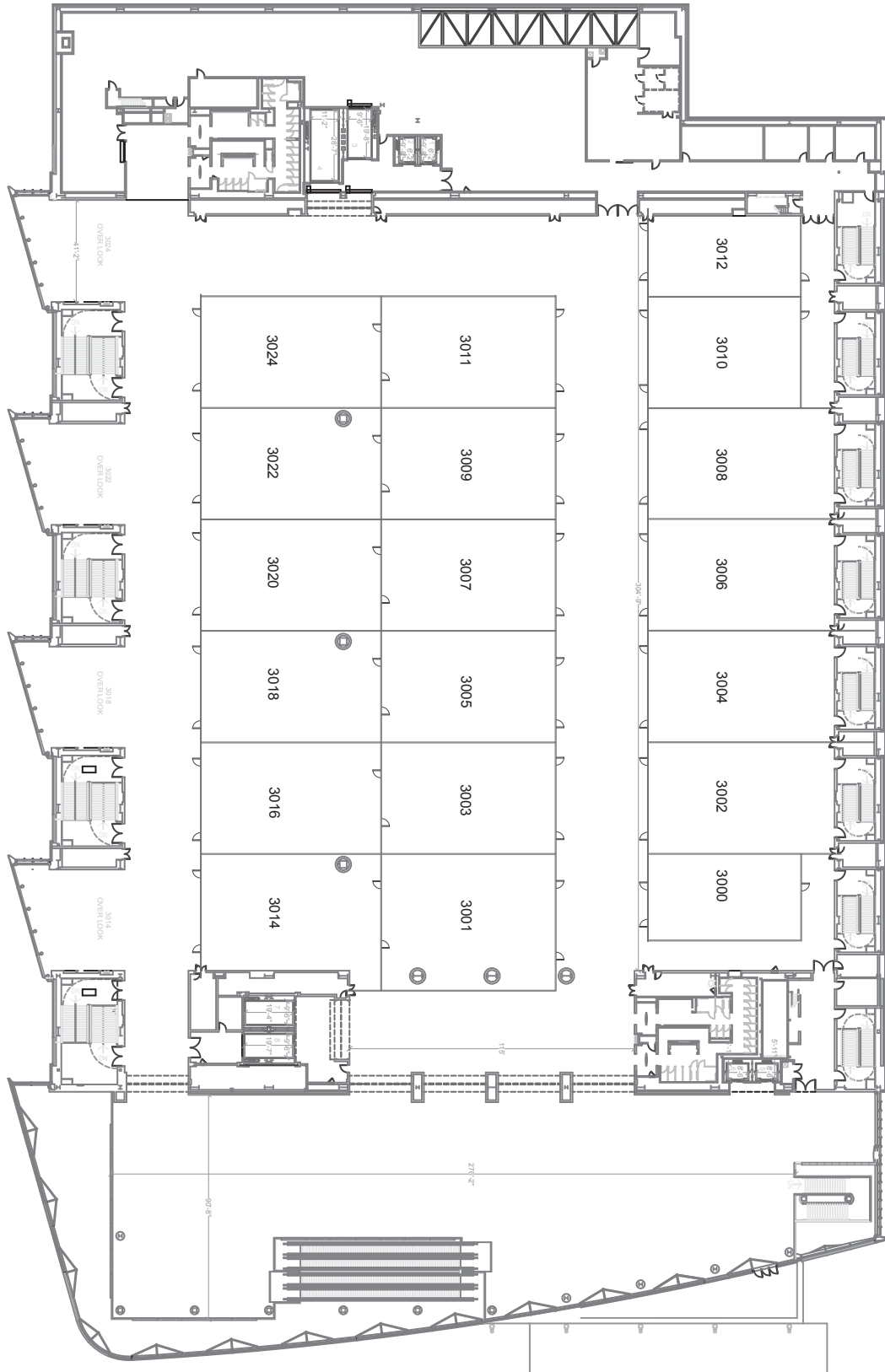
Transformative Math Teaching and Learning: Stories from Railside High (Session 178)

Wednesday, April 13, 1:15 p.m. – 2:30 p.m.

Moscone West, 3006

Floor Plans

Moscone West



Welcome!

On behalf of Research Committee of the National Council of Teachers of Mathematics (NCTM) and the Special Interest Group/Research in Mathematics Education of the American Educational Research Association, we welcome you to NCTM's Research Conference.

The Research Conference serves multiple purposes. The Research Conference

- brings researchers together annually to examine and discuss current issues in mathematics education;
- provides an opportunity for researchers, beginning and seasoned, to receive feedback on their work and to benefit from exposure to alternative points of view;
- affords opportunities to interact and network with other researchers in the field; and
- allows the field to capitalize on the collective wisdom available when researchers and practitioners come together to discuss mathematics education and research.

The Research Conference continues to receive many high quality proposals from the community. This year we received 389 submission and extended 207 acceptances for the final program, giving an overall acceptance rate of 53%. You will see an expansion of Brief Research Reports to better accommodate the larger number of submissions in that category. The conference program also includes several invited sessions highlighting topics and new trends relevant to the field.

We thank the members of NCTM's Research Committee, members of the executive board for the SIG/RME, and the members of the research community who served as reviewers. Your work is greatly valued and appreciated. Moreover, we would like to thank the staff at NCTM for helping us with the logistics of the conference, registration, the program, and all that makes the conference run smoothly. We would like to thank all the presenters for their thoughtful proposals and their willingness to share their work. Finally, we would like to thank everyone in attendance, and we hope that you will find the conference stimulating and enjoyable. We are glad you are here.

Sincerely,

Kathryn Chval
NCTM Research Committee, Chair

Ilana Horn
AERA SIG/RME Co-Chair

Janine Remillard
AERA SIG/RME Co-Chair

David Barnes
NCTM Research Committee, Staff Liaison

Opening Session—Monday, 5:00 p.m.

Cynthia W. Langrall, *JRME* Editor
JRME: A Tale of Unicorns, Mastodons, and Ants
Monday, April 11, 2016: 5:00 p.m.–7:00 p.m.

3001/3003/3005

Monday, April 11th

5:30 p.m.–7:00 p.m.

1

JRME: A Tale of Unicorns, Mastodons, and Ants

Opening Session

What do unicorns, mastodons, and ants have to do with the *Journal for Research in Mathematics Education*? Join me at this opening session of the Research Conference to find out. I will share insights I have gained as editor of the journal, which point to challenges and opportunities for mathematics education research.

Cynthia W. Langrall

Illinois State University, Normal, Illinois

3001/3003/3005



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For your safety and because of fire regulations, only those with seats will be allowed in meeting rooms. To comply with fire codes, we will have to ask any persons sitting on the floor or standing to leave the room.

Please remember:

- All meeting rooms will be cleared between presentations.
- All seats are available on a first-come, first-served basis.
- Reserving spaces in line or saving seats is not permitted.
- As a courtesy to the speaker and your colleagues, please turn off your cell phone during all presentations.

7:30 a.m.–8:20 a.m.

1.5

Access, Equity, Identity and Agency

Discussion Session

What structures and conditions need to be created and dismantled for the brilliance of marginalized children to flourish? As a community what collaborative and courageous actions can we take to affect and sustain change? Come join, collaborate and participate.

Matt Larson, NCTM President-Elect

Lincoln Public Schools, Nebraska

David Barnes

NCTM, Reston, Virginia

3001/3003/3005

8:30 a.m.–9:00 a.m.

2

A Classroom Intervention: Strengthening Prospective Elementary Teachers' Knowledge of Divisibility

Brief Research Report

This brief report presents a study investigating the impact of a sequence of instructional tasks on prospective elementary teachers' (PSTs') knowledge of divisibility. Analysis of written assessments revealed significant improvements in PSTs' use of prime factorization to identify a variety of factor types, signaling a diminished dependence on more traditional and error-prone methods.

Matt B. Roscoe

The University of Montana, Missoula, Montana

3007

3

A Practical and Powerful Screener of Middle School Mathematics Difficulties

Brief Research Report

This study identifies a fraction screener administered in elementary school as a strong diagnostic tool for the prediction of later middle school mathematics difficulties. Practitioners can utilize the screener to identify students who need supplemental support in order to attain desired mathematics benchmarks.

Jessica Carrique

University of Delaware, Newark, Delaware

Nicole Hansen

Fairleigh Dickinson University, Teaneck, New Jersey

Ilyse Resnick

University of Delaware, Newark, Delaware

Nancy I. Dyson

University of Delaware, Newark, Delaware

Ai Ye

University of Delaware, Newark, Delaware

Nancy C. Jordan

University of Delaware, Newark, Delaware

3008

4

Activity and Impact of Elementary Mathematics Specialists in Rural Schools

Brief Research Report

This session will present the findings of a two-year randomized control-treatment study that investigated the impact of elementary mathematics specialists on student achievement in rural schools, characterized the amount and type of specialists' professional activity, and, in treatment schools only, evaluated the relationship between the focus of specialists' activities and student achievement.

Patricia F. Campbell

patc@umd.edu

University of Maryland, College Park, Maryland

Matt Griffin

University of Maryland, College Park, Maryland

3010

5

An Analysis of U.S. Expert Teachers' Lessons on Inverse Relations

Brief Research Report

This study explores eight U.S. expert teachers' algebraic knowledge for teaching (AKT) through analyzing 32 videotaped lessons on inverse relations (grades 1–4). Based on three IES recommendations, we explore common features of teachers' effective use of worked examples, representations, and deep questions in existing classrooms. Challenges in these instructional components are identified.

Meixia Ding

Temple University, Philadelphia, Pennsylvania

Ryan Hassler

Temple University, Philadelphia, Pennsylvania

Xiaobao Li

Widener University, chester, Pennsylvania

Wei Chen

Nanjing Normal University, Nanjing, China

3011

6

Angle and Slope Connections: Challenging Teacher Assumptions in Trigonometry**Brief Research Report**

Using a series of tasks and video, we challenged beginning teachers to consider trigonometric relationships between angles and slope. This presentation focused on a common misconception these tasks revealed in trigonometric reasoning and on how the task prompted teachers to reconsider their assumptions.

David Glassmeyer

Kennesaw State University, Kennesaw, Georgia

Aaron Brakoniecki

Boston University, Boston, Massachusetts

Julie Amador

University of Idaho, Coeur d'Alene, Idaho

3018

7

Approaches to Constructing General Mathematical Statements**Brief Research Report**

I will share results from a study of university students' construction of general mathematical statements. From analysis of data from ten students in math-focused majors, I describe approaches to constructing domains of applicability for given property statements. The approaches have implications for designing activities to increase students' proficiency at conjecturing generalities in mathematics.

Duane Graysay

dtg105@psu.edu

The Pennsylvania State University, University Park, Pennsylvania

3020

8

Are Adolescents' Views of Mathematics Changing?**Brief Research Report**

This study examines how adolescents' view of mathematics as a gendered domain varies based on one's gender and class type (i.e., single-sex or coeducational). One significant finding from the study is that participants typically associated mathematics as a neutral domain (i.e., for both females and males).

Amber Simpson

amsimps@g.clemson.edu

Indiana University, Bloomington, Indiana

3022

10

Attending to Precision in Statistics**Brief Research Report**

The Common Core Standards for Mathematical Practice are processes and proficiencies that mathematics educators would like to develop in their students. In this session, we present a case study of three teachers, which looks at the prevalence of Mathematical Practice 6, Attending to Precision, in a professional development statistics course for in-service teachers largely focused on open-ended activities. We also illustrate how the elicited Attending to Precision may differ in the context of statistics compared to mathematics.

Christina Eubanks-Turner

Loyola Marymount University, Los Angeles, California

Anna E. Bargagliotti

Loyola Marymount University, Los Angeles, California

3004

11

"It Won't Work Every Time": The Refutations of Preservice Teachers**Brief Research Report**

Reforms to the teaching of mathematics encourage teachers to support students both in making conjectures and refuting those that are false using counterexamples. This study reports on the counterexamples provided by 17 preservice elementary teachers when asked to refute students' false conjectures about fractions. The analysis drew upon existing frameworks to distinguish the pedagogical power and accessibility of counterexamples. Findings indicate that preservice elementary teachers' counterexamples lacked pedagogical power. Additionally, counterexamples that lacked pedagogical power also varied in terms of: (a) their mathematical complexity and (b) their ability to mirror the reasoning used by the student who authored the false conjecture being refuted. Future work may examine how counterexamples displaying a range of mathematical complexity and mirroring ability support students in abandoning their false conjectures.

Michael Jarry-Shore

Stanford University, Stanford, California

3002

12

Professional Identity and Cultural Competence Development among STEM Professionals

Brief Research Report

This study followed eight preservice teacher career-changers, of varying STEM backgrounds, on their journeys to becoming urban mathematics teachers. Participants had an opportunity to gain a new identity as a culturally responsive teacher entering the teaching profession. This study gave voice to preservice teachers' evolving views, insights, and experiences during the process of constructing and reconstructing their professional identity and cultural competence as a mathematics teacher preparing to meet the educational needs of a diverse population of students in an urban high-need school district.

Belinda P. Edwards

Kennesaw State University, Kennesaw, Georgia

Desha L. Williams

Kennesaw State University, Kennesaw, Georgia

3006

13

The Influence of Consecutive Flipped Courses on Students' Math Anxieties

Brief Research Report

This session will examine how taking consecutive mathematics courses for elementary preservice teachers influenced their anxieties and perceptions of teaching and learning mathematics. Participants will examine preliminary data and discuss how this may impact those interested in trying to integrate flipped learning into their teaching practices.

Anthony Michael Dove

adove3@radford.edu

Radford University, Radford, Virginia

3024

14

Understanding How to Differentiate Instruction for Middle School Students

Brief Research Report

Today's middle school mathematics classrooms are marked by increasing cognitive diversity. Traditional responses to cognitive diversity are tracked classes that contribute to opportunity gaps and can result in achievement gaps. Differentiating instruction (DI) is a novel but untested response to cognitive diversity, in which teachers proactively plan to adapt pedagogical activities to address individual students' needs in an effort to maximize learning for all students. This paper reports on this question: How did pedagogical activities facilitate and impede differentiating mathematics instruction for middle school students in an after school design experiment? The data comes from an 18-episode experiment with nine cognitively diverse seventh- and eighth-grade students, focusing on four episodes in which students worked on representing multiplicative relationships among quantitative unknowns. Analysis revealed two pedagogical activities that facilitated DI and three that both facilitated and impeded it.

Amy J. Hackenberg

Indiana University-Bloomington, Bloomington, Indiana

Mark A. Creager

Indiana University-Bloomington, Bloomington, Indiana

Mi Yeon Lee

Arizona State University, Phoenix, Arizona

Ayfer Eker

Indiana University-Bloomington, Bloomington, Indiana

3016

15

Beyond the Demonstration of Procedures in YouTube-Style Math Videos

Brief Research Report

Despite the tremendous growth in online mathematics videos for K–12 students, there is surprising uniformity in the expository mode of presentation and the procedural nature of the content. The purpose of this study was to locate, analyze, and categorize the approach of conceptually and/or dialogically oriented online math videos.

Joanne Lobato

San Diego State University, San Diego, California

C. David Walters

San Diego State University, San Diego, California

Carren Walker

San Diego State University, San Diego, California

3004

16

Conferring in the Elementary Mathematics Classroom

Brief Research Report

Math conferences, an interactional structure adapted from literacy instruction, can be used to provide responsive instruction in the moment to collaborating students. This qualitative study characterizes the math conference, identifies its defining feature—the nudge—and describes six types of nudges teacher use to push student thinking forward.

Jen Munson

Stanford University, Stanford, California

3007

17

Connections among Mathematics Vocabulary, General Vocabulary, and Computation

Brief Research Report

Understanding mathematics is more than working with numerals and symbols. In many instances, students must interpret vocabulary terms (e.g., prime number, improper fraction) to understand mathematics concepts and procedures. We conducted an analysis of the mathematics vocabulary knowledge of students at grades 1, 3, and 5. We present the longitudinal mathematics vocabulary knowledge of students as well as how general vocabulary and computation knowledge predict mathematics vocabulary understanding.

Sarah Rannels Powell

University of Texas at Austin, Austin, Texas

Gena Nelson

University of Minnesota, Minneapolis, Minnesota

3008

18

Constructing and Critiquing Arguments: Effect of an Instructional Sequence

Brief Research Report

We present the design and implementation of our before-during-after instructional sequence aimed at developing students' capabilities in constructing viable arguments and critiquing the reasoning of others. The results show that our instructional sequence had a significant effect in students' work shifting from empirical to deductive arguments.

Sean P. Yee

University of South Carolina, Columbia, South Carolina

Yi-Yin Ko

Indiana State University, Terre Haute, Indiana

Sarah K. Bleiler

Middle Tennessee State University, Murfreesboro, Tennessee

Justin D. Boyle

The University of Alabama, Tuscaloosa, Alabama

3009

19

Constructions of Coordinate Systems: Four Ninth-Grade Students

Brief Research Report

This paper presents data from a two-year teaching experiment with four ninth-grade students investigating their constructions of coordinate systems in organizing space. We will discuss the difference in perspectives the students were able to take in relation to the levels of units they were able to coordinate.

Hwa Young Lee

University of Georgia, Athens, Georgia

3010

20

Designing Professional Development to Support Teachers in Learning Trajectory-Based Instruction

Brief Research Report

The aim of this project was to examine the design and implementation of a professional development that was part of an integrated learning system developed to align performance assessments, classroom activities, and reporting with a learning trajectory on geometric measurement of area.

Jennifer L. Kobrin

Pearson, Wayne, New Jersey

Nicole Panorkou

Montclair State University, Montclair, New Jersey

3011

21

Developing Ambitious Practice: A Cross-Case Analysis of Novice Mathematics Teachers

Brief Research Report

In this study, I investigated how novice mathematics teachers work toward promoting access and equity within their classrooms through the implementation of high-leverage practices. I found that the high-leverage practice of building classroom culture emerged from the data as central to the work of novice mathematics teachers.

Dawn M. Woods

dwoods@smu.edu

Southern Methodist University, Dallas, Texas

3018

22

Developing Facilitation Practices in a Secondary Math Teacher Learning Community

Brief Research Report

Research has shown that teacher learning communities have potential in supporting teacher learning of more ambitious practices. In this paper, we contribute to an emerging body of work on development of facilitator practices. We provide a provisional trajectory based on an analysis of a facilitator's practices in leading a secondary mathematics teacher learning community, and we describe how facilitation practices developed to increasingly provide opportunities for teacher learning. This expanding image of development will help to design supports for math leaders as they continue their work with teacher learning communities.

Terry Wan Jung Lin

McGill University, Montreal, Canada

Kara Jackson

University of Washington, Seattle, Washington

Marta Kobiela

McGill University, Montreal, Canada

Zachary Parker

McGill University, Montreal, Canada

3020

23

Developing Knowledge and Theory of Math Education through Action Research

Brief Research Report

This study examines teachers' understanding of reform-based mathematics education as they engaged in action research, a major component of a sustained professional development initiative. Data are analyzed through the lenses of student thinking, mathematics content, and social interaction. Knowledge acquisition and theory generation are reported, as well as the processes used in implementing the action research.

Eula E. Monroe

Eula_Monroe@byu.edu

Brigham Young University, Provo, Utah

Debra S. Fuentes

Brigham Young University, Provo, Utah

3022

24

Does Experiential Learning Influence the Way Students Learn Mathematics?

Brief Research Report

This experimental study aims to determine if teaching mathematics while respecting the four stages of the experiential learning cycle of Kolb (1984) has an effect on grade 7 students' learning of probabilities. During the session, the study will be presented and participants will be invited to discuss how experiential learning can be integrated into the classroom. A discussion will also aim to develop a better understanding of the results.

Manon LeBlanc

Université de Moncton, Moncton, Canada

Mylène Savoie

Université de Moncton (student), Moncton, Canada

Michel T. Léger

Université de Moncton, Moncton, Canada

Mathieu Lang

Université de Moncton, Moncton, Canada

Nicole T. Lirette-Pitre

Université de Moncton, Moncton, Canada

3024

26

Underrepresented Students Pursuing Mathematics Degrees: Changes after Transitioning to College

Brief Research Report

This longitudinal qualitative study followed a cohort of mathematics-intending underrepresented high school students into their freshman year of college to identify changes on their path to mathematics-intensive degree attainment. Results indicated that four of the seven participants persisted on their degree path while the remaining

three switched to less-mathematics-intensive programs. The greatest positively contributing factor for the participants who persisted was participation in collaborative learning with their peers in mathematics. The participants who did not persist reported that they experienced a decrease in their sense of competence in mathematics when they transitioned from high school to college. All participants, whether they persisted or not, reported that they felt underprepared for college-level mathematics. These results highlight the continued need for increased collaboration between stakeholders at the secondary and postsecondary levels.

Alison S. Marzocchi

California State University, Fullerton, Fullerton, California

3006

27

Using Video to Prepare Preservice Teachers to Pose Purposeful Questions

Brief Research Report

This study documents the effects of exemplar video observation on the development of deep questioning skills of preservice teachers (PSTs) with (experimental) and without (control) direct depth of knowledge instruction in a mathematical content course for K–8 preservice teachers. In particular, we examine the questioning strategies used by preservice teachers in written responses related to Common Core-aligned videotaped math lessons. Data was analyzed to develop multitiered general categories and levels of questions used by the PSTs. Through an examination of the trending categories and question levels relational to the videos we offer suggestions for preservice teacher education courses.

Christina Eubanks-Turner

Loyola Marymount University, Los Angeles, California

Anita Kreide

Loyola Marymount University, Los Angeles, California

3016

28

20 Weeks to Better Eliciting: A Case of Teacher Preparation

Discussion Session

Beginning elementary teachers struggle with knowing and identifying their students' mathematical knowledge. Knowing their students' thinking allows teacher to tailor instruction to their individual students' needs and understandings. This study describes how 10 preservice teachers, purposely selected from a cohort of 28, developed their eliciting student thinking practice over a 20-week period in their practice-based teacher education program.

Diana Sherman

University of Michigan, Ann Arbor, Michigan

3010

29

Assessing Secondary Teachers' Mathematical Habits of Mind**Discussion Session**

In this session, we share ongoing work to develop instruments to assess secondary teachers' mathematical habits of mind (MHoM). We envision MHoM as a critical component of mathematical knowledge for teaching. Moreover, many of the eight Mathematics Teaching Practices in NCTM's *Principles to Actions* depend on teachers' MHoM for implementation. We are investigating the research question: What are the MHoM that secondary teachers use, how do they use them, and how can we measure them? The focus of the session is on our paper and pencil (P&P) assessment that measures how teachers use MHoM while doing mathematics on their own. Session participants will engage in working through the P&P items, rubrics, and sample teacher responses. Participants will also have an opportunity to share questions, concerns, and reactions to the items. The discussion will center on the challenges of validity, reliability, scoring, and use of the P&P assessment.

Ryota Matsuura

St. Olaf College, Northfield, Minnesota

Sarah E. Sword

Education Development Center, Inc., Waltham, Massachusetts

Miriam Gates

Education Development Center, Inc., Waltham, Massachusetts

Al Cuoco

Education Development Center, Inc., Waltham, Massachusetts

Glenn Stevens

Boston University, Boston, Massachusetts

3024

30

Complementary Approaches to Formative Assessment in Mathematics**Research Symposium**

The Common Core State Standards (CCSS) present unprecedented opportunities and challenges for schools and districts as they work to adopt the standards. The stakes are high for students, teachers, and administrators. We offer the use of formative assessment (FA) as one instructional approach to help practitioners leverage these standards to develop mathematical procedural skills, reasoning abilities, and conceptual understanding in students. Using the work from two research universities, this symposium will present an overview of two complementary approaches to FA and will present findings from joint validity studies of two intervention studies.

Deborah La Torre Matrundola

latorre@cse.ucla.edu

UCLA, Los Angeles, California

Christine Ong

UCLA, Los Angeles, California

Kevin Schaaf

UCLA, Los Angeles, California

Huy Chung

UC Davis, Santa Ana, California

Jamal Abedi

UC Davis, Davis, California

Bahareh Abhari

UC Davis, Davis, California

Leslie Banes

UC Davis, Davis, California

3007

31

Generalization across Multiple Mathematical Areas**Research Symposium**

Generalization is a key aspect of doing mathematics, with policy makers recommending that it be a central component of instruction from elementary school through undergraduate mathematics. This recommendation poses serious challenges, however, given students' difficulties in creating and expressing correct generalizations. Furthermore, how to foster productive generalization is not well understood. This symposium addresses these challenges by introducing a comprehensive framework characterizing productive mathematical generalization in grades 8–16. Four related projects across the domains of algebra, geometry and combinatorics share results on students' generalizing activity in interview settings, identifying (a) categories of mental content making up the basis of students' operating, and (b) categories of activity types supporting the formation of generalizations. The presentations will be followed by a discussion of the links between insight, generalizing, and justifying.

Amy Ellis

University of Wisconsin-Madison, Madison, Wisconsin

Kevin C. Moore

University of Georgia, Athens, Georgia

Elise Lockwood

Oregon State University, Corvallis, Oregon

Erik S. Tillema

IUPUI, Indianapolis, Indiana

Discussant: Ferdinand Rivera

San Jose State University, San Jose, California

3008

32

Interactive Paper Session**Presider: Kathryn B. Chval**

chvalkb@missouri.edu

*University of Missouri-Columbia, Columbia, Missouri***Successful White Mathematics Teachers of Black Students**

In this session, framed within an eclectic theoretical framework of critical theory, critical race theory, and Whiteness studies, the classroom practices of four White high school mathematics teachers who were “successful” with Black children are explored.

Carla R. Bidwell*Metropolitan Regional Educational Service Agency, Smyrna, Georgia***David W. Stinson***Georgia State University, Atlanta, Georgia***Grappling with Ready-Made Narratives around Race, Motivation, Achievement, and Opportunity in Mathematics**

A prominent feature of K–12 education is the widespread endorsement of a narrative that to achieve in mathematics one must solely be motivated enough. This narrative articulates a direct link between individual motivation and academic achievement, and is employed by a range of educational stakeholders. In STEM domains, especially mathematics, this narrative is often coupled with another suggesting that a special intelligence is required for people to do math and science. We argue that the tendency to enlist such narratives to make sense of math achievement is problematic with respect to the views students from nondominant (and dominant) racial, ethnic, and linguistic backgrounds develop of their intelligence and capacity for success in STEM. Narratives such as these obscure the role of broader sociopolitical structures and hierarchies in shaping individual and group success in school. In this paper, we analyze the negotiation of such master-narratives by students from nondominant backgrounds as they figure themselves and others in the world of mathematics and school achievement. We draw upon Ochs and Capp’s (2001) notion of lived narratives to explore the kinds of stories students evoked in positioning themselves and others around mathematics and school achievement. Our analysis demonstrates the importance of initiating and orchestrating conversations that support students in explicitly grapple with these master-narratives.

Maria R. Zavala*San Francisco State University, San Francisco, California*

Additional authors

Victoria M. Hand*University of Colorado, Boulder, Boulder, Colorado***The Construction of Disability in Racial Storylines in Mathematics**

Identification with mathematics for students of color is complicated by racial storylines (Nasir and Shah 2011). This presentation explores the underlying construction of ability, thus disability, in racial storylines, exploring the complex narratives of a Latina with a learning disability on race, language, and disability in mathematics.

33

Interactive Paper Session**Presider: Michelle Stephan**

michelle.stephan@uncc.edu

*UNC Charlotte, Charlotte, North Carolina***Ways in Which Engaging in Someone Else’s Reasoning Is Productive**

Typical goals for inquiry-oriented mathematics classrooms are for students to explain their reasoning and to make sense of others’ reasoning. In this paper we offer a framework for interpreting ways in which engaging in the reasoning of someone else is productive for the person who is listening and making sense.

Naneh Apkarian*San Diego State University, San Diego, California*

Additional authors

Chris Rasmussen*San Diego State University, San Diego, California***Tommy Dreyfus***Tel Aviv University, Tel Aviv, Israel***Hayley Milbourne***CRMSE, San Diego, California***Using DGS Strategically to Support Students’ Thinking**

The authors developed a practical framework to support mathematics teachers in assessing the role of technology in a task, and analyzing how it supports students’ mathematical thinking. This paper reports on teachers’ use of the framework to create tasks that use technology to support students’ high-level mathematical thinking.

Milan Sherman*Drake University, Des Moines, Iowa***Charity Cayton***East Carolina University, Greenville, North Carolina***Kayla Chandler***NC State University, Raleigh, North Carolina***Middle School Students’ Development of Algebraic Reasoning: Comparing Effects of Three Instructional Approaches (Visual, Structural, and Modeling)**

This algebra-readiness study was based on a teaching experiment with three seventh-grade classes in a Midwestern middle school. Three different algebra approaches to early algebra—a Modeling approach, a Visual-Number approach, and a Structural approach—were employed, with just one approach being taught to a particular class. The same teacher (Ms. X) taught all three classes, each for a period of seven weeks. Before the teaching experiment, Miss X had participated in a three-week professional development program led by the researcher and two experienced algebra education professors. Pre-teaching and post-teaching data were collected, the instruments being an Algebra Readiness test (ART), a Modeling test, a Visual-Number test, and a Structure test. In addition to data gathered from

responses to the pencil-and-paper instruments, data from 36 one-on-one interviews with students (18 pre-teaching and 18 post-teaching) were analyzed. Initial findings indicated that whereas the Modeling class's mean gain score was significantly different from zero, the mean gain scores for the other two groups increased only slightly. In this paper the data analyses are summarized and results interpreted.

Sinan Kanbir

Illinois State University, Normal, Illinois

3022

34 Interactive Paper Session

Presider: Jeffrey J. Wanko

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Miami University, Oxford, Ohio

How Do Children Really Measure? Strategy Use on Assessment Tasks

We conducted 1-on-1 interviews with 1060 pre-K–grade 2 children using measurement assessment items. This paper focuses on using qualitative analysis of children's strategies to guide and inform the larger, statistical analyses. These analyses help solidify the cognitive profiles and also enhance our understanding of children's development.

Douglas W. Van Dine

University of Denver, Denver, Colorado

Additional authors

Douglas H. Clements

University of Denver, Denver, Colorado

Julie Sarama

University of Denver, Denver, Colorado

Infusing Spatial Reasoning into Early Years Mathematics: A Year-Long K–2 Intervention

We report on a quasi-experimental, 7-month teacher-led intervention involving a spatial approach to geometry instruction with a focus on mental rotation and visualization. K–2 students in schools serving First Nation communities outperformed a control group on measures of geometry and spatial reasoning and on a measure of symbolic number comparison.

Joan Moss

University of Toronto, Toronto, Canada

Beverly Caswell

University of Toronto, Toronto, Canada

Zachary Hawes

University of Toronto, Toronto, Canada

3020

35 Measurement, Discourse, and Technology: Three Research Compendium Chapters Interact

Research Symposium

This symposium, based on the forthcoming NCTM *Research Handbook*, features authors of three new chapters. We will present (1) a specific content area, measurement, with (2) an important attribute of

classroom pedagogy, discourse, and (3) research-based affordances of technology. The discussion will engage the audience around emerging concepts of research-based classroom practice.

Jeremy Roschelle

SRI Education, Menlo Park, California

Beth Herbel-Eisenmann

Michigan State University, East Lansing, Michigan

Jack Smith

Michigan State University, East Lansing, Michigan

Discussant: Jinfa Cai

University of Delaware, Newark, Delaware

3016

36 Graduate Student, Junior Faculty, and Researcher Mentoring Session

Presider: Stephen J. Pape

Johns Hopkins University School of Education

Transitioning to faculty member/beginning a career in academia

Charles Munter

University of Pittsburgh

Finding faculty positions/developing a program to research

Sybilla Beckmann

University of Georgia

Navigating the tenure process

Keith R. Leatham

Brigham Young University

Publishing research

Edward A Silver

University of Michigan

Heather Lynn Johnson

University of Colorado Denver

Working with graduate students

Juli K. Dixon

University of Central Florida

Karen Karp

Johns Hopkins University

Writing grant proposals

Melissa D. Boston

Duquesne University

Collaboration with practitioners

Fran Arbaugh

The Pennsylvania State University

Needs of mathematics educators for research

Signe Kastberg

Purdue University

3002

37 Oral Assessments as Learning Opportunities for Preservice Teachers

Discussion Session

This session draws on 114 videos of oral assessments (38 students, 3 exams each) from a number and operations course for pre-service elementary teachers taught in two sections at a large research university. We are using this video data to address the following questions: 1. What student learning gains do we observe taking place during an oral assessment? 2. What characteristics of this assessment format support the learning gains we observe? In this interactive session, participants will watch selected video clips and discuss how one recognizes and characterizes learning opportunities, specifically in the context of oral assessments in math content courses for preservice elementary teachers.

Nina White

University of Michigan, Ann Arbor, Michigan

Daniel Visscher

University of Michigan, Ann Arbor, Michigan

3011

38 Research on Math Teacher Education in an Online Multimedia Environment

Research Symposium

In the research symposium we share results from several studies investigating the use of LessonSketch, an online multimedia environment, and how it supports practice-based teacher education. LessonSketch is an online environment where teachers can create, discuss, annotate, and share representations of teaching (Chieu and Herbst 2012). We share research that examines the use of LessonSketch tools for solving challenging problems of practice that are common in teacher education. Presentations will span teachers' development of content knowledge necessary for teaching and rehearsal of skills associated with essential instructional practices.

Wendy Rose Aaron

Oregon State University, Corvallis, Oregon

Emina Alibegovic

University of Utah, Salt Lake City, Utah

Joel Amidon

University of Mississippi, University, Mississippi

Sandra Crespo

Michigan State University, Ann Arbor, Michigan

Amanda M. Milewski

University of Michigan, Ann Arbor, Michigan

Kristi Hanby

University of Michigan, Ann Arbor, Michigan

Crystal Kalinec-Craig

The University of Texas at San Antonio, San Antonio, Texas

Alyson E. Lischka

Middle Tennessee State University, Murfreesboro, Tennessee

3009

39 Teacher Development in Statistics Education: A Critical Examination of How Teachers' Experiences Impact Their Knowledge, Beliefs, and Practices for Teaching Statistics

Invited

Today's teachers are faced with a difficult task of teaching statistical topics and approaches. This session will take a critical look at teachers' learning opportunities in statistics content and pedagogy across a spectrum of contexts in undergraduate teacher preparation, in-person local professional development, and professional development in a massive open online course serving teachers around the world. In all three contexts we seek to understand how the nature of experiences with which teachers engage impacts their content knowledge, beliefs about statistics learning and teaching, and their classroom practices. Reaction and commentary will connect to suggestions from the American Statistical Association.

Hollylynn Lee

NC State University, Raleigh, North Carolina

Jennifer Nickell Lovett

NC State University, Raleigh, North Carolina

Susan A. Peters

University of Louisville, Louisville, Kentucky

3006

40 Writing for NCTM Journals: Publishing Your Research in Teacher-Friendly Articles

Invited

Tips, guidelines, and descriptions of important features of the three NCTM school journals will be presented in a whole-group discussion. Journal-specific topics will be addressed in small groups. We encourage you to bring specific ideas or manuscripts to discuss in small groups facilitated by editorial panel members.

Terry Wyberg

wyber001@umn.edu

Mathematics Teaching in the Middle School, Editorial Panel Member, Lakeville, Minnesota

Roger P. Day

Illinois State University, Normal, Illinois

Cathery Yeh

University of California, Irvine, Irvine, California

3000

41 Effectiveness of Curriculum Units for Preservice Elementary Teachers

Brief Research Report

This brief report describes a mathematics curriculum designed for use in content courses for prospective elementary teachers (PTs), as well as presents empirical evidence of its impact on PTs' content knowledge for teaching mathematics (CKTM). Assessment data of nearly 1,500 PTs show that the curriculum was significantly effective in increasing PTs' CKTM.

Suzanne H. Chapin

Boston University, Boston, Massachusetts

Alejandra Salinas

Boston University, Boston, Massachusetts

Laura Kyser Callis

Boston University, Boston, Massachusetts

3004

42 Elementary Preservice Teachers' Self-Efficacy for Teaching Mathematics and Content Knowledge

Brief Research Report

The possible relation between preservice teachers' mathematics content knowledge and their self-efficacy for teaching mathematics is of particular importance to teacher educators. This experimental, one-group posttest-only study found no statistical significance for relationship between personal efficacy beliefs or mathematics teaching outcome expectancy and mathematics content knowledge.

Rebecca M. Giles

University of South Alabama, Mobile, Alabama

Kelly O. Byrd

University of South Alabama, Mobile, Alabama

Angelia Bendolph

University of South Alabama, Mobile, Alabama

3006

43 Elementary Students Articulation and Application of Theory of Measure

Brief Research Report

This project aimed to identify the different measurement principles elementary students articulate when solving clock problems. It was found that students articulate their theory of measure in different ways.

Alicia C. Gonzales

*University of Massachusetts, Amherst, College of Education,
Graduate Student, Amherst, Massachusetts*

Darrell Earnest

University of Massachusetts Amherst, Amherst, Massachusetts

3007

44 Elicited Models of Resampling and Bootstrapping

Brief Research Report

This study examines the models of resampling and bootstrapping constructed and developed by secondary and tertiary introductory statistics students while participating in a model-eliciting activity.

Jeffrey Allen McLean

Syracuse University, Syracuse, New York

Helen M. Doerr

Syracuse University, Syracuse, New York

3008

45 Eliciting Student Understanding of Mathematical Aspects of the Multiplication Principle

Brief Research Report

In this paper, we report on a subtle mathematical issue that is entailed in the multiplication principle (MP)—the independence of stages in a counting process—and we report on a particular task that helped students address this issue as they reinvented a statement of the MP. Doing so sheds light on students' reasoning about the MP.

Elise Lockwood

Oregon State University, Corvallis, Oregon

3009

46 Eliminating Counterexamples: A Conception of Contrapositive Proving for Adolescents

Brief Research Report

This brief research report addresses implementing activities that promote reasoning and proving. An adolescent's indirect reasoning is used to develop a conception of indirect argumentation that improves her understanding of contrapositive proving.

David A. Yopp

*dyopp@uidaho.edu
University of Idaho, Moscow, Idaho*

3010

47

Evaluating the Effectiveness of Symmetry Software for Early Elementary Children

Brief Research Report

Children develop the ability to perceive symmetry very early in life; symmetry is abundant in the world around us, and it is a naturally occurring theme in children's play and creative endeavors. This study sought to develop and evaluate a computer program that expands young children's understanding of symmetry and its subtypes—reflection, translation, and rotation. Results showed that children assigned to the experimental condition were better able to identify and explain symmetry subtypes than the control group. Children who used the symmetry software also showed improvement compared to their peers in the control group in completing translation tasks and in overall posttest scores, controlling for pre-existing ability.

Nicole Fletcher

Temple University, Ambler, Pennsylvania

3016

48

Examining the Impact of Multiple Representations on Students' Achievement

Brief Research Report

This study examined the impact of two teaching approaches (i.e., traditional algorithmic versus instruction using multiple representations) on middle school students' achievement on problems that integrated fractions, decimals, and percents. Results indicated gains in achievement with both teaching approaches; however, a statistically significant higher achievement gain was found with the traditional algorithmic approach. In terms of the order of teaching approaches, no significant differences were found.

Raymond Flores

Texas Tech University, Lubbock, Texas

Fethi Inan

Texas Tech University, Lubbock, Texas

Sunyoung Han

Texas Tech University, Lubbock, Texas

3024

49

Exploring the Narratively Constructed Mathematical Identities of Latina Bilingual Students

Brief Research Report

This study involved exploring the mathematics stories of three seventh-grade Latina students who attended an urban middle school. The mathematics stories of one primary caregiver for each student and the students' mathematics teacher were also explored. The goal was to understand the factors that attributed to the formation of the young girls' mathematics identities and how these identities informed their decisions to engage with mathematical activity. The findings illuminated important classroom experiences, how the students

made sense of these experiences, and how they took up and rejected opportunities to engage with mathematics because of those experiences.

Suzanne E. Kaplan

University of Arizona, Tucson, Arizona

3002

50

Preservice Teachers' Horizon Knowledge for Teaching Addition and Subtraction

Brief Research Report

Teachers' ability to connect what they are teaching to other related topics is central in their teaching. Analyzing video presentations of elementary preservice teachers, this study examined characteristics of their competence in connecting concepts that they are teaching to other relevant mathematics ideas. Results showed that participants preferred to connect addition and subtraction to concepts previously learned, such as place value, regrouping, number composition, and counting strategies, while paying less attention to the concepts that students will learn later, such as the inverse relationship of addition and subtraction, and the associative and commutative properties. The implications of this study for future research and mathematics teacher preparation are discussed.

Yuanhua Wang

Texas Tech University, Lubbock, Texas

Jian Wang

Texas Tech University, Lubbock, Texas

Xi Zeng

Texas Tech University, Lubbock, Texas

3020

51

Simultaneous Measurement of Preservice Teachers' Professional Noticing and MKT

Brief Research Report

The purpose of this session is to present the results of a research study focused on simultaneously measuring both professional noticing of children's mathematical thinking and mathematical knowledge for teaching of elementary student teachers' through an intervention focused on analysis of their students' multi-digit addition and subtraction work.

Lara Dick

Bucknell University, Lewisburg, Pennsylvania

3000

52 Using Content Maps to Represent Qualities of Teachers' Mathematical Instruction

Brief Research Report

A scaling-up study of the SimCalc approach revealed significant learning gains that were robust across demographic and regional variation in teachers and students. In order to determine what might have contributed to these gains, we theorized that students' opportunities to engage with content would be a significant source of information about what and how students learned. We developed a representational tool we call Content Maps that we used to analyze the content of classroom discourse around mathematical tasks. Maps that were generated from three teachers' enactments of three lessons reveal the various ways in which these teachers drew on their mathematical knowledge in whole-class discussion. These maps may therefore prove to be a more useful assessment of their mathematical knowledge as a learning resource than quantitative measures of their mathematical knowledge for teaching.

Steven Greenstein

Montclair State University, Montclair, New Jersey

3018

53 Utility of the TMSSR Framework for Investigating Instructional Practices

Brief Research Report

To illustrate the affordances of the Teacher Moves for Supporting Student Reasoning (TMSSR) Framework for investigating (a) the different ways teachers provide instructional support for students, and (b) how those differences may support students' reasoning, we will present the analysis of two classroom implementations of a research-based unit via the TMSSR framework. We will also discuss the utility of the TMSSR framework as a tool for studying instructional practices.

Lindsay Reiten

University of Wisconsin, Madison, Madison, Wisconsin

Zekiye Ozgur

University of Wisconsin-Madison, Madison, Wisconsin

Amy Ellis

University of Wisconsin-Madison, Madison, Wisconsin

3011

54 Cracking Her Codes: Investigating Technology Boundary Objects Using Interaction Analysis

Discussion Session

We describe a cross-departmental, cross-university research collaboration project aimed at understanding the extent to which technology tools function as boundary objects for high school females in a math camp setting. Emergent results from our interaction analysis suggest that technology tools when viewed as boundary objects served different purposes for different student pairs—one was

a sharing purpose, and one was a use to put up a wall—in different figured worlds. The effects of these purposes were weighty in terms of participation and engagement in the mathematical task. Participants will examine multiple excerpts from our data and help us think about how to move our ideas forward in ways that are productive, novel, and helpful to a broad audience.

Gretchen Matthews

Clemson University, Clemson, South Carolina

Nicole A. Bannister

Clemson University, Clemson, South Carolina

Amber Simpson

Indiana University, Bloomington, Indiana

3016

55 Engaging Principles to Actions, Teachers' Actions, and Game Design

Discussion Session

This presentation addresses two questions: “How do digital game environments relate to the National Council Teachers of Mathematics' Principles to Actions: Ensuring Success for All (2014)?” and, “What should teachers know about designing ‘sandbox games’ such as Minecraft, advance sense making, reasoning, problem solving, and communication” (NCTM 2014)?

Beth Bos

Texas State University

3002

56 Examining an Instrument for Assessing Primary Grades Mathematics Classrooms

Research Symposium

This session will describe the examination of an instrument designed to assess instructional quality in a mathematics classroom. Of particular interest are mathematics rigor and discourse in the primary grades. Results of the instrument's validity and reliability with this targeted population will be presented, in addition to correlation results between instructional quality as measured by this instrument and student outcomes.

Kristopher J. Childs

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University of Central Florida, Orlando, Florida

Makini Sutherland

University of Central Florida, Orlando, Florida

Nesrin Sahin

University of Central Florida, Orlando, Florida

Rebecca Gault

University of Central Florida, Orlando, Florida

Juli K. Dixon

University of Central Florida, Orlando, Florida

3007

57

Interactive Paper Session**Presenter: Beth Herbel-Eisenmann***Michigan State University, East Lansing, Michigan***Resources for Teachers' Equity-Oriented Learning and Identities**

Access to four types of resources may distinguish teachers who sustain engagement with equity work from those who don't. Using the case of a successful teacher, I define each resource type and show how they support learning and identities, with practical implications for teachers and teacher educators and theoretical implications for understanding professional learning.

Nicole L. Louie*University of Texas at El Paso, El Paso, Texas***Supporting Teachers to Enact Equitable Mathematics Instruction**

We will share results from a research initiative intended to support equitable mathematics instruction and enhance mathematical learning opportunities for African-American students. We will describe what classroom observations, surveys, and interviews indicate about productive and unproductive mindsets towards equitable mathematics instruction and students' opportunities to learn mathematics.

Melissa D. Boston*Duquesne University, Pittsburgh, Pennsylvania***Charles Munter***University of Pittsburgh, Pittsburgh, Pennsylvania***Carol Parke***Duquesne University, Pittsburgh, Pennsylvania***Carmen Thomas-Browne***Duquesne University, Pittsburgh, Pennsylvania***Calli Shekell***University of Pittsburgh, Pittsburgh, Pennsylvania***Cara L. Haines***University of Pittsburgh, Pittsburgh, Pennsylvania*

3018

58

Interactive Paper Session**Presenter: Nathalie Sinclair***Simon Fraser University, Burnaby, BC, Canada***Gaps Between Knowledge and Practice: The Case of Teacher Questioning**

We describe specific challenges that we encountered in designing and implementing a "simulated student" intervention to support preservice teachers in developing the skill of asking questions that draw out and build on student thinking. We share implications for future iterations of the intervention.

Corey Webel*University of Missouri, Columbia, Missouri***Kimberly A. Conner***University of Missouri, Columbia, Missouri***Unintended (but Good!) Outcomes: Impacting PSTs' Vision of Role of Teacher**

We report a study from a secondary mathematics methods course designed to enhance PSTs' capacities to pose purposeful questions and elicit/use evidence of student thinking. Findings revealed an unintended outcome—an increase in PSTs' visions of high-quality mathematics instruction (Munter 2014), specifically in the "role of teacher" dimension.

Fran Arbaugh*The Pennsylvania State University, University Park, Pennsylvania***Ben Freeburn***Bradshaw Christian Schools, Sacramento, California***Nursen Konuk***The Pennsylvania State University, Univ Park, Pennsylvania***Duane Graysay***The Pennsylvania State University, University Park, Pennsylvania***Preservice Elementary Teachers' Development in Facilitating Mathematics Discussions**

This presentation shares how two preservice teachers (PSTs) developed pedagogical skills by participating in an approximation of practice for facilitating discussion. Video of PSTs working with children are shared to illustrate how collaborative teaching supported teacher development. Discussion addresses strategies for sustaining PST growth.

Allyson Hallman-Thrasher*Ohio University, Athens, Ohio*

3022

59

Interactive Paper Session**Presenter: Trena Wilkerson***Baylor University, Waco, Texas***The Role of Different Learning Opportunities in Teachers' Knowledge Growth**

This study examines the role of several key features of effective professional development in changes in teachers' mathematical knowledge needed for quality teaching. All activities of 568 teachers completed as part of the Math and Science Partnership programs were coded based on the core features identified in earlier literature and participating teachers' mathematical knowledge were captured by valid teacher content knowledge instruments. Results of two-level hierarchical linear models provided insights on which form (e.g., study group or workshop), what content knowledge was addressed (e.g., general pedagogy, pedagogical content knowledge, knowledge of curriculum and standard), and how the activities were designed (e.g., examining student work and solving math problems) were related to gain in teachers' mathematical knowledge.

Yasemin Copur-Gencturk*University of Houston, Houston, Texas***Debra Junk***University of Texas at Austin, Austin, Texas*

Rural Elementary Mathematics Teacher Education through International Partnerships

This paper will: describe the phased activity approach used to develop an international, cross-sector, interdisciplinary research partnership that worked towards co-creating sustainable strategies and models for primary mathematics teacher development for rural and remote communities in Tanzania; and will describe the lessons learned from this work.

Florence Glanfield

University of Alberta, Edmonton, Canada

Additional authors

Elaine Simmt

University of Alberta, Edmonton, Canada

Joyce Mgombelo

Brock University, St Catharines, Canada

3020

60 "Power Concedes Nothing without a Demand": Challenging the Pervasive Deficit Discourse about Children in Mathematics Education

Invited

While equity is a stated priority for the mathematics education community, many children continue to have an inequitable mathematics education. Inequities are often rationalized by research-based practices that perpetuate institutionalized forms of discrimination and rank cognitive, cultural, and linguistic capacities of children to learn mathematics. The purpose of this panel is to highlight theoretical and empirical approaches that actively challenge the pervasive deficit discourses about historically marginalized youth's engagement and success in learning mathematics. Panelists will dialogue about tensions and trajectories of this work that challenges dominant deficit views and demands a more just mathematics education for our nation's children.

Julia Aguirre

University of Washington, Tacoma, Tacoma, Washington

Robert Q. Berry

Curry School of Education, University of Virginia, Charlottesville, Virginia

Rochelle Gutiérrez

University of Illinois at Urbana-Champaign, Champaign, Illinois

Danny B. Martin

University of Illinois, Chicago, Chicago, Illinois

Anita A. Wager

University of Wisconsin - Madison, Madison, Wisconsin

3006

61 Mathematics Instruction and Learning in the Community College

Research Symposium

Research regarding teaching and learning in community colleges (CC) remains so rare that Mesa et al. (2014) identified it as a "New Research Frontier." This set of three dissertation studies documents the challenges that Latina/o CC students faced in completing Calculus courses,

the nature of interactions in two developmental mathematics CC classrooms and the limited fraction understanding developmental math CC students had at the conclusion of their courses. Since community college represents fertile ground for mathematics education research on innovative practices, being informed about existing practices in community college settings is a critical first step in such endeavors.

Rebecca Ambrose

University of California, Davis, Davis, California

Cathleen Alexander

College of the Siskiyous, Weed, California

Minerva Moreno

American River College, Sacramento, California

Angelica Cortes

University of California-Davis, Davis, California

Discussant: Vilma Mesa

University of Michigan, Ann Arbor, Michigan

3008

63 Problematizing Mathematics Homework as Punishment: Practice and Theory

Discussion Session

This session will engage participants in a discussion of the legitimacy of the meaning of mathematics homework as punishment and the potential for punishments such as homework detention to change students' homework practices. We will also focus on how practice (educators' experiences) and theory (homework as a social practice and site for meaning making) can inform each other.

Mara Landers

Los Medanos College, Pittsburg, California

3009

64 Studies of Children's Emerging Sense of Space and Measure

Research Symposium

This symposium features four studies investigating elementary grades students' sense of space and measure. Conceptions of space and measure are pivotal to many core mathematical ideas, and learning environments carefully designed around an exploration of space also afford opportunities for students to engage in key mathematical practices. We explore ways in which space and measure serve to expand children's and teachers' mathematical experiences when instructional design capitalizes on children's resources for learning.

Richard Lehrer

Vanderbilt University, Nashville, Tennessee

Amy B. Holmes

Vanderbilt University, Nashville, Tennessee

Megan Joanne Wongkamalasai

Vanderbilt, Nashville, Tennessee

Portia K. Botchway

Vanderbilt University, Nashville, Tennessee

Discussant: David W. Henderson

Cornell University, Ithaca, New York

3011

65

The Role of Theoretical Frameworks in Research Dissemination

Invited

Members of the *JRME* Editorial Panel will discuss common weaknesses panel members have identified when reviewing manuscripts and will propose broad principles that can address these weaknesses and guide productive theoretical framing. Together the presenters and attendees will unpack examples from recent *JRME* articles that illustrate those principles.

Keith R. Leatham

Brigham Young University, Provo, Utah

Percival Matthews

University of Wisconsin-Madison, Madison, Wisconsin

Jinfa Cai

University of Delaware, Newark, Delaware

3000

66

Understanding Practices Preservice Teachers Use to Elicit Students' Thinking

Discussion Session

Instructional practices that make students' mathematical ideas available are essential to successful teaching. Eliciting in ways that uncover student thinking is a complex practice that needs to be learned. In some cases it might require unlearning approaches commonly used in everyday life. Participants will explore examples of preservice teachers' eliciting practices in which preservice teachers state a student's thinking and ask the student to agree/disagree with the statement. Participants will discuss the form and function of this practice, one that the researchers call "filling," and ways in which teacher educators could support awareness of the practice and the use of alternative approaches.

Timothy Boerst

University of Michigan, Ann Arbor, Michigan

Meghan Shaughnessy

University of Michigan, Ann Arbor, Michigan

Susanna Farmer

University of Michigan, Ann Arbor, Michigan

Sarah Kate Selling

University of Michigan, Ann Arbor, Michigan

Deborah Loewenberg Ball

University of Michigan, Ann Arbor, Michigan

3010

67

Who's In Charge? Teachers' Talk Cultivates Students' Mathematical Authority

Discussion Session

Mathematics educators agree that students' having mathematical authority is beneficial, but which teacher moves delegate authority to students? This research paper examines how two teachers in two diverse, urban, Algebra 1 schools used teacher talk to delegate mathematical

authority to students. Implications for teacher education, in the era of the Common Core State Standards mathematical practices, are discussed. Participants will engage in transcript analysis.

Teresa K. Dunleavy

Vanderbilt University, Nashville, Tennessee

Maria R. Zavala

San Francisco State University, San Francisco, California

3004

68

Exploring Effects of Content Organization on Specific Algebraic Concepts

Brief Research Report

In this study, a pretest-posttest study design was used to statistically compare algebraic performance of high school students who learn from a subject-specific course pathway and integrated course pathway. Data from a large-scale observational study was used. The results revealed no statistical differences exist in the outcomes between students from the two groups.

Derrick Saddler

University of South Florida, Tampa, Florida

3002

69

Exploring Quality of PSTs' Arguments in "Constructing" and "Critiquing" Situations

Brief Research Report

With an eye on the strength and coherence of mathematical arguments, we will discuss the quality of mathematical arguments that grades 1–8 PSTs' formulate in "constructing" and "critiquing" mathematical arguments situations. We examined PSTs' arguments with a focus on four dimensions: completeness and correctness of conclusion, conceptual reference on which the argument rests, sufficiency of evidence, and sufficiency of the reasoning that justifies that the evidence supports the claim.

Marta T. Magiera

Marquette University, Milwaukee, Wisconsin

Vecihi Serbay Zambak

Marquette University, Milwaukee, Wisconsin

3004

70

Exploring the Use of Mathematics Coaches and Specialists

Brief Research Report

Using restricted-use data from the 2011 NAEP Mathematics Assessment and advanced statistical analyses, the current study examined the relationship between mathematics coaches and specialists (MCSs) and the mathematics achievement of more than 190,000 fourth-grade students in more than 7,400 schools nationwide. Additionally, the study examined whether that relationship differed for students with and without disabilities, a vital concern with the continued focus of equity in mathematics education. Lastly, the study examined the relationships between principal-reported time spent on the different NAEP-defined roles and responsibilities of MCSs and fourth-grade students' mathematics achievement. Findings, implications, and future research will be shared and discussed.

Kristin E. Harbour

University of Alabama, Tuscaloosa, Alabama

Karen S. Karp

Johns Hopkins University, Baltimore, Maryland

Jill L. Adelson

University of Louisville, Louisville, Kentucky

3006

71

Facilitating the Collective Learning of Teachers in Practice-Based Learning Experiences

Brief Research Report

How do professional educators—professional development facilitators, teacher educators, and coaches—help establish a learning culture in which participants' engage in collective learning experiences embedded in classroom contexts? This session reports the findings of a study that identified facilitator moves that supported risk taking and rich learning among participants.

Lynsey Gibbons

Boston University, College of Education, Boston, Massachusetts

Alison Fox

University of Washington, College of Education, Seattle, Washington

Becca Lewis

University of Washington, College of Education, Seattle, Washington

Hannah Nieman

University of Washington, Seattle, Washington

3007

72

Ferris Wheels and Filling Bottles: Investigating a Student's Transfer

Brief Research Report

We share results of a design experiment study in which we used an actor-oriented perspective on transfer to investigate the research question: What similarities might a student construe between Ferris wheel and filling bottle tasks, and how might that influence a student's

reasoning across tasks? We discuss implications for research and teaching.

Heather Lynn Johnson

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University of Colorado Denver, Denver, Colorado

Evan McClintock

University of Colorado Denver, Denver, Colorado

Peter Hornbein

University of Colorado Denver, Denver, Colorado

3008

73

First Graders' Use of Variable Notation in a Teaching Experiment

Brief Research Report

We will answer the following question: In what ways do Kindergarten and grade 1 students use variable notation as a way to represent indeterminate quantities in algebraic problems? Our results indicate that after a brief teaching experiment most interviewed students were able to use variable notation to represent indeterminate quantities.

Barbara M Brizuela

Tufts University, Medford, Massachusetts

Maria Blanton

TERC, Cambridge, Massachusetts

Katharine B. Sawrey

Tufts University, Medford, Massachusetts

Angela Gardiner

TERC, Cambridge, Massachusetts

Yangsook Kim

Tufts University, Medford, Massachusetts

3009

74

Generic Use of Examples for Proving

Brief Research Report

The study examines how students use examples in order to justify the truth value of mathematical statements. We focus on provided generic examples that have the potential of leading to a generic proof. The findings show how students build on these examples productively and gain insights to underlying proof ideas.

Orit Zaslavsky

New York University, New York, New York

Inbar Aricha-Metzer

New York University, New York, New York

3010

75

How Novice Teachers Connect Tasks to the CCSSM Math Practices

Brief Research Report

In order to engage students in the CCSSM math practices, teachers must select appropriate tasks for their students to work on. This study examines how first- and second-year teachers abstractly talked about tasks that addressed the math practices compared to specific tasks the teachers selected to engage their students in the practices.

Keely Machmer-Wessels

Saint Mary's College, Moraga, California

3011

76

How Secondary Students Determine the Validity of Mathematical Arguments

Brief Research Report

The study investigated the factors students considered when evaluating the validity of mathematical arguments. Analysis of 8 eighth graders' interview transcripts indicated that when determining the validity of mathematical arguments, the source of conviction seemed to have the largest impact, followed by the presentation of the argument, while the link to conclusion (or mode of reasoning) seemed to have the least impact.

Yating Liu

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Old Dominion University, Norfolk, Virginia

3016

77

How Teachers' Evaluate Breaches of Norms in High School Geometry

Brief Research Report

This paper reports on a study of two norms of an instructional situation in high school geometry—Geometric Calculation in Algebra—that consisted of confronting practitioners with representations of practice

as a way to stimulate them to relay their knowledge of practice. The purpose of the study was to determine whether participants recognize two hypothesized norms and how those participants evaluate actions that breach them. The focus of this paper is on our use of the Appraisal system (Martin and White 2005) in Systemic Functional Linguistics to detect evidence of participants' evaluation of the breaches of one of those norms.

Nicolas Boileau

University of Michigan, Ann Arbor, Michigan

Patricio G. Herbst

University of Michigan, Ann Arbor, Michigan

3018

78

Hypothesizing Fragmented Growth of Mathematical Proficiency for Teaching

Brief Research Report

We compare two accounts of change in preservice teachers' (PSTs') knowledge and motivation for teaching multi-digit addition and subtraction that were a result of taking a mathematics methods class. Using scales with strong psychometric properties, we found knowledge increased but found no evidence of change in motivation. However, by comparing pre- and posttest responses item by item we found compelling patterns of linked change.

Erik Daniel Jacobson

Indiana University, Bloomington, Indiana

Fetiye Aydeniz

Indiana University, Bloomington, Indiana

Mark A. Creager

Indiana University-Bloomington, Bloomington, Indiana

Michael Daiga

Indiana University, Bloomington, Indiana

Erol Uzan

Indiana University, Bloomington, Indiana

3020

79

Impact of Early Algebra Instruction across Populations of Diverse Learners

Brief Research Report

Algebraic thinking and reasoning have been identified as an important and emerging curricular strand in K–8 education. Recognizing that historical paths to algebra have been largely unsuccessful, scholars now advocate that students have long-term algebra experiences, beginning in the elementary grades. Our purpose in this paper is to determine how students with low standardized test scores after receiving an algebra curriculum treatment perform relative to control students of all standardized performance levels.

Michael Eiland

WCER, Madison, Wisconsin

3022

80

Initial Understanding of Fractions: Children with Learning Disabilities and Difficulties**Brief Research Report**

Little to no information exists explaining the nature of initial conceptions of fractions held by students with learning disabilities. This study extends existing literature by presenting key indicators of understandings of fractional quantity of 44 children with learning disabilities and difficulties as evidenced through their problem-solving strategy, observable operations, and language across six tasks based in the measure and partitive interpretations. Constant comparison analysis of the children's work across the tasks documents indicators reflective of a framework. Pending future research, the framework may be a useful tool to practitioners wishing to document students' initial conceptions of unit fractions.

Jessica Hunt*The University of Texas at Austin, Austin, Texas***Juanita Silva***The University of Texas at Austin, Austin, Texas***Jasmine Welch-Ptak***The University of Texas at Austin, Austin, Texas*

3024

81

Student Internalization of Representations**Brief Research Report**

In this session we present the results of a study that investigated how students made use of their internal representations while generalizing algebraic tasks. A framework of internalization will be introduced and common pathways from this framework that students used to generalize each task will be discussed.

Laban J. Cross*Tri-Valley High School, Downs, Illinois***David Barker***Illinois State University, Normal, Illinois*

3000

82

Ambitious Enactments in Secondary Math Methods Courses**Discussion Session**

We share research on the design and use of instructional activities (IAs) in secondary mathematics methods courses. IAs provide opportunities for teacher candidates (TCs) to develop skill with instructional practices, such as those in Principles to Actions (Leinwand, Brahier, Huinker et al. 2014), that provide students opportunities to productively engage with mathematical ideas. Because the skilled use of instructional practices is dependent on interactions with students, IAs situate TC learning in authentic classroom settings. The session begins with theoretical perspectives of designing and using IAs in secondary mathematics methods courses and our research questions. We also

share the structure of an IA, Going Over a Problem, which secondary TCs enact in authentic classrooms settings. Our presentation ends with comments from a discussant. The second half of the session is a discussion among the audience and presenters around the design and use of IAs in secondary methods courses.

Wendy Rose Aaron*Oregon State University, Corvallis, Oregon***Matthew P. Campbell***West Virginia University, Morgantown, West Virginia***Rebekah Elliott***Oregon State University, Corvallis, Oregon***Grace Kelemanik***Boston Teacher Residency, Boston, Massachusetts***Melinda C. Knapp***Oregon State University, Bend, Oregon***Kristin Lesseig***Washington State University, Vancouver, Washington***Amy Lucenta***Boston Teacher Residency, Boston, Massachusetts*

3009

83

Approaching Intersecting Challenges: Mathematics Remediation at Four-Year Universities and Mathematics Identity as a Lens on Inequitable Access**Invited**

In recent articulations of “grand challenges” in mathematics education, equity has received renewed attention and has been framed as a prevailing concern for researchers. In this talk, I reframe this challenge as one that requires us to unpack empirically how inequities adhere to institutional practices and policies—and how they ultimately impact the mathematics socialization of learners. I describe two projects that focus on examining the mathematics identities that learners construct in non-credit-bearing remediation courses amid their transitions to universities. By attending to mathematics identities as an empirical lens, I argue that such research can contribute much-needed perspectives on a longstanding and largely inequitable phenomenon.

Gregory V. Larnell*University of Illinois at Chicago, Chicago, Illinois*

3006

84

Examining the Mathematics in the Next Generation Science Standards

Discussion Session

The mathematics knowledge and skills needed for students to be successful in science classrooms implementing the Next Generation Science Standards requires more than recording and interpreting data. Come explore the mathematics behind the NGSS and discuss the potential collaboration needed between mathematics and science educators to improve K–12 STEM performance.

Kim Gattis

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American Institutes for Research, Washington, District Of Columbia

Alka Arora

American Institutes for Research, Washington, District Of Columbia

Will Tad Johnston

American Institutes for Research, Washington, District Of Columbia

3000

85

Intersections of Instructional and Relational Dimensions of Urban Mathematics Classrooms

Research Symposium

This symposium presents findings from four research studies that examined connections between high-quality instruction, student learning and identity, and teacher-student relationships in urban mathematics classrooms. Across the studies, presenters will highlight theoretical and methodological variation in understanding urban mathematics classrooms as instructional, learning, and relational spaces and characterizing activity therein.

Luis A. Leyva

Rutgers Graduate School of Education, New Brunswick, New Jersey

Anne Garrison Wilhelm

Southern Methodist University, Dallas, Texas

Charles Munter

University of Pittsburgh, Pittsburgh, Pennsylvania

Kara Jackson

University of Washington, Seattle, Washington

Cara L. Haines

University of Pittsburgh, Pittsburgh, Pennsylvania

Daniel Battey

Rutgers University, New Brunswick, New Jersey

Calli Shekell

University of Pittsburgh, Pittsburgh, Pennsylvania

Discussant: Victoria M. Hand

University of Colorado, Boulder, Boulder, Colorado

3004

86

Interactive Paper Session

Presider: Stephen J. Pape

Johns Hopkins University School of Education, Baltimore, Maryland

Learning from Assessment Data: Epistemic Foundations of Data Use

The authors take a grounded theory approach to investigating how math educators use assessment data to inform instruction. Educators make epistemic assumptions about what data represent, which lead to different epistemic practices around how data are used. By identifying the ways educators make sense of data, the authors provide recommendations to inform educators' professional learning opportunities.

Brette Garner

Vanderbilt University, Nashville, Tennessee

Additional author

Ilana S. Horn

Vanderbilt University, Nashville, Tennessee

Mathematical Writing in Open Response Problems: Benefits for Emergent Bilinguals

This study used student samples in one state's open response items to identify the features of clearly written mathematical arguments. We report on how we can use these features to improve the performance of ELLs in mathematics tests. Evidence is provided to show that students' performance in open response questions is related not only to their mathematical understanding but also to their abilities in writing.

Michael Gilbert

University of Massachusetts Boston, Boston, Massachusetts

Fabián Torres-Ardila

University of Massachusetts, Boston, Massachusetts

Ana Solano-Campos

University of Massachusetts Boston, Boston, Massachusetts

A Unified Framework of Teachers' Conceptions of Learning and Assessment

The National Research Council's (2001) report, "Knowing what students know," called for assessments to be explicitly connected to models of student learning. Notably, this call is not just for large-scale assessments designed by psychometricians, but also for classroom assessments designed by teachers. This means that teachers' conceptions of learning and assessment should be understood in relation to each other. However, while there has been considerable research into teachers' conceptions of learning and assessment individually, there is no research that explores the connection between the two. In this presentation, we address this gap by exploring the question, "how do math teachers conceive of learning and assessment?" We present our results in the form of a unified framework of teachers' conceptions of learning and assessment.

Raymond Johnson

University of Colorado Boulder, Boulder, Colorado

Derek Briggs

University of Colorado, Boulder, Colorado

Frederick Peck

Freudenthal Institute US, Boulder, Colorado

Jessica Alzen

University of Colorado, Boulder, Colorado

3018

87

Interactive Paper Session**President: Kathryn B. Chval**

chvalkb@missouri.edu

*University of Missouri-Columbia, Columbia, Missouri***Influence of Proportional Relationships on Item Accessibility and Student Strategies**

Our research investigates the influence of task characteristics on (a) item accessibility (using Rasch modeling) and (b) student strategies with a focus on informing the construction of a trajectory of students' initial development of fluent and flexible use of the scalar and functional relationships in proportional reasoning situations.

Michele Brown Carney*Boise State University, Boise, Idaho***Gwyneth Hughes***Boise State University, Boise, Idaho***Jonathan L Brendefur***Boise State University, Boise, Idaho***Everett V. Smith***University of Illinois - Chicago, Chicago, Illinois***What Does Perseverance in Problem Solving Mean for Collaborative Learning?**

This presentation examines the conceptual and pedagogical implications of the Common Core's first practice standard (perseverance in problem solving) in the context of collaborative learning. Grounded in empirical examples of fifth-grade algebraic problem solving, the presentation explores the idea of encouraging and assessing "perseverance" as a collective capacity of students above and beyond individual effort.

Tesha Sengupta-Irving*University of California - Irvine, Irvine, California***Priyanka Agarwal***Student, Irvine, California***Situation Model Perspective on Mathematics Classroom Teaching: A Case Study on Inverse Relations**

From the perspective of a situation model, this study explores how two U.S. expert teachers facilitate connection-making when teaching an important early algebra topic, inverse relations between multiplication and division. Specifically, teachers' uses of instructional tasks, representations, and questions have been examined in terms of connection-making so as to form situation models to facilitate comprehension of this critical concept.

Ryan Hassler*Temple University, Philadelphia, Pennsylvania*

Additional author

Meixia Ding*Temple University, Philadelphia, Pennsylvania*

3020

88

Language and Mathematics Learning/Teaching: A Discussion**Research Symposium**

The session will use four studies addressing issues of language and mathematics learning/teaching to consider (a) directions for future research and (b) instructional resources for supporting students in developing academic literacy in mathematics. Four empirical studies will be presented to ground discussion of theoretical and methodological issues in the study of language and mathematics learning/teaching.

Judit N. Moschkovich

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*Univ. of California, Santa Cruz, Santa Cruz, California***Beth Herbel-Eisenmann***Michigan State University, East Lansing, Michigan***Carolyn A. Maher***Rutgers, New Brunswick, New Jersey***Elizabeth Uptegrove***Felician College, Lodi, New Jersey***Louise C. Wilkinson***Syracuse University, Syracuse, New York*

3002

89

Linking Research and Practice: Teachers and Researchers Talk**Discussion Session**

In this discussion session, a researcher and two teachers who formed a research collaborative for five years will engage participants in a discussion about the practices and artifacts from research that enable and motivate teachers to link their teaching practices with research. Discussants share how Classroom Based Design Research serves as a viable research methodology for engaging teachers in the summative and formative data analysis that informs instruction and provides rigorous results that can be shared beyond their classrooms.

Michelle Stephan

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*UNC Charlotte, Charlotte, North Carolina***George McManus***Seminole County Public Schools, Oviedo, Florida***Jennifer Smith***Seminole County Public Schools, Sanford, Florida*

3024

90

Mathematics Education Research, Policy, and the National Science Foundation

Invited

This session will discuss the role of mathematics education research in the development of fundamental knowledge about teaching and learning in mathematics. The discussion will also address programs at the National Science Foundation and their connections to problems of research, policy and practice in mathematics education including broadening participation in STEM disciplines.

Joan Ferrini-Mundy

National Science Foundation, Arlington, Virginia

Karen D. King

NSF, Arlington, Virginia

Margret Hjalmarsen

National Science Foundation, Arlington, Virginia

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91

New Research on Extending Multiplicative Relationships beyond Whole Numbers

Research Symposium

This symposium brings together three current NSF-funded projects that use constructivist perspectives to investigate extensions of multiplicative reasoning beyond whole numbers. The projects differ in the variants of constructivist perspectives they use, the populations they study, and the mathematical topics they choose. The perspectives include variants of radical constructivism and knowledge-in-pieces. The populations include elementary students, middle grades students, and preservice teachers. The topics include fraction multiplication, multiplicative relationships between quantitative unknowns, and proportional relationships between co-varying quantities. Comparing insights across projects will advance and broaden our understanding of what might be involved in teaching and learning core upper elementary and middle grades content in ways that take into account how learners' prior knowledge both supports and constrains extensions of multiplicative reasoning beyond whole numbers.

Andrew Izsák

University of Georgia, Athens, Georgia

Sybilla Beckmann

University of Georgia, Athens, Georgia

Amy J. Hackenberg

Indiana University-Bloomington, Bloomington, Indiana

Martin Simon

New York University, New York, New York

Discussant: Anderson Norton

Virginia Tech, Blacksburg, Virginia

3011

92

Structuring Two- and Three-Dimensional Space: A Focus on Representations

Research Symposium

In this session we will discuss four related studies focused on students' understanding of structuring two- and three-dimensional space. In these four sessions we will address two main questions. First, in what ways do the different aspects of volume measurement including filling, packing, building, and comparing, affect students' strategy use and conceptual understanding? Second, in what ways does instruction focused on structuring units affect students' understanding and skills in area and volume measurement and area estimation tasks? Participants will be engaged in discussion about the different aspects of volume as well as the role representations can play in students' perception of area and volume measurement.

Craig J. Cullen

Illinois State University, Normal, Illinois

Douglas W. Van Dine

University of Denver, Denver, Colorado

Jeffrey E. Barrett

Illinois State University, Normal, Illinois

Douglas H. Clements

University of Denver, Denver, Colorado

Theodore J. Rupnow

Illinois State University, Normal, Illinois

Discussant: Julie Sarama

University of Denver, Denver, Colorado

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93

Supporting Students' Mathematical Reasoning with Digital Tools

Research Symposium

While every publisher claims that their "digitally enhanced curricula" will improve students' learning, most such digital enhancements are drill and practice, videos of traditional lectures, or digital incarnations of pre-digital mathematical experiences. In contrast, what we call Deeply-Digital Representational Technologies (DDRTs) can uniquely change students' experiences in learning mathematics. DDRTs allow students to engage with mathematical representations that can only be expressed in digital technology, allowing them to develop new mathematical models, and expand their ability to express their mathematical reasoning. This session will describe three approaches to DDRTs: Each presentation will describe and demonstrate a particular approach, and by addressing a set of common questions, audience members will learn about commonalities and differences in the ways DDRTs can be used in classrooms.

Andee Rubin

TERC, Cambridge, Massachusetts

Phil J. Vahey

SRI International, Menlo Park, California

Nicholas Jackiw

SRI International, Vancouver, Canada

3022

94

Using Mobile Technology to Promote K–2 Mathematical Reasoning and Discourse

Research Symposium

A research-practice collaboration is studying how interactive mobile technology may promote mathematical reasoning and discourse in K–grade 2. Collaborators will discuss a strategy where students use iPads to record, review, and share mathematical explanations and how it can support mathematics learning and teaching in elementary classrooms.

Josephine Louie

Education Development Center, Waltham, Massachusetts

Pam Buffington

Education Development Center, Waltham, Massachusetts

Kelly McCormick

University of Southern Maine, Gorham, Maine

Patricia Moyer-Packenham

Utah State University, Logan, Utah

3007

95

When the Numbers Are There, But the Representation Doesn't Work

Discussion Session

In this session we will observe elementary students using self-generated representations to reason about computational patterns that are governed by the behavior of the arithmetic operations. Together we will examine and discuss what can be learned about students' developing operation sense by looking at their representations. In particular, we will consider how the salience of number and lack of attention to the arithmetic operations can short circuit student reasoning. Questions that bring the action of the operations into focus can help students align their representational, symbolic, and verbal descriptions and support the development of mathematical argument.

Traci Higgins

TERC, Cambridge, Massachusetts

Susan Jo Russell

TERC, Cambridge, Massachusetts

Deborah Schifter

EDC, Northampton, Massachusetts

Virginia Bastable

Mount Holyoke College, South Hadley, MA 01075, Massachusetts

3010

96

A CROSS-Institutional Effort to Develop Teacher Understanding about Statistical Investigations

Poster Session

This study investigates the development of teachers' understanding about statistical investigations as a result of a graduate course on teaching and learning statistics across two institutions. Using the

Guidelines of Assessment and Instruction of Statistics Education (GAISE) framework, we examined teachers' report as they use technological tools to examine two sets of data on the pre and post. Preliminary results show that teachers improved their understanding about four components of a statistical investigation—formulate questions, collect data, analyze data, and interpret results.

Kemal Akoglu

NC State University, Raleigh, North Carolina

Dung Tran

NC State University, Raleigh, North Carolina

Third Level Prefunction

97

Analyzing Development of Norms Conducive to Productive Discourse

Poster Session

By employing an in-depth case study of a fifth-grade classroom, this study investigates: (1) What social and sociomathematical norms are associated with mathematically productive discourse? (2) What strategies can a teacher use to establish these norms in their classroom?

Peter Klosterman

Washington State University, Pullman, Washington

Third Level Prefunction

99

Assessing Secondary Teachers' Algebraic Habits of Mind

Poster Session

We define mathematical habits of mind (MHoM) as the ways of thinking about mathematical concepts that resemble those employed by mathematicians. This poster shares an observation framework for examining use of MHoM in secondary classrooms, and a paper and pencil assessment that measures how secondary teachers engage MHoM when doing mathematics.

Sarah E. Sword

Education Development Center, Inc., Waltham, Massachusetts

Ryota Matsuura

St. Olaf College, Northfield, Minnesota

Miriam Gates

Education Development Center, Inc., Waltham, Massachusetts

Al Cuoco

Education Development Center, Inc., Waltham, Massachusetts

Glenn Stevens

Boston University, Boston, Massachusetts

Third Level Prefunction

101

Children's Mathematics Experiences, with Significant Others, Prior to School**Poster Session**

This study investigated the types of activities parents view as contexts for preschool children's mathematics learning, as well as the differences and similarities in the activities within and across families. Parent-child dyads from six middle-class families were videotaped at home over two years as they participated in everyday events of their choosing (e.g., baking cookies, reading a story book) that the mothers believed involved mathematics learning. The results indicated that these mothers, predominately chose to videotape different types of play (29 activities) or everyday at-home events such as baking (15 activities). A limited number (11) of the activities involved commercially produced mathematics materials. Four families focused mainly on geometry concepts, one family engaged equally with geometry and number, while only one family focused primarily on number concepts. Implications of these young children's mathematics experiences prior to school are discussed.

Ann Anderson*University of British Columbia, Vancouver, Canada***Jim Anderson***University of British Columbia, Vancouver, Canada*

Third Level Prefunction

102

Communicating about Fractions: Comparing the Use of Technology vs. Traditional Writing**Poster Session**

This presentation reports on the development and implementation of an evidence-based intervention to increase students' reasoning strategies and ability to communicate about fraction size and equivalence in two environments. While overall findings reveal that all students' reasoning improved, those in the technology group provided more complete reasoning than those in the paper/pencil group.

Sarah Quebec Fuentes*s.quebec.fuentes@tcu.edu**Texas Christian University, Fort Worth, Texas***Lindy Crawford***Texas Christian University, Fort Worth, Texas***Jacqueline Huscroft-D'Angelo***Texas Christian University, Fort Worth, Texas*

Third Level Prefunction

105

Developing Preservice Teachers' Constructs of Problem Solving**Poster Session**

Preservice elementary and middle level teachers participated in project requiring them to work on a nonroutine problem over a period of several days, and reflected on their experiences. A qualitative analysis of data shows that participants began to revise their beliefs about what it

means to do mathematics, and to value persistence in problem solving.

Mary Pat Sjostrom*mpshoemath@gmail.com**Winthrop University, Rock Hill, South Carolina***Cory A. Bennett***Idaho State University, Pocatello, Idaho*

Third Level Prefunction

106

"Mistakes = Information": Norms for Discussion of Mathematical Errors**Poster Session**

Part of the findings from a yearlong case study of a fifth-grade classroom, specific classroom social and sociomathematical norms are illustrated. The classroom expectations we discuss relate to students learning from errors as part of the "productive struggle" of learning mathematics. Implications for teachers and researchers are considered.

Nicole Leveille Buchanan*UC Berkeley, Berkeley, California***Alyssa Fyson***UC Berkeley, Berkeley, California***Esther Hessong***UC Berkeley, Berkeley, California*

Third Level Prefunction

107

Developing Representational Ability with Fractions: A Textbook Analysis**Poster Session**

This study investigated the degree to which lessons on fraction equivalence and fraction comparison in Common Core-aligned textbooks are anchored in principles of instruction that are empirically validated to increase student achievement. Specifically, we examined the frequency of various representations, whether or not the textbooks provide explicit instruction about representations, the ways in which students are required to use various representations, and the number of opportunities for instruction and practice with these representations.

Nicole Hansen*Fairleigh Dickinson University, Teaneck, New Jersey***Jessica Carrique***University of Delaware, Newark, Delaware*

Third Level Prefunction

108

Developing Teachers' Professional Noticing with Technology**Poster Session**

While the importance of instruction that builds on student thinking and understanding has been advocated by both research (Fennema, et al. 1996) and policy documents (NCTM 2000), this type of instruction is often challenging for teachers to design and enact (Sherin 2002). Building on the teacher “noticing” research (Sherin, Jacobs, and Philipp 2011), we explore 24 mathematics teachers’ participation in a design-based research project. We report on the initial development of an online assessment and feedback environment and explore the question: What are the characteristics of an online assessment and feedback environment that effectively scaffolds teachers’ attention to student thinking and implementation of formative assessment?

Jason Silverman

Drexel University School of Education, Philadelphia, Pennsylvania

Valerie Klein

Drexel University School of Education, Philadelphia, Pennsylvania

Third Level Prefunction

109

Enactment of CCSSM: Curriculum, Professional Development, and Teaching**Poster Session**

This study investigates the enactment of CCSSM, and analyzed the curriculum, teaching, assessment, and teacher professional development as the key components of the enactment process. The extent to which the curricula and teaching adhere to CCSSM, and the influence of professional development and teachers’ curriculum choices on their enactment of CCSSM are examined. The relations between low or high enactments of CCSSM, aligned or not aligned curriculum resources, and professional developments are described.

Ozgul Kartal

St Xavier University, Chicago, Illinois

Judith S. Lederman

Illinois Institute of Technology, Chicago, Illinois

Third Level Prefunction

110

English Learners' Participation in Mathematical Discourse**Poster Session**

Due to the increasing diversity of mathematics classrooms, teachers need guidance on how to support English learners (ELs) in mathematics classes in a way that situates language learning within mathematical activity. Unfortunately, neither mathematics education research nor EL education research is sure how to navigate the complexity of teaching ELs mathematics while supporting both their language development and their mathematical development through their participation in mathematical activity. This study examined ELs’ participation in mathematical Discourse, investigating how ELs used non-English language (NEL) symbol systems to support spoken English. I developed

the Replace Augment Learn (RAL) framework to describe how ELs used NEL symbol systems to make up for decreased English literacy. Findings show how ELs with basic conversational English can use literacy with a variety of symbol systems to participate meaningfully in mathematical discourse.

Lindsay Merrill

Brigham Young University, Provo, Utah

Third Level Prefunction

111

Evaluating Children's Spatial Ability: Teacher Versus Test**Poster Session**

In this research, we examined the relationship between a teacher’s judgment of grade three and four students’ geometry and spatial ability (i.e., grades), three spatial ability tasks (Water-Level-Task, the Rod-and-Frame Test and the Mental-Rotations-Test), and composite spatial ability score. Results suggest that teachers’ assessment practices may not be yielding sufficient insight into students’ spatial ability.

Samantha Makosz

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Wilfrid Laurier University, Waterloo, Canada

Donna Kotsopoulos

Wilfrid Laurier University, Waterloo, Canada

Joanna Zambrzycka

OISE/UT, Toronto, Canada

Michelle Cordy

Thames Valley District School Board, London, Canada

Third Level Prefunction

112

Examination Teaching Efficacy and Mathematics Instruction in Virtual Classroom Environment**Poster Session**

We examined the relationship between preservice teachers’ mathematics instruction (MI) performance (which was comprised of 21 indicators) and their teaching self-efficacy beliefs. Correlations were calculated between each of the 21 mathematics instruction indicators and the two MTEBI subscales. It was found that there were no statistically significant relationships between the 21 MI indicators and the PMTE and MTOE subscales. There were several statistically significant relationships across the 21 MI indicators (7 items).

Trina Davis

Texas A&M University, College Station, Texas

Tugba Oner

Texas A&M University, College Station, Texas

Third Level Prefunction

113

Examining Multiple Perspectives on Effective, Problem-Centered Mathematics Lessons

Poster Session

This study explored multiple perspectives on effective, problem-centered mathematics lessons by examining and comparing what different analytic frameworks make salient about the moves that accomplished teachers make to capitalize on student thinking.

Kwame Yankson

University of Michigan, Ann Arbor, Michigan

Edward A Silver

University of Michigan, Ann Arbor, Michigan

Third Level Prefunction

114

Examining Teachers' Learning as They Use Learning Maps to Study Mathematics

Poster Session

The present study examined teachers' reflections of their professional learning in response to using learning maps to unpack mathematics content standards. Journal entries were analyzed to identify and describe teachers' perceptions of their mathematical knowledge in terms of content knowledge, pedagogical knowledge, and instructional practices.

Angela Broaddus

broaddus@ku.edu

University of Kansas, Lawrence, Kansas

Third Level Prefunction

115

Examining the Effects of a Dynamic Geometry Task Analysis Framework

Poster Session

This study examines teacher use of a framework for analyzing and writing tasks in dynamic geometry software environments. Case studies of six teachers reveal the potential for this framework to refine notions of quality regarding written tasks and student technology use.

Aaron Trocki

Elon University, Elon, North Carolina

Third Level Prefunction

116

Exploration of an Innovative Tool to Capture Preservice Teacher Noticing

Poster Session

In this poster session mathematics teacher educators report promises and limitations of using video recording glasses as a tool to capture preservice teacher noticing. Discussion will focus on specifics of PST

noticing and implications to support the learning of future teachers with the implementation of this methodology.

Anne Estapa

Iowa State University, Ames, Iowa

Third Level Prefunction

118

Gaze Analysis of Fraction Comparison Strategies

Poster Session

Gaze patterns can reveal different task strategies, which have been shown to predict performance on analogical reasoning tasks. In this experiment, we apply gaze analysis methods to a fraction comparison task designed to elicit alternate strategies (and thus differing gaze patterns) in different conditions. Preliminary analyses show that gaze patterns indicating conversion to equivalent fractions is both the most prevalent and the most accurate strategy, over benchmarking by magnitude. Cross-multiplication is most effective in the most difficult condition. We also explore the costs and benefits of consistently using a particular strategy versus flexibly switching strategies according to the specific fraction pairs presented.

Alison T. Miller Singley

UC Berkeley, Berkeley, California

Third Level Prefunction

119

How Do Teacher Journals Integrate Mathematics with Other Subjects?

Poster Session

We analyzed 136 articles presenting “subject integration” activities and research from 10 years of three peer-reviewed journals written for practicing elementary teachers: *Teaching Children Mathematics*, *Science and Children*, and *Social Studies and the Young Learner*. We relate our findings to analytic frameworks for mathematical content and processes, cognitive demands of tasks, and approaches to curricular integration. We consider the implications of findings for recent calls for curricular integration, such as common rhetoric about STEM education.

Andrea McCloskey

Penn State University, University Park, Pennsylvania

Third Level Prefunction

120

Identifying Challenges and Resources for ELLs Reasoning about Linear Functions

Poster Session

English learners face both linguistic and mathematical challenges and bring resources for learning new mathematical concepts. We incorporate research on ELs in mathematics to construct a modified hypothetical learning trajectory (Simon 1995) in the area of linear functions that accounts for both content learning objectives and the linguistic/discourse demands of school mathematics.

William Zahner

San Diego State University, San Diego, California

Lynda Wynn

San Diego State University, San Diego, CA, California

Third Level Prefunction

122

Lesson Plan to Animation: Preservice Teachers' Approximations through Lesson Plan-imation

Poster Session

The purpose of this session is to share research on preservice teachers' visions for enacting a lesson plan in a simulated elementary classroom through the flexibility and structure of an online animation platform. The focus is on how preservice teachers describe differences between mathematics lesson plans and visualizations of those plans, along with their rationale.

Julie Amador

University of Idaho, Coeur d'Alene, Idaho

Darrell Earnest

University of Massachusetts Amherst, Amherst, Massachusetts

Third Level Prefunction

123

Leveraging Mathematics Common Planning Time for Effective Instruction

Poster Session

This poster describes a research-practice partnership project intending to grow and strengthen the partnership between a state university and a local public school district. University faculty alongside teachers and coaches aim to reconceptualize the approach to common planning time (CPT) by analyzing ways CPT currently helps or hinders teachers' ability to attend to students' mathematical thinking. By increasing teacher collaboration and a focus on mathematics and the curriculum during CPT meetings, we hypothesize teachers will learn to tailor lessons to students' mathematical thinking, develop models for mathematical concepts, and consider the important developments related to CCSSM.

Eileen Murray

Montclair State University, Montclair, New Jersey

Dorothy Y. White

University of Georgia, Athens, Georgia

Erin Krupa

Montclair State University, Montclair, New Jersey

Tanya Maloney

Montclair State University, Montclair, New Jersey

Third Level Prefunction

124

Making Sense of Mathematics Sensemaking: Examining Co-Constructed Learning Environments

Poster Session

How do students negotiate moving from a receptive transmission-based instructional model to one based on productive sensemaking and discussion? How do teachers and students co-construct the norms and culture of an effective mathematics classroom? Let's discuss!

Jennifer L. Ruef

Stanford University, Palo Alto, California

Third Level Prefunction

126

Nos/otr@s Relationships in Secondary Mathematics Classrooms

Poster Session

Addressing the concern of teaching mathematics effectively, this study shows how three beginning secondary mathematics teachers approach nos/otr@s relationships with marginalized students. All express the importance of positive relationships with students and yet they share challenges that they experienced. Implications for teaching mathematics equitably are discussed.

Juan M. Gerardo

University of Illinois at Urbana-Champaign, Champaign, Illinois

Rochelle Gutiérrez

University of Illinois at Urbana-Champaign, Champaign, Illinois

Gabriela E. Vargas

University of Illinois at Urbana-Champaign, Champaign, Illinois

Third Level Prefunction

131

Promoting Situational Understanding or Word Problems through Reflection on Drawings

Poster Session

This study addresses the phase of textual understanding of a word problem by analyzing the drawings made by high school students after reading a verbal math problem that has arisen in some textbooks. Through a psycholinguistic perspective, we analyzed and classified ninety drawings of third graders of high school. The results obtained allowed us to propose a working method for reflection, analysis, and discussion of student productions in order to promote their situational comprehension on these problems.

José Antonio Juárez López

Benemérita Universidad Autónoma de Puebla, Puebla, Mexico

Third Level Prefunction

133

Relationship between Students' Attitude and Reasoning via TIMSS 2011

Poster Session

In this study, we investigated how students' attitude toward mathematics is related to mathematical reasoning skills through the TIMSS 2011 in comparing the differences between the U.S. and Finland. We use three TIMSS variables to observe students' attitude toward mathematics: liking mathematics, valuing mathematics, and confidence in mathematics. We applied a multistep linear regression model including interactions of the attitude variables and a mathematics reasoning score. As a result, we found that confidence in mathematics had positive relationships with mathematics reasoning at any levels of other attitude variables in both countries while liking mathematics and valuing mathematics showed significant interactions with other attitude variables. Generally, Finland showed stronger relationships than the U.S. The findings suggested mathematics educators and policymakers not to imitate others' education systems with regard to the complex relationships between attitude and reasoning.

Jihyun Hwang

University of Iowa, Iowa City, Iowa

Cristina Runnalls

University of Iowa, Iowa City, Iowa

Sneha Bhansali

University of Iowa, Iowa City, Iowa

Kyong Mi Choi

University of Iowa, Iowa City, Iowa

Third Level Prefunction

134

Robotics, Computational Thinking, and Mathematics Achievement

Poster Session

This research report examines learning among 45 fifth, sixth, and seventh graders during Year 2 of a study on afterschool robotics clubs.

The time in this session will be used to present the context of the study and findings, as well as allow the audience to ask questions and offer suggestions for data capture in Year 3.

Jacqueline Leonard

University of Wyoming, Laramie, Wyoming

LaVarr Dixon

School District Philadelphia, Philadelphia, Pennsylvania

Monica B. Mitchell, Ed.D.

MERAssociates, Vienna, Virginia

Farhad Jafari

University of Wyoming, Laramie, Wyoming

Third Level Prefunction

135

Secondary In-Service Teachers Professional Noticing

Poster Session

In this poster session we present quantitative results about the nature of in-service teachers' professional noticing of students' mathematical thinking. In particular, we provide evidence that this expertise requires support from math teacher educators, and discuss possible ways for supporting such development.

Raymond Laroche

SDSU Research Foundation, San Diego, California

Susan Nickerson

San Diego State University, San Diego, California

Lisa L. Lamb

San Diego State University, San Diego, California

Casey Hawthorne

San Diego State University, San Diego, California

Third Level Prefunction

136

Secondary School Responsive Teaching: Noticing Students' Algebraic Generalizations

Poster Session

While a growing amount of research is devoted to exploring teachers' practice as they engage in responsive teaching at the elementary school level, less is known about the secondary school level. One particular challenge at the secondary school level is that well-developed learning trajectories of student thinking are uncommon. This study investigates two teachers who, after receiving extensive professional training, both create classroom environments where students' conceptions serve as a focus of their instruction and who are both able to attend to and interpret the details of student thinking. Notwithstanding these similarities, subtle differences in their classroom instruction result in major differences in outcomes. This session reports on these differences and highlights the important role learning trajectories play in responsive teaching and the professional noticing of students' mathematical thinking.

Casey Hawthorne

San Diego State University, San Diego, California

Third Level Prefunction

138

Teddy Bear Pre-K Math Assessment: Validation of a Game-Based Measure

Poster Session

This research evaluated an interactive, story- and game-based measure of preschool mathematical development. The hypothesis was that 9 measurable variables—quantification, counting, set comparison, numerals, number line, positional terms, shapes, addition/subtraction, and patterning—would make a significant contribution to the latent construct of mathematical development. CFA indicated good model fit: $\chi^2(24, N=118)=24.283$, $p=.446$; $NFI=.968$; $CFI=1.000$; and $RMSEA=.010$. All standardized path coefficients demonstrated both statistical and practical significance: regression weights ranged from .562 to .894. The results indicate that the measurement tool is a valid and reliable measure of mathematical development for this sample. Conferees will be able to view a child's assessment via laptop and discuss the developmental trajectories and statistical validation, as presented on the poster, with the researcher.

Sally Moomaw

University of Cincinnati, Cincinnati, Ohio

Third Level Prefunction

139

The Early Concept of Angle: Definition, Development, and Cognitively Diagnostic Assessment

Poster Session

The study investigates the early concept of angle—the angle-related knowledge, skills, and understandings appropriate and relevant for students in grades 3 through 5—in terms of cognitive attributes that underlie students' performance on angle-related mathematical tasks, identifies the leaning path(s) of the concept development, and creates a cognitively-diagnostic assessment of the concept.

Elvira Khasanova

LA Pierce College, Woodland Hills, California

Third Level Prefunction

140

The Mathematics of Cryptography and Cybersecurity

Poster Session

The purpose of this research is to determine the best pedagogical methods for introducing students to cryptography, key elements of cybersecurity, how cryptography is used to secure cyberspace, and the mathematics that supports modern cryptographic systems. The hypothesis is that early exposure to well-formed and engaging activities will increase the number of students entering higher education programs in cryptography and cybersecurity and later, the workforce as cybersecurity professionals. The importance of research such as this cannot be understated as increasing the size of the qualified and competent cybersecurity workforce has become a national priority. A mathematics-based unit to engage students was implemented. Data on student interest in cybersecurity and the mathematics involved

was collected and analyzed. Students used the Engineering Design Process to refine cryptographic protocols for sending messages that are encrypted, unmodified in transit, and authenticated.

Amanda M. Sopko

Indian Hill Middle School, Cincinnati, Ohio

Third Level Prefunction

141

The Reliability and Validity of a Mathematical Modeling Knowledge Scale

Poster Session

This study explored efforts to design and empirically measure teachers' content knowledge about the nature of mathematical modeling. The author describes the items developed and discusses results from item analysis, reliability, and factor analysis. The construct was unidimensional, which indicated psychometrically acceptable scale for measuring teachers' content knowledge about the nature of mathematical modeling.

Reuben S. Asempapa

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Ohio University, Athens, Ohio

Third Level Prefunction

142

Understanding Changes in Novice Teachers' Social Networks

Poster Session

In this study we investigated novice teachers' instructional advice networks. We were interested in whom novice teachers turn to for advice and how that changes over time. We found that there were significant changes to teachers' social networks including becoming smaller and more school-centric over time.

Anne Garrison Wilhelm

Southern Methodist University, Dallas, Texas

Dawn M. Woods

Southern Methodist University, Dallas, Texas

Third Level Prefunction

143

Using Email Alerts to Motivate Mathematics Students: Will They Listen?

Poster Session

While educators are constantly searching for better ways to teach, it is often the behavior of the student that is most in need of changing. Busy social lives and jobs occupy much of college students' time and frequently academics suffer. Students often fall behind in classes without ever realizing it and are never able to catch up. This study examines the effects on student performance of email alerts sent to students who have fallen behind in their mathematics coursework, and whether they read the emails at all.

Brian S. Rickard

University of Arkansas, Fayetteville, Arkansas

Third Level Prefunction

144

Analyzing Classroom Interactions by Coordinating Status and Positioning Theories

Discussion Session

This paper seeks to investigate classroom interactions through the coordination of Status and Positioning Theories. I show that coordinating these theories in a mathematics classroom relates students' moment-to-moment discursive acts to their resulting classroom positions. I first describe how, on its own, Status Theory offers a way of understanding how valued status characteristics lead to generalized expectations for competence and an individual's status. I then describe how Positioning Theory offers an in-depth look at the relationship between moment-to-moment discursive acts and an individual's resulting position. I argue that by coordinating these two theories, discursive positioning moves mediate the development of expectations for individuals' competence, over time. Participants will engage in transcript analysis.

Teresa K. Dunleavy

Vanderbilt University, Nashville, Tennessee

3011

145

Analyzing Mathematics Teacher Learning Using Frame Alignment Processes

Discussion Session

We describe a cross-university research collaboration project aimed at understanding how mathematics teachers become inducted into the profession in a positive way. Preliminary analyses suggest that teacher learning is productively linked to a teacher's frame alignment processes over time. We will explain this linkage through cases from our data that compare an individual teacher's interpretive orientation with NCTM's vision for teaching and learning mathematics. Participants will examine multiple excerpts from our data and help us think about how to move our ideas forward in ways that are productive, novel, and helpful to a broad audience.

Nicole A. Bannister

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Clemson University, Clemson, South Carolina

Fran Arbaugh

The Pennsylvania State University, University Park, Pennsylvania

3010

146

A Report from the 2015 SIP Conference on Mathematics Methods

Discussion Session

We will highlight discussions from the Scholarly Inquiry and Practices (SIP) Conference on Mathematics Methods Education, a NSF-funded conference held in fall 2015, and engage attendees at this session in further exploration of the issues present in mathematics methods courses at all grade levels. Keynote speakers will share their perspective on conference discussions (Rochelle Gutiérrez – social/political, Martin Simon – cognitive, and Elham Kazemi (or her colleague who also attended the SIP conference) – situated) to orient discussion among the attendees.

Wendy B. Sanchez

wsanchez@kennesaw.edu

Kennesaw State University, Kennesaw, Georgia

Signe Kastberg

Purdue University, West Lafayette, Indiana

Andrew Tyminski

Clemson University, Clemson, South Carolina

Alyson E. Lischka

Middle Tennessee State University, Murfreesboro, Tennessee

Rochelle Gutiérrez

University of Illinois at Urbana-Champaign, Champaign, Illinois

Martin Simon

New York University, New York, New York

Elham Kazemi

University of Washington, Seattle, Washington

3007

147

Examining the Impact of Elementary Mathematics Specialists and Coaches

Research Symposium

We present and discuss three studies that examine the role and impact of elementary mathematics specialists and coaches as key strategies for supporting teachers and increasing students' mathematical learning.

James E. Tarr

University of Missouri, Columbia, Missouri

Corey Webel

University of Missouri, Columbia, Missouri

Kim A. Markworth

Western Washington University, Bellingham, Washington

Lynsey Gibbons

University of Washington, Seattle, Washington

Discussant: Patricia F. Campbell

University of Maryland, College Park, Maryland

3022

148

Expanding Horizons in K–3 Geometry and Spatial Thinking: The Implementation and Results of a New Curriculum and PD Model

Invited

Geometry is inherently spatial; an historical pillar of mathematics that involves perceiving, visualizing, manipulating, and reasoning about spatial relationships. And yet, geometry and spatial thinking are neglected focal points of early mathematics instruction (Clements and Sarama 2011; Davis and the Spatial Reasoning Study Group 2015). This neglect occurs despite large-scale efforts by NCTM and NRC to promote the foundational importance of geometry and spatial instruction throughout K–12 education. In this session, we report on a two-year study that engaged both teachers and their students in an experimental approach to early years geometry and spatial instruction. We share results that demonstrate the powerful effects of attending to and supporting young children’s geometrical and spatial thinking throughout the school year. Not only did the teacher-led intervention support children’s geometric and spatial thinking, but it appeared to support basic number skills as well. In addition to sharing the effects of the intervention, we also highlight our unique teacher-researcher Professional Development (PD) model, theorizing about the critical mechanisms believed to drive both teacher and student change. A recurring theme throughout the presentation will be a discussion on the reconceptualization of early geometry instruction from a spatial lens. In short, we will look to shift the current focus of early geometry from its current static approach (e.g., labeling and sorting shapes) to one that is dynamic, spatial, and imaginative.

Joan Moss

University of Toronto, Toronto, Canada

Zachary Hawes

university of Toronto, toronto, Canada

3006

149

Focusing Flipped Classroom Research on Enacted Teaching Practices

Discussion Session

Interest in and support for the flipped classroom is strong and growing. In this discussion session, we will identify the distinctive (and sometimes contentious) features of the flipped classroom, discuss the dynamic role that technology can play in the flipped classroom, and propose a way to focus flipped classroom research on enacted teaching practices. Participants will formulate their own types of flipped classrooms based on the *Principles to Actions* teaching practices. Come ready to formulate and share research questions of interest in response to the presentation.

Jeremy F. Strayer

jeremy.strayer@mtsu.edu

Middle Tennessee State University, Murfreesboro, Tennessee

Theodore Hodgson

Northern Kentucky University, Highland Heights, Kentucky

Lucy Watson

Middle Tennessee State University, Murfreesboro, Tennessee

3016

150

From the Bronx to the Bay: Contextualizing Mathematics Curriculum

Discussion Session

This session will present the concept of contextualization in developmental mathematics (in community colleges) and engage participants in a discussion of how we define “real-life” mathematics, how we can create curricula with contexts that are meaningful to students, and the possibilities for universal curricula for students in different cultural and geographical contexts. The goals are to advance our collective understanding of how to select meaningful curricular contexts, to propose design principles for such curricula, and to propose a research agenda for investigating student learning through these curricula.

AJ Stachelek

Hostos Community College, Bronx, New York

Mara Landers

Los Medanos College, Pittsburg, California

3002

151

Investigating Mathematical Learning and Racial Identity with Middle Grades Students

Discussion Session

This session presents data from an empirical study on mathematical learning and racial identity, illuminates major implications this combined focus could have on the redistribution of power in mathematics education in moving toward a more equitable and less White dominant narrative, and engages participants in this discourse.

Erik S. Tillema

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IUPUI, Indianapolis, Indiana

Andrew Gatzka

Indiana University, IUPUI, Indianapolis, Indiana

3004

152

Interactive Paper Session**President: Marta Civil***University of North Carolina at Chapel Hill, Chapel Hill, North Carolina***Preparedness of Preservice Secondary Mathematics Teachers' to Teach Statistics**

This session presents the results of a cross-institutional study regarding preparedness of preservice secondary mathematics teachers to teach statistics. To examine preparedness, statistical knowledge was measured using the Levels of Conceptual Understanding of Statistics (LOCUS) assessment and statistics teaching efficacy was measured using the Self-Efficacy for Teaching Statistics (SETS) instrument.

Jennifer Nickell Lovett*NC State University, Raleigh, North Carolina***Development of Teacher Candidates Mathematical Knowledge for Teaching (MKT) in a Preservice Setting**

We used the Professional Noticing Framework as an analytic tool to examine and understand their developing Mathematical Knowledge for Teaching of preservice teacher candidates.

Michael S. Meagher*Brooklyn College - CUNY, Brooklyn, New York***Michael Todd Edwards***Miami University of Ohio, Oxford, Ohio***Hea-Jin Lee***The Ohio State University, Lima, Ohio***Asli Ozgun Koca***Wayne State University, Detroit, Michigan***Improving Preservice Teachers' Mathematics Teaching: An Innovative Affect-Based Reflection**

This proposal outlines a successful innovation in reflective practice within a multi-university project conducted across regional eastern Australia. The reflection forms part of an iterated sequence of enhancement-lesson-reflection (ELR) and the innovation is built around a protocol based on affect-based critical moments in teaching. These moments are related to positive or negative emotions experienced during teaching, which the PSTs select and examine, with peers and experts, in the reflection sessions.

Geoff Woolcott*Southern Cross University, Lismore, Australia*

153

Interactive Paper Session**President: Michelle Stephan***UNC Charlotte, Charlotte, North Carolina***Mathematical Dispositions at an Art Crating Company**

This paper describes the mathematical dispositions of workers at an art crating company. Participants described themselves as failures in school mathematics, but engaged in sophisticated spatial reasoning at work designing and building custom crates for art objects. We outline three dispositions tied to the mathematical practices of measurement and representation at the art crating company.

Jasmine Y. Ma*New York University, New York, New York***Sarah C Radke***New York University, New York, New York***The Intertwinement of Activity and Artifacts in Realistic Mathematics Education**

Realistic mathematics education (RME) is guided by the notion that mathematics is the human activity of mathematizing the world. In much of the RME literature, mathematizing is theorized to be an individual activity. In this paper I extend these ideas and discuss how mathematizing is mediated by, and distributed across, cultural artifacts. Such a cultural perspective on RME is a necessary consequence of RME's first principles, and has implications many of RME's key principles. Exploring these implications is the next frontier in RME research

Frederick Peck*Freudenthal Institute US, Boulder, Colorado***Understanding Parent Expectations of Mathematics Learning**

Parent criticism of curriculum reform is often described as a key obstacle to change, but their involvement is essential for student learning. Understanding parent perceptions of the differences between their own learning and their children's learning illuminate their expectations and provide an important starting place for dialogue.

Lynn M. McGarvey*University of Alberta, Edmonton, Canada*

Additional author

Janelle McFeetors*University of Alberta, Edmonton, Canada*

3018

3020

154

Making Content Explicit: The Practice and Beginners' Skills

Discussion Session

The session focuses on the teaching practice of making content explicit as key to equitable access to and success with complex mathematics. We define what we mean by this practice, distinguishing it clearly from direct instruction and showing how it can be done in ways that do not do the mathematics for the students. We offer a decomposition of the practice into specific elements that can be taught to novice teachers. Additionally, we share a tool for assessing beginners' progress with this practice. Drawing on data from a study using this tool, we report on patterns we found in beginning teachers' efforts to make content explicit, and consider what this might tell us about the challenges in learning this practice and implications for teacher preparation.

Meghan Shaughnessy

University of Michigan, Ann Arbor, Michigan

Nicole Garcia

University of Michigan, Ann Arbor, Michigan

Michaela Krug O'Neill

University of Michigan, Ann Arbor, Michigan

Sabrina Bobsin Salazar

University of Michigan, Ann Arbor, Michigan

Charles Wilkes

University of Michigan, Ann Arbor, Michigan

Amber Willis

University of Michigan, Ann Arbor, Michigan

Deborah Loewenberg Ball

University of Michigan, Ann Arbor, Michigan

3024

155

Persistence, Instruction, and Coordination in the National Study of Calculus

Research Symposium

This research symposium examines three aspects of successful Calculus I programs in the United States: persistence, instruction, and coordination. The presentations use data collected as part of the Mathematical Association of America's (MAA's) national study of Characteristics of Successful Programs in College Calculus (CSPCC). The work presented in the three papers in the symposium is informed by various theoretical frameworks from education, higher education, and instruction. The availability of different types of institutions also allow for investigations of the contexts in which these two features are enacted. In spite of the repeated calls for improving college Calculus I, it seems that very little progress has been made. Investigating the experience of students in college calculus is highly relevant to secondary educators to better understand experiences they are preparing their students for and how those relate to students' high school calculus experience.

Chris Rasmussen

San Diego State University, San Diego, California

Vilma Mesa

University of Michigan, Ann Arbor, Michigan

Helen Burn

Highline College, Seattle, Washington

Jesica Ellis

Colorado State University, Fort Collins, Colorado

Nina White

University of Michigan, Ann Arbor, Michigan

Discussant: Eric Hsu

San Francisco State University, San Francisco, California

3009

156

What Is STEM Education?

Invited

The integration of science, technology, engineering, and mathematics—the STEM disciplines—is growing in popularity across schools in the U.S. and around the world. But what do we really mean when we say it's "good" to integrate these disciplines? This session will explore what the research tells us, what we can learn from on-the-ground implementations, and what can we say about promising programs and practices.

Margaret Honey

NYSCL, Corona, New York

Linda Curtis-Bey

New York City Dept. of Educ., New York, New York

Janet Coffey

Gordon and Betty Moore Foundation, Palo Alto, California

3008

157

Writing MTE Manuscripts That Avoid Common Mistakes Aspiring Authors Make

Invited

In this workshop-style session, *Mathematics Teacher Educator (MTE)* Editorial Board Members will engage the audience in identifying, responding to, and avoiding common issues of unsuccessful submissions to *MTE*. Potential authors and reviewers will learn more about expectations for publishing in *MTE* and the variety of manuscript types that are appropriate.

Laura R. Van Zoest

Western Michigan University, Kalamazoo, Michigan

Sandra Crespo

Michigan State University, Ann Arbor, Michigan

Nadine Bezuk

San Diego State University, San Diego, California

David Barnes

NCTM, Reston, Virginia

3000

158

Plenary: How Research into Second-Language Learning Might Be Useful to Mathematics Educators

Plenary Sessions

I draw on longitudinal collaborations with practicing teachers to suggest that a shift in teaching practice can be analogous to learning a new language. Borrowing from research into second-language learning, I offer descriptions of three distinct types of speaker in the mathematics teaching communities with which I work: a few unilingual native speakers (Traditionalists), some fluently bilingual speakers (Reformers), and many speakers of a “mixed language” in which sensibilities are intermingled. While the emergence of mixed-language speakers generally signals significant cultural evolution, it can also be problematical because speakers can appear bilingual well before they understand the nuances of the new language. Consequently, necessary supports are sometimes withdrawn prematurely, before sensibilities are understood deeply enough to transform practice. Using the example of spatial reasoning, and drawing further on the literature of second-language learning, I speak to emerging foci for research, teacher education, professional development, and classroom resources.

Brent Davis

University of Calgary, Calgary, Canada

3001/3003/3005

159

Instructional Practices Related to Students' Conceptions of Mathematics

Brief Research Report

It is critically important that secondary students develop a conception of mathematics as sensible and connected. This study examines instruction practices related to the development of such a conception in beginning algebra students.

Maureen M. Grady

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East Carolina University, Greenville, North Carolina

3004

160

Instruction, Self-Efficacy, and Achievement in Grades 4–8 Mathematics

Brief Research Report

We will present preliminary results from a longitudinal investigation of $N = 2,000$ middle levels students' self-efficacy, perceptions of instruction, and subsequent performance in state mathematics assessments. Findings include estimated direct and indirect effects of mathematics self-efficacy and active learning practices on future mathematics achievement.

Joe Champion

Boise State University, Boise, Idaho

161

Investigating a Student's Reasoning with Ratios: The Case of Gabriel

Brief Research Report

The purpose of this session is to communicate about the role that distributive reasoning plays in the construction of ratio reasoning. The presenter will share findings from data with a middle school student and will seek participants' input about their efforts to talk about the difficulties in this specific area.

Fetiye Aydeniz

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Indiana University, Bloomington, Indiana

3009

162

Investigating Fifth-Grade Students' Conceptions of Fractions on the Number Line

Brief Research Report

In this study, clinical interviews focusing on students' understanding of fractions as numbers on the number line were conducted with six fifth-grade students both before and after an intervention designed by teacher-researchers. Although in general students demonstrated improved understanding of fraction concepts even in situations requiring reversible thinking, difficulties in finding benchmarks on the number line and a limited awareness of density of fractions on the number line persisted among students.

Rukiye Didem Taylan

MEF University, İstanbul, Turkey

Zelha Tunc-Pekkan

Yeditepe University, İstanbul, Turkey

Utkun Aydin

MEF University, İstanbul, Turkey

Bengi Birgili

MEF University, İstanbul, Turkey

Mustafa Ozcan

MEF University, İstanbul, Turkey

3010

163

Investigating Online Homework: How Do Teaching Practices Change?

Brief Research Report

When students do homework, an online tool such as ASSISTments can provide immediate feedback and can organize students' practice according to research-based principles. When homework is online, teachers can more easily monitor student work, use student work in their discussions, and see which problems presented challenges. Doing homework online can lead to adaptive pedagogies. We report on a large study involving 93 seventh-grade teachers from 47 middle schools in the state of Maine. The overarching questions examine the impact of ASSISTments on student learning. Herein we focus specifically on whether teachers' practices change when they use online homework and whether students benefit.

Janet Fairman

University of Maine, Orono, Maine

Mingyu Feng

SRI Education, Menlo Park, California

Jeremy Roschelle

SRI Education, Menlo Park, California

3007

164

Investigating Secondary Preservice Teachers' Noticing of Student Thinking

Brief Research Report

There is a need for research that examines how to support secondary teachers' abilities to notice student thinking. We describe the impact of a curricular module, centered around a task-based interview, on secondary preservice teachers' ability to attend to, interpret, and respond to student thinking.

Erin Krupa

Montclair State University, Montclair, New Jersey

Maryann Elizabeth Huey

Drake University, Des Moines, Iowa

Kristin Lesseig

Washington State University, Vancouver, Washington

Stephanie Casey

Eastern Michigan University, Ypsilanti, Michigan

Debra Monson

St. Thomas University, Minneapolis, Minnesota

3008

165

Linking Teacher Concerns and Professional Development with the CCSSM Implementation

Brief Research Report

The purpose of this mixed methods study was to investigate and understand the concerns of secondary mathematics teachers during the initial stages of implementing the Common Core State Standards of Mathematics and to determine if a relationship existed between the

concerns and professional development during the initial stages. The research was grounded in the theoretical framework of the Concerns Based Adoption Model focusing on the Stages of Concern. Data analysis methods encompassed quantitative, qualitative, and profile interpretation. Data gathered from this study is relevant as it could be used to project levels of use in subsequent stages of the curriculum implementation. These projections can be used by education leaders to design interventions and effective professional development aiding teachers in the continued implementation of CCSSM and to guide change facilitators to understand the relationship between teacher concerns and professional development.

Suzanne T. Jennings

University of Southern Mississippi, Hattiesburg, Mississippi

3016

166

Maintaining High Levels of Cognitive Demand through Student Silence

Brief Research Report

Student engagement in high-level cognitive demand instruction is pivotal for student learning. However, many teachers are unable to maintain such instruction, especially in instances of non-responsive students. This case study of three middle school teachers explores prompts that aim to move classroom discussions past student silence. Prompt sequences were categorized into progressing, focusing, and redirecting actions, and then analyzed for maintenance of cognitive demand. Results indicate that prompts that raise cognitive demand typically start out as procedural or concrete and progress to include students' thoughts or ideas about mathematical concepts. This presentation aims to discuss implications on how teachers can use prompting techniques to effectively maintain high levels of cognitive demand during student silence.

Jessica Lynn Jensen

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University of Iowa, Iowa City, Iowa

Anna Kye

University of Iowa, Iowa City, Iowa

Marina Sherry

University of Iowa, Iowa City, Iowa

Kyong Mi Choi

University of Iowa, Iowa City, Iowa

3018

167

Math Teachers' Influence on Student Growth Mindset**Brief Research Report**

This session presents on a year long mixed-methods study that investigated how math teachers might contribute to students' beliefs about their own math potential (mindset). The session will share results from analysis of survey data that examined whether teachers' beliefs predict students' mindset. This session will also present findings from analysis of classroom observations and artifacts that identified potential instructional practices that may explicitly or implicitly communicate mindset messages to students. This session has implications for both researchers and practitioners.

Kathy Liu Sun*Santa Clara University, Santa Clara, California*

3024

168

Principals and Implementation on Common Core State Standards for Mathematics**Brief Research Report**

As noted in *Principles to Actions*, principals' practices can influence successful implementation of CCSSM. In this literature review, twenty-nine studies are analyzed and synthesized to understand how principal instructional leadership influenced teachers' classroom instruction with a particular focus on CCSSM. Overall, researchers have found that principals can influence instruction primarily through indirect practices, such as working with teachers to define an instructional vision. Additionally, the degree of principal involvement with instruction was most effective when it served to understand how to support teachers through professional development rather than direct feedback. Overall, the studies reviewed provide evidence on how principals influence instruction, yet more needs to be understood particularly in relation to CCSSM and how local contextual factors influence instructional leadership.

Adrian Larbi-Cherif*Vanderbilt University, Teaching and Learning, Nashville, Tennessee*

3020

169

Studying Mathematics Beginning Teaching Using MQI, CLASS, and FFT**Brief Research Report**

Studies of student achievement suggest that beginning teachers are less effective than their more experienced peers. These findings lead us to investigate the features of early-career teaching. Using hierarchical measurement and logistics regression models, we analyze teacher observation data from 653 teachers in six districts to learn more about beginning mathematics teaching.

L. Joy Johnson*University of Michigan, Ann Arbor, Michigan***Delena Harrison***University of Michigan, Ann Arbor, Michigan*

170

The Algebraic Thinking of Teachers in China and the U.S.**Brief Research Report**

The study investigated 20 Chinese and 20 U.S. high school teachers' interpretation and response to a student's errors in solving a quadratic equation. Analysis results show that the Chinese teachers provided more negative evaluations toward students' errors and identified more students' errors than the U.S. teachers did. Responding to students' errors, the two groups of teachers highlighted conceptual explanations targeting students' mistakes. The U.S. teachers were more likely to provide general knowledge guidance while the Chinese teachers tended to go back to basic knowledge.

Qintong Hu*The University of Tennessee, Knoxville, Tennessee***Ji-Won Son***University at Buffalo, Buffalo, New York***Lynn L. Hodge***The University of Tennessee, Knoxville, Tennessee*

3011

171

Third Graders' Development of Quantitative Reasoning about Angle Measure**Brief Research Report**

The purpose of this session is to report on the findings of a study investigating the effects of two instructional interventions designed to provide third graders with opportunities to work with dynamic and static models of angles in a dynamic geometry environment. We discuss the effects of the instructional interventions on the children's development of quantitative reasoning about angle measure.

Amanda L. Miller*Illinois State University, Normal, Illinois***Craig J. Cullen***Illinois State University, Normal, Illinois*

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Conceptualizing Teacher Discourse Moves Using Different Focal Lengths**Research Symposium**

Using the metaphor of camera focal length, three research groups will share their conceptualizations of teacher moves to facilitate meaningful mathematical discourse. The approaches will be analyzed in relationship to each other to better understand teacher actions in response to student contributions during instruction.

Laura R. Van Zoest

Western Michigan University, Kalamazoo, Michigan

Shari L. Stockero

Michigan Technological University, Houghton, Michigan

Keith R. Leatham

Brigham Young University, Provo, Utah

Blake E. Peterson

Brigham Young University, Provo, Utah

AnnaMarie Conner

University of Georgia, Athens, Georgia

Laura M. Singletary

Lee University, Cleveland, Tennessee

Suzanne H. Chapin

Boston University, Boston, Massachusetts

Catherine O'Connor

Boston University, Boston, Massachusetts

3011

Kadir Almus

North American University, Houston, Texas

Alpaslan Sahin

Dr. Robert M. Capraro, College Station, Texas

Melahat Almus

University of Houston, Houston, Texas

3018

173

Interactive Paper Session

Presider: Marta Civil

University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

Gender and Doctoral Mathematics: Impactful Factors for Female Students' Success

This study was designed to identify factors crucial to success for female students and compare these factors for male students to better understand doctoral retention. A survey was administered to a sample of mathematics professors. Results indicate that different factors were influential in the success of male and female students. Recommendations are proposed to guide program revisions.

Emily Miller

University of Illinois at Urbana-Champaign, Champaign, Illinois

Investigating Learning and Success: Innovating in College Remediation

This study examines strategies to promoting equity and access in mathematics learning and success in community college remediation sequences; learning outcomes associated with teaching concepts through contextualized problems compared with focusing on procedures for symbolic manipulation; and the effects of acceleration and concept-focused curriculum and pedagogy on future course success.

Mickey Davis

University of California, Berkeley, Berkeley, California

Chris Quarles

Everett Community College, Everett, WA, Washington

Does STEM Designation Matter?: A Longitudinal Analysis of T-STEM Academies' Performance in Mathematics

This study aims to conduct a longitudinal analysis of T-STEM designated schools' to investigate how STEM designation affects schools' high school mathematics performance over the years by comparing STEM-designated schools with non-STEM schools.

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Interactive Paper Session

Presider: Michelle Stephan

UNC Charlotte, Charlotte, North Carolina

Developing Empirical Thinking, Davydov's Theory in Curriculum Design

Davydov theorized that early mathematics instruction needed to target the development of empirical generalizations. Children's everyday observations and conceptions serve as the starting point for the development of scientific concepts in school mathematics. In this empirical study we examine how this theory is implemented in curriculum design and the resultant effects on algebra preparedness.

Linda Venenciano

University of Hawaii, Honolulu, Hawaii

Common Core Takes Hold: Changes in Teachers' Mathematics Curriculum Use

This paper lays out a case study of the changes in teachers' mathematics curriculum use in one large urban district in the U.S. from three years before the adoption of Common Core State Standards for Mathematics (CCSSM) to three years after with implications for curriculum adoptions.

Mollie H. Appelgate

Iowa State University, Ames, Iowa

Brooks Rosenquist

Vanderbilt, Nashville, Tennessee

Thomas M Smith

Vanderbilt, Nashville, Tennessee

Examining 6–12 PSTs' Attention to Curriculum Materials When Planning

This session describes an exploratory study that examines one aspect of Curricular Noticing. Specifically, what did secondary PSTs attend to in their curriculum materials when planning a lesson from a reform-oriented curriculum?

Lorraine M. Males

University of Nebraska-Lincoln, Lincoln, Nebraska

Matthew Flores

University of Nebraska, Lincoln, Nebraska

3020

175

Lesson Study in Florida: Unveiling the Process of Professionalism Development

Research Symposium

Principles to Actions discusses lesson study as an exemplar professional development context in which teachers collaboratively research and reflect on their lessons, classroom practices, and student learning, and hold themselves and colleagues accountable for the success of all students. Florida is the first state to promote lesson study statewide in the United States. In this symposium, we will present five studies that investigated different aspects of this state-wide implementation of lesson study in Florida and its influences on schools, both quantitatively and qualitatively. Each paper frames the situation with different research questions, and after short presentations of each paper, we will invite audience to together discuss about development of professionalism of mathematics teachers.

Aki Murata

University of California, Berkeley, Berkeley, California

Motoko Akiba

Florida State University, Tallahassee, Florida

Gareth Wilkinson

Florida State University, Tallahassee, Florida

Cassie Howard

Florida State University, Tallahassee, Florida

Angelina Kuleshova

Florida State University, Tallahassee, Florida

Guillermo Farfan

Florida State University, Tallahassee, Florida

3022

176

Managing Students' (Apparently) Incorrect Mathematical Responses

Discussion Session

Though there are many teaching practices that matter for student learning, one practice that is embedded within many of these and is ubiquitous to teaching is the practice of managing students' incorrect responses. This session will explore the work of teaching involved in the enactment of this complex practice.

Annick Rougee

University of Michigan, Ann Arbor, Michigan

3007

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MET Grants Support Classroom Research

Invited

Action and classroom research grants available through the MET will be described as possible funding sources for mathematics education research. Brief reports from three classroom research projects funded by the MET will be presented: Fostering Number Sense of Diverse Young Learners; Navigating Ratios and Proportions in a Project-Based Learning Environment; Student Built Widgets in a Pre-Calculus Class.

Carol A. Edwards

Chair, Mathematics Education Trust (MET) Board of Trustees, Chandler, Arizona

Haiping Hao

Texas A&M University, College Station, Texas

Mary Margaret Capraro

Texas A&M University, College Station, Texas

Kisha Lee

Texas A&M University, College Station, Texas

Maggie L. McHugh

LaCrosse Design Institute, La Crosse, Wisconsin

Jennifer Kosiak

University of Wisconsin - La Crosse, La Crosse, Wisconsin

Beth Bos

Texas State University-San Marcos, San Marcos, Texas

Ryan Gertenbach

The University of Texas at Austin, Austin, Texas

3009

178.62

Measuring and Supporting the Improvement of Mathematics Teaching at Scale

Discussion Session

With the advent of CCSSM, states have been thrust into managing large-scale instructional improvement in mathematics. We describe our emerging theory of mathematics teaching for the Common Core era and provide early evidence of the internal and consequential validity of a set of newly developed measures for monitoring and supporting this vision across an entire state.

Mary Kay Stein

University of Pittsburgh, Pittsburgh, Pennsylvania

Richard Correnti

University of Pittsburgh, Pittsburgh, Pennsylvania

Katelynn Kelly

University of Pittsburgh, Pittsburgh, Pennsylvania

3024

179

Prospective Pre-K–8 Teachers' Selection of Initial Problem-Solving Strategies

Discussion Session

We examined prospective teachers' problem-solving strategies for three non-routine problems introduced at the beginning of a three-course pre-K–8 mathematics content sequence. Students relied heavily on guess-and-check or algebraic strategies at the expense of more visual or intuitive approaches. Participants of this session will analyze examples of student work on these tasks and discuss the implications of students' problem solving strategies with respect to pre-K–8 mathematics content courses.

LouAnn Lovin

James Madison University, Harrisonburg, Virginia

Kyle Schultz

James Madison University, Harrisonburg, Virginia

3010

180

Scaffolding Coherence in Digital Worlds Using CCSSM-Aligned Learning Maps

Discussion Session

In light of the CCSSM standards, and reduced budgets for school districts, it is now common for teachers and district leaders to construct significant portions of their curricula from online resources. However, recent research suggests that few tools exist to guide this work, and that current approaches often lead to fragmented learning experiences for students. In this session, presenters describe a learning map and corresponding diagnostic assessment system designed to support teachers to construct coherent instructional experiences for middle school students from online resources aligned to CCSSM. The learning map represents student thinking using the idea of Relational Learning Clusters, and presenters will describe how research on learning trajectories is represented in the map. Attendees will explore the map, assessments, and discuss opportunities and challenges in this new line of work.

Jere Confrey

College of Education, North Carolina State University, Raleigh, North Carolina

Ryan Seth Jones

North Carolina State University, Raleigh, North Carolina

Margaret Hennessey

North Carolina State University, Raleigh, North Carolina

Meetal Shah

North Carolina State University, Raleigh, North Carolina

3016

181

Slope and Covariational Reasoning to Make Sense of Fitting Lines

Research Symposium

We will present multiple research studies from our collaborative research program that has conducted empirical studies to learn how students draw upon and coordinate their conceptualizations of slope and covariational reasoning from their work in mathematics to understand and perform the statistical task of placing a best fit line.

Stephanie Casey

scasey1@emich.edu

Eastern Michigan University, Ypsilanti, Michigan

Courtney Nagle

Penn State Erie, Erie, Pennsylvania

Discussant: Gail Burrill

Michigan State University, East Lansing, Michigan

3008

182

Supporting Mathematics Specialists: Identification and Development of High Leverage Practices

Discussion Session

Mathematics specialists' impact was explored by: (1) analyzing high-leverage practices through various lenses and frameworks in existing research; and (2) implementing multi-site professional development based on *Principles to Actions*. Participants will identify similarities within the mathematical teaching practices of *Principles To Actions*. Suggestions will be gathered for future PD.

Pamela R. Bailey

prbailey@mbc.edu

Mary Baldwin College, Staunton, Virginia

Courtney Baker

George Mason University, Fairfax, Virginia

Shannon Larsen

University of Maine at Farmington, Farmington, Canada

3024

183

Teacher Professional Development through Ethnomathematics

Discussion Session

The Ethnomathematics and STEM Institute aims to advance equitable and high-quality mathematics education with diverse populations. Our presentation highlights data from this collaborative project whose purpose is to design and implement transformative professional development in academic and community-based contexts. Examples of teacher professional and personal growth will be shared.

Linda Furuto

lfuruto@hawaii.edu

University of Hawai'i at Mānoa, Honolulu, Hawaii

Joseph Zilliox

University of Hawai'i at Mānoa, Honolulu, Hawaii

Darienne Dey

Kānehūnāmoku Voyaging Academy, Kāne'ohe, Hawaii

Emily Uribe

Leeward Community College, Pearl City, Hawaii

3004

184

Teachers' Uses of Curriculum and Assessment with the Common Core

Research Symposium

This symposium presents four studies from a larger research project involving 92 middle school mathematics teachers. Drawing on multiple data sources (e.g., classroom observations, background interviews, lesson planning interviews), we studied teachers' perceptions and uses of the Common Core (CCSSM), curriculum materials, and assessments. Presentation 1 focuses on teachers' perceptions of CCSSM-aligned assessments in relation to the official and operational curricula. Presentation 2 presents findings on teachers' classroom-based assessment practices and resources in the context of CCSSM. Presentation 3 discusses case studies of eight teachers with a focus on curricular noticing when planning and enacting lessons. Presentation 4 presents case studies of four special education teachers' curricular noticing for students with special needs. Findings and implications for researchers, teacher educators, curriculum and assessment designers, and policymakers will be discussed.

Amy Roth McDuffie

Washington State University Tri-Cities, RICHLAND, Washington

Corey Drake

Michigan State University, East Lansing, Michigan

Amy Ray

Michigan State University, East Lansing, Michigan

Joanne K. Philhower

Michigan State University, East Lansing, Michigan

Jennifer Brown

Washington State University Vancouver, Vancouver, Washington

Discussant: Karen D. King

NSF, Arlington, Virginia

3002

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Transformative Math Teaching and Learning: Stories from Railside High

Invited

What does it take to create and sustain a community of learners—teachers and students—that collectively works toward supporting all students to fully engage with learning meaningful and empowering mathematics? Join us as we share our stories about teaching and learning math at Railside High from a variety of perspectives, including those of Railside students, math teachers, researchers, and contributors to the new book, *Mathematics for Equity*. This session includes posters about various pieces of research done at Railside, opportunities to interact with Railside students and teachers, and a whole-group discussion about what makes transformative teaching and learning possible, challenging, and necessary.

Lisa Jilk

University of Washington, Seattle, Washington

Nicole L. Louie

University of Texas at El Paso, El Paso, Texas

Ruth Cossey

Mills College, Oakland, California

Rachel Lotan

Stanford University, Stanford, California

Megan Staples

University of Connecticut, Storrs, Connecticut

Railside Teachers

Ashanti Branch, Carlos Cabana, Joanne da Luz, Kristina Dance, Laura Evans, Ladan Malek, Karen O'Connell, Eric Price, Barbara Shreve, Ruth Tsu, Phil Tucher, Maria Valesquez, Estelle Woodbury

3006

186

Mathematical Discourse in a Kindergarten Classroom: A Case Study

Brief Research Report

Classroom discourse is integral to mathematics instruction at all levels. This work is challenging at all levels but especially for very young learners who are just beginning to learn the language of school. In this talk, we explore the following questions: How can kindergarten teachers support students in engaging in mathematical discourse? How do kindergartners engage in mathematical discourse? We use a case study of one kindergarten teacher's classroom to look for the answers to this question, and we conclude that kindergartners are capable of authentic mathematical discourse using multiple modalities including formal and informal language, acting on manipulatives, drawings, gestures, and formal symbols. The teacher played a crucial role in supporting students in this work through laying groundwork for productive discourse, intentionally facilitating students' sharing of ideas about mathematics, and refining students' discourse toward more precise and sophisticated communication.

Sarah Lord

University of Wisconsin - Madison, Madison, Wisconsin

Aimee H. Cardon

University of Wisconsin - Madison, Madison, Wisconsin

Hala Ghousseini

University of Wisconsin - Madison, Madison, Wisconsin

3002

187

Mathematical Induction as an Explanatory Proof

Brief Research Report

This paper examines how the following aspects may facilitate students' engagement with mathematical induction as an explanatory proof: problem formulation, student experience with using examples in proving, and student ability to recognize and apply induction as an appropriate proof method. We focus on undergraduate mathematics students working on proving problems.

Gabriel J. Stylianides

University of Oxford, Oxford, United Kingdom

James Sandefur

Georgetown University, Washington D.C., District Of Columbia

Anne Watson
University of Oxford, Oxford, England

3004

188 Mathematical Play and Neuroplasticity in Children with Cancer

Brief Research Report

In a 24-week study, we investigated an intervention for children with cancer using the Lego Mindstorms EV3 robotics kits. The intervention is designed to address issues of children's mathematical thinking and learning and functional and structural changes to the brain following chemotherapy and/or radiation.

Megan L. Nickels
Megan.Nickels@ucf.edu
University of Central Florida, Orlando, Florida

3006

189 Mathematics and the African American Males' Graduation Success

Brief Research Report

The purpose of the study is to examine the relationships among graduation of African American males from predominantly White institutions and historically Black colleges and universities and their mathematics self-efficacy, mathematics anxiety, mathematics attitude, deep learning, peer relationships, faculty relationship, major of study, social capital, and life satisfaction after graduation and critical race identity. Mathematics is the most important predictor of academic success at postsecondary institutions. The types of math courses students take in college affect their college graduation and their earning capacity in the job market. Students who take more advanced math classes will learn skills that might be directly applicable to certain jobs, and those learned skills are more strongly correlated with labor market success than other measures of student achievement. Critical race theory is the theoretical framework of this study.

Claude N. Stuart
NYCDOE, Long Island, New York, New York

Stephanie L. Tatum
Dowling College, Oakdale, New York

Elsa-Sofia Morote
Dowling College, Oakdale, New York

3010

190 Measuring Primary Grade Teachers' Mathematical Knowledge for Teaching

Brief Research Report

We will share information about an instrument designed to measure Mathematical Knowledge for Teaching (MKT) of teachers of early elementary mathematics. We will discuss how we specified various facets of MKT and report scale reliability and other results from two field studies involving U.S. primary grades teachers in 2014 (n=413) and 2015 (n=636).

Wendy Bray
WBray@lsi.fsu.edu

Florida Center for Research in Science, Technology, Engineering, and Mathematics (FCR-STEM), Florida State University, Tallahassee, Florida

Robert Schoen
Florida Center for Research in Science, Technology, Engineering, and Mathematics (FCR-STEM), Florida State University, Tallahassee, Florida

3007

191 Measuring Teachers' Beliefs in Relation to Standards for Mathematical Practice

Brief Research Report

An instrument that measures the self-efficacy and outcome expectancy beliefs of teachers in regards to the Standards for Mathematical Practice will be presented.

Iris M. Riggs
California State University, San Bernardino, San Bernardino, California

David Fischman
California State University, San Bernardino, San Bernardino, California

Matt L. Riggs
California State University, San Bernardino, San Bernardino, California

Madeleine Jetter
California State University, San Bernardino, San Bernardino, California

Joseph Jesunathadas
California State University, San Bernardino, San Bernardino, California

3008

192 Navigating the Tension between Direct and Dialogic Mathematics Teaching Practices

Brief Research Report

This session reports on research findings describing a tension between direct and dialogic mathematics teaching practices in an upper elementary setting. Implications from findings of the study include recommendations for how to use *Principals to Actions* to create useful professional development in addressing the tension.

Monica Smith Karunakaran
Pennsylvania State University, University Park, Pennsylvania

3009

193

Predictors of Mathematics Achievement**Brief Research Report**

The purpose of this study is to examine the predictors of mathematics achievement in deaf and hearing college students. More specifically, this study was (1) to investigate the possible associations among cognitive skills, fractional knowledge, and mathematics achievement in both hearing and deaf students groups; and (2) to determine whether mathematics achievement can be better predicted by fractional knowledge among college students. This study indicated that fractional knowledge is a strong predictor of mathematics achievement in both hearing and deaf students.

ChongMin Lee*Lamar University, Beaumont, Texas*

3016

194

Preparing Teachers to Link Research to Practice: Successes and Failures**Brief Research Report**

As part of a multi-semester design-based research study, we developed a sequence of learning experiences meant to prepare prospective teachers with the skills necessary to engage in the process of linking research to practice. In this session, we report on in-depth, qualitative analyses of the work of three prospective teachers. These three cases serve to illustrate the benefits but also the shortcomings of our approach to linking research to practice.

Sarah van Ingen*University of South Florida, Tampa, Florida***Lakesia L. Dupree***University of South Florida, Tampa, Florida*

3018

195

Preservice Elementary Mathematics Lesson Study: Visions and Learning to Teach**Brief Research Report**

This study investigated the learning process of preservice elementary teachers (PSTs) through lesson study in a mathematics teaching methods course. Lesson study meeting data of kindergarten PSTs were analyzed to examine the shifting focus on (1) student collaboration in classroom (vision), (2) teaching practices (making content accessible), and (3) understanding of student thinking of mathematics, in teachers' talks. The four learning phases were identified in which the PSTs' vision guided sense-making process, where lesson study provided the structure for the process. Visions can support or distract PSTs' learning, and learning experiences should guide PSTs to understand how to enact their visions in relationship to classroom practices.

Aki Murata*University of California, Berkeley, Berkeley, California***Anna McGee***UC Berkeley, Berkeley, California***Tia Madkins***University of California, Berkeley, Berkeley, California***Dennis Gillingham***University of California, Berkeley, Berkeley, California***Judith Fabrega***University of California, Berkeley, Berkeley, California***Hee-jeong Kim***University of California, Berkeley, Berkeley, California***Becca Shareff***University of California, Berkeley, Berkeley, California*

3020

196

Preservice Secondary Teachers' Learning of Purposeful Questioning**Brief Research Report**

A number of mathematics teacher educators have begun to focus curricula of methods courses on mathematics teaching practices and designing coursework around pedagogies of practice. However, the field is just beginning to address preservice secondary teachers' learning in such methods courses. This session shares results from a study examining preservice secondary teachers' learning of a mathematics teaching practice (purposeful questioning) as they were enrolled in a methods course designed around pedagogies of practice.

Ben Freeburn*Bradshaw Christian Schools, Sacramento, California*

3024

197

Teachers as Problem Solvers: Insights from Professional Development**Brief Research Report**

This exploratory phenomenological study centers on secondary educators' problem-solving experiences with the use of open-ended tasks. An analysis of a three-week professional development program focused on supporting middle school teachers' conceptual and procedural knowledge through a first-hand involvement in problem solving processes. Data from journal reflections, mathematical work samples, and video segments are presented to explore educators' personal experiences as learners and teachers of problem solving. The participants of this session will gain further understanding regarding the use of problem-solving tasks to support teacher content and pedagogical knowledge, consider a diverse set of teacher perspectives, and discuss implications for instructional practice.

Cinthia Rodriguez*The University of Texas at San Antonio, San Antonio, Texas***Priya V. Prasad***University of Texas at San Antonio, San Antonio, Texas***Emily P. Bonner***University of Texas at San Antonio, San Antonio, Texas*

3000

198

Preservice Teachers' Use of Schema-Based Diagrams for Teaching Word Problems

Brief Research Report

Solving addition and subtraction word problems is an important, yet difficult task for both elementary students and teachers. Categorizing problem types and using schema-based diagrams in teaching are regarded as effective strategies to help students conceptualize and solve word problems. Therefore, in this study, elementary preservice teachers learned how to integrate word problem types with diagrams. Using video analysis, we examined the characteristics of these preservice teachers' understanding of addition and subtraction word problem types and their use of schema-based diagrams to represent and solve these problems. The study revealed that while participants had abilities in using diagrams to solve word problems procedurally, their conceptual understanding of problem types and accuracy in using schema-based diagrams was limited. The results implied that future research and teacher preparation should focus on improving preservice teachers' mathematics knowledge.

Shuang Zhang

Texas Tech University, Lubbock, Texas

Jian Wang

Texas Tech University, Lubbock, Texas

Raymond Flores

Texas Tech University, Lubbock, Texas

Pablo Dominguez

Texas Tech University, Lubbock, Texas

3006

199

Reasoning Paths from Exploration to Argument

Brief Research Report

We present a framework for types of reasoning that can be used when generating and arguing for a general mathematical claim. The framework was used to analyze reasoning elicited in task-based interviews with eighth-grade students. We illustrate with examples of student reasoning and arguments for the audience to analyze.

Anne E. Adams

University of Idaho, Moscow, Idaho

David A. Yopp

University of Idaho, Moscow, Idaho

Robert Ely

University of Idaho, Moscow, Idaho

3009

200

Refinement of the Conceptual Models for Integer Addition and Subtraction

Brief Research Report

The Conceptual Models for Integer Addition and Subtraction (CMIAS) were initially developed from the stories that students posed for integer addition and subtraction open number sentences. Three grade

5 students participated in a 12-week teaching experiment where they solved open number sentences for integer addition and subtraction open number sentences in four Individual Sessions. The students' responses (verbal and drawings) as they solved these open number sentences were analyzed. This data supported the refinement of the CMIAS. The refinement of the CMIAS, which includes the changes that were made to initial descriptors and the data that supported these refinements, will be highlighted.

Nicole M. Wessman-Enzinger

George Fox University, Newberg, Oregon

3010

201

Reforming an Increasingly Reductionistic U.S. Mathematics Education Culture

Brief Research Report

Significant reduction-based aspects of U.S. mathematics education (that limit student/teacher learning and systemic reform initiatives) are compared, clarified, and classified with more holistic approaches used by other high-achieving nations. I detail a new theoretical framework that maps general U.S. classroom pedagogy onto U.S. teaching culture and professional development approaches; I argue that U.S. mathematics education reform attempts of the last several decades have utilized similar (reduced) pedagogical approaches at the systemic level. I recommend simple strategic shifts to harness potential (but as yet, dormant) U.S. education strengths.

Thomas E. Ricks

tomricks@lsu.edu

Louisiana State University, Baton Rouge, Louisiana

3011

202

Rethinking Elementary Preservice Teachers' Addition Strategies

Brief Research Report

This presentation will focus on an exploratory study of how elementary preservice teachers (PSTs) communicated their mathematical thinking while solving carefully selected, multi-digit, addition problems. The numbers were purposefully chosen for the problems to elicit both procedural and conceptual knowledge. This presentation seeks to demonstrate that although many PSTs used the standard algorithm, some simultaneously used unprompted conceptual strategies based on their own prior mathematical knowledge and experiences. This presentation will discuss the implications of this study for mathematics teacher educators as they leverage the nuanced ways that PSTs' communicate their mathematical thinking while developing PSTs' pedagogical content knowledge.

Carey Walls

University of Texas at San Antonio, San Antonio, Texas

Crystal Kalinec-Craig

The University of Texas at San Antonio, San Antonio, Texas

Priya V. Prasad

University of Texas at San Antonio, San Antonio, Texas

Raquel Vallines-Mira

University of Texas at San Antonio, San Antonio, Texas

3018

203

Sustaining Lesson Study: Mathematics Teachers' Conceptions of Lesson Study**Brief Research Report**

This study on mathematics teacher professional development and sustaining lesson study examines practicing U.S. teachers' conceptions of mathematics lesson study and demonstrates how some conceptions supported teachers' ability to sustain lesson study while other conceptions constrained them.

Bridget Druken*California State University, Fullerton, Fullerton, California*

3024

204

Teachers' Beliefs: Relationships with Accountability Pressure and Student Achievement**Brief Research Report**

This analysis draws on multiple regression methods to examine the relationships between the accountability pressures facing schools who fail to make sufficient improvement on end-of-year state tests and the nature of teachers' beliefs and practice pertaining to inquiry-oriented mathematics instruction. Drawing on data from a longitudinal study of teachers' practice in the context of district-wide instructional improvement efforts, this analysis is framed around three research questions: i) Is there a relationship between school-level pressure to improve assessment scores and teachers' likelihood to describe productive, inquiry-oriented supports for students who struggle in mathematics? ii) Are teachers at schools facing significant accountability pressures more likely to describe and enact practices that are inconsistent with their espoused beliefs about teaching and learning in mathematics? iii) How do these institutional settings shape teachers' beliefs and practices differentially?

Charlotte J. Dunlap*Vanderbilt University, Nashville, Tennessee*

3000

205

Teachers' MKT and Curricular Reasoning in Algebra and Statistics**Brief Research Report**

This study investigates grade 7 teachers' curricular reasoning and MKT in algebra and statistics. Although the use of curriculum materials and MKT both influence the quality of mathematics instruction, no relationship between teachers' curricular reasoning and MKT was found. Further, teachers' curricular reasoning across algebra and statistics was very similar despite differences in these fields and differences in MKT.

Kolby J. Gadd*University of Michigan, Ann Arbor, Michigan*

206

The Connections between Number and Notation: Elementary PSTs' Understanding**Brief Research Report**

This study reports on the ways that 32 elementary preservice teachers understood whole and rational numbers and notation and the connections between them at the start of their mathematics education coursework and after participation in a number and numeration unit designed to develop their understanding of the connections. Results indicate that PSTs typically did not begin their education coursework with a strong understanding of rational numbers, fractions, and decimals but were able to develop a stronger understanding during the unit. Activities that supported non-symbolic representations of both fractions and rational decimals (especially repeating decimals) were particularly supportive.

Christy Pettis*University of Minnesota, St. Paul, Minnesota*

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