<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 - 1:15 pm</td>
<td><strong>Grand Ballroom</strong></td>
<td><strong>OPENING SESSION</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Salons 2-4</strong></td>
<td></td>
</tr>
<tr>
<td>1:25 - 1:55 pm</td>
<td><strong>City Center A</strong></td>
<td><strong>SESSION 1 – CONTRIBUTED REPORTS</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Grand Ballroom</strong></td>
<td><strong>Abstract Algebra and Secondary School Mathematics: Identifying</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Salon 5</strong></td>
<td><strong>Mathematical Connections in Textbooks</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Marquis</strong></td>
<td><strong>It’s about time: How instructors and students experience time</strong></td>
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<td></td>
<td><strong>Ballroom B</strong></td>
<td><strong>constraints in Calculus 1</strong></td>
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<td></td>
<td></td>
<td><strong>Jessica Ellis, Estrella Johnson and Chris Rasmussen</strong></td>
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<td></td>
<td><strong>Opportunity to learn the concept of group in a first class meeting on</strong></td>
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<td><strong>abstract algebra</strong></td>
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<td></td>
<td><strong>Tim Fukawa-Connelly</strong></td>
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</tbody>
</table>
2:05 - 2:35 pm  
**SESSION 2 – PRELIMINARY REPORTS**

*City Center A*  
**Generalization in undergraduate mathematics education**

*Allison Dorko, Eric Weber and Steven Jones*

*City Center B*  
**A preliminary categorization of what mathematics undergraduate students include on exam “crib sheets”**

*Antony Edwards and Birgit Loch*

*Marquis Ballroom A*  
**The textbook, the teacher, and the derivative: Examining community college instructors’ use of their textbook when teaching about derivatives in a first semester calculus class**

*Linda Leckrone*

*Grand Ballroom Salon 5*  
**Discourse in mathematics pedagogical content knowledge**

*Shandy Hauk, Allison Toney, Reshmi Nair, Nissa Yestness and Melissa Troudt*

*Marquis Ballroom B*  
**Components of a formal understanding of limit**

*Stephen Strand*

*Marquis Ballroom C*  
**An analysis of sociomathematical norms of proof schemes**

*Brian Katz, Rebecca Post, Milos Savic and John Paul Cook*

2:35 – 3:05 pm  
**COFFEE BREAK**
3:05 – 3:35 pm  
**SESSION 3 – CONTRIBUTED REPORTS**

**Grand Ballroom Salon 5**  
Mathematicians’ uses of examples when developing conjectures  
*Elise Lockwood, Alison G. Lynch, Amy B. Ellis and Eric Knuth*

**Marquis Ballroom A**  
Roles of proof in an undergraduate inquiry-based transition to proof course  
*Sarah Bleiler and Jeffrey Pair*

**Marquis Ballroom B**  
An investigation of beginning mathematics graduate teaching assistants’ teaching philosophies  
*Kedar Nepal*

**Marquis Ballroom C**  
Leveraging historical number systems to understand number and operation in base 10  
*Eva Thanheiser and Andrew Riffel*
3:45 – 4:15 pm  
**SESSION 4 – CONTRIBUTED REPORTS**

**Marquis Ballroom A**  
**Pedagogical challenges of communicating mathematics with students:**  
Living in the formal world of mathematical thinking  
*Sepideh Stewart, Ralf Schmidt, John Paul Cook and Ameya Pitale*

**Grand Ballroom Salon 5**  
**The Structure, content, and feedback of Calculus I homework at doctoral degree granting institutions and the role of homework in students’ mathematical success**  
*Jessica Ellis, Kady Hanson, Gina Nunez and Chris Rasmussen*

**Marquis Ballroom B**  
**Teachers' meanings for the substitution principle**  
*Stacy Musgrave, Neil Hatfield and Patrick Thompson*

**Marquis Ballroom C**  
**A model of the structure of proof construction**  
*Tetsuya Yamamoto*
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location</th>
<th>Topic</th>
<th>Presenters</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:20 – 4:50 pm</td>
<td><strong>SESSION 5 – PRELIMINARY REPORTS</strong></td>
<td>Grand Ballroom</td>
<td>Connecting research on students’ common misconceptions about tangent lines to instructors’ choice of graphical examples in a first semester calculus course</td>
<td>Brittany Vincent and Vicki Sealey</td>
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<tr>
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<td></td>
<td>Salon 5</td>
<td></td>
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<tr>
<td>City Center A</td>
<td>Undergraduate students’ experiences in a remedial mathematics classroom</td>
<td></td>
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<td>Durrell Jones and Beth Herbel-Eisenmann</td>
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<tr>
<td>City Center B</td>
<td>Differentiating instances of knowledge of content and students (KCT): Responding to student conjectures</td>
<td></td>
<td></td>
<td>Kristin Noblet</td>
</tr>
<tr>
<td>Marquis Ballroom A</td>
<td>Business faculty perceptions of the calculus content needed for business courses</td>
<td></td>
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<td>Melissa Mills</td>
</tr>
<tr>
<td>Marquis Ballroom B</td>
<td>Knowledge for teaching: Horizons and mathematical structures</td>
<td></td>
<td></td>
<td>Nicholas Wasserman and Ami Mamolo</td>
</tr>
<tr>
<td>Marquis Ballroom C</td>
<td>Undergraduate students reading and using mathematical definitions: Generating examples, constructing proofs, and responding to true/false statements</td>
<td></td>
<td></td>
<td>Valeria Aguirre Holguin</td>
</tr>
</tbody>
</table>
5:00 – 5:30 pm  
**SESSION 6 – CONTRIBUTED REPORTS**

**Grand Ballroom Salon 5**

How do mathematics majors translate informal arguments into formal proofs

*Dov Zazkis, Keith Weber and Juan Pablo Mejia-Ramos*

**Marquis Ballroom C**

Developing a creativity-in-progress rubric on proving

*Milos Savic, Gulden Karakok, Gail Tang and Houssein El Turkey*

**Marquis Ballroom B**

Application of multiple integrals: From a physical to a virtual model

*Ivanete Siple and Elisandra Figueiredo*

**Marquis Ballroom A**

Pre-Service Teachers’ Inverse Function Meanings

*Teo Paoletti, Irma E. Stevens, Natalie L. F. Hobson, Kevin R. Laforest and Kevin C. Moore*
5:30 – 6:20 pm

**POSTER SESSION & RECEPTION**

**Grand Foyer**

The Efficacy of projects and discussions in increasing quantitative literacy outcomes in an online college algebra course

*Luke Tunstall*

Students’ reasoning about marginal change in an economic context

*Thembinkosi Mkhatshwa and Helen Doerr*

Challenges and resources of learning mathematics in English for a ‘mathematically intelligent’ student weak English background

*Balarabe Yushau*

Code-switching and mathematics assessment: Some anecdotal evidence of persistence of first language

*Balarabe Yushau*

Students’ conceptions of rational functions

*Nicholas Fortune and Derek Williams*

Using journals to support student learning: The case of an elementary number theory course

*Christina Starkey, Hiroko Warshauer and Max Warshauer*

Developing abstract knowledge in advanced mathematics: Continuous functions and the transition to topology

*Daniel Cheshire*
Prospective secondary mathematics teachers’ (PSMTs’) understanding of abstract mathematical structures

Younhee Lee

When mathematicians grade students' proofs, why don't the scores agree?

Robert C. Moore

Formal logic and the production and validation of proof by university level students

Sarah Mathieu-Soucy

Unconventional use of mathematical language in undergraduate students' proof writing

Kristen Lew and Juan Pablo Mejia-Ramos

Embodied world thinking: The calculus laboratory

Sepideh Stewart

Understanding participants' experiences in a flipped large lecture calculus course

Erin Glover

Learning in one classroom: Developmental mathematics students and prospective mathematics teachers

Kenneth Bradfield, Raven McCrory, Aditya Viswanathan and Kristen Bieda

An examination of college students’ reasoning about trigonometric functions with multiple representations

Soo Yeon Shin

An RME-based instructional sequence for change of basis and eigentheory

Megan Wawro, Michelle Zandieh, Chris Rasmussen and Christine Larson
Students’ visual attention while answering graphically-based Fundamental Theorem of Calculus questions

Rabindra Bajracharya, John Thompson and Jennifer Docktor

Domain, Co-domain and causation: A study of Britney’s conception of function

Nathan Phillips

An intended meaning for the argument of a function

Ashley Duncan

6:30 – 9:00 pm

DINNER AND PLENARY

Grand Ballroom

Salons 2-4

Charles Henderson
SESSION 7 – CONTRIBUTED REPORTS

Grand Ballroom
Salon 5
Variation in implementation of student-centered instructional materials in undergraduate mathematics education
Christine Andrews-Larson and Valerie Kasper

Marquis Ballroom A
Balancing formal, symbolic an embodied world thinking in first year calculus lectures
Sepideh Stewart, Clarissa Thompson, Keri Kornelson, Lucy Lifschitz and Noel Brady

Marquis Ballroom B
Students’ understanding of concavity and inflection points: Graphical, symbolic, verbal, and physical representations
Michael Gundlach and Steven Jones

Marquis Ballroom C
An analysis of students’ difficulties with the opening stage of proof construction
Tetsuya Yamamoto
9:15 – 9:45 am  
**SESSION 8 – PRELIMINARY REPORTS**

*Grand Ballroom Salon 5*

**Students’ perceptions of the disciplinary appropriateness of their approximation strategies**  
*Danielle Champney, David Kato, Jordan Spies and Kelsea Weber*

*City Center A*

**Math Teachers’ Circles: Connections to teacher leadership**  
*Diana White and Jan Yow*

*City Center B*

**Silence: A case study**  
*Matthew Petersen*

*Marquis Ballroom A*

**Social networks among communities of calculus-teaching faculty at PhD-granting institutions**

*Marquis Ballroom B*

**The use of examples in the learning and teaching of proof writing**  
*Sarah Hanusch*

*Marquis Ballroom C*

**The purpose of Calculus I labs: Instructor, TA, and student beliefs and practices**  
*Yuliya Melnikova*

9:45 – 10:15 am  
**COFFEE BREAK**
SESSION 9 – PRELIMINARY REPORTS

10:15 – 10:45 am

Marquis Ballroom A
Digging in deep: From instrumental to logical understanding in calculus
Douglas Riley and Maria Stadnik

Marquis Ballroom C
Conditions for cognitive unity in the proving process
Kelly Bubp

Grand Ballroom Salon 5
Solving linear systems: Augmented matrices and the reconstruction of X
Michelle Zandieh and Christine Andrews-Larson

Marquis Ballroom B
Formative assessment and classroom community in calculus for life sciences
Rebecca Dibbs and Brian Christopher
10:55 – 11:25 am  
**SESSION 10 – CONTRIBUTED REPORTS**

**Grand Ballroom Salon 5**  
**A discursive approach to support teachers’ development of student thinking about functions**  
*Beste Gucler and Heather Trahan-Martins*

**Marquis Ballroom A**  
**Instructional practices and student persistence after Calculus I**  
*Lisa Manitini and Kitty Debock*

**Marquis Ballroom B**  
**Best practices for the inverted (flipped) classroom**  
*Spencer Bagley*

**Marquis Ballroom C**  
**Seeking solid ground: A study of novices’ indirect proof preferences**  
*Stacy A. Brown*
SESSION 11 – CONTRIBUTED REPORTS

11:35 – 12:05 pm

**Grand Ballroom**

**Salon 5**

Variation in successful mathematics majors proving
deducing difficulty

*Dov Zazkis, Keith Weber and Juan Pablo Mejia-Ramos*

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**Marquis**

**Ballroom A**

The generalization of the function schema: The case of parametric functions

*Harrison Stalvey and Draga Vidakovic*

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**Marquis**

**Ballroom B**

Linear algebra in the three worlds of mathematical thinking: The effect of permuting worlds on students’ performance

*John Hannah, Sepideh Stewart and Michael Thomas*

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**Marquis**

**Ballroom C**

Promoting students’ construction and activation of the multiplicatively-based summation conception of the definite integral

*Steven Jones*

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12:05 – 1:05 pm

**Grand Ballroom**

**Salons 2-4**

LUNCH
SESSION 12 — PRELIMINARY REPORTS

City Center A
Elementary mathematics pre-service teachers’ consequential transitions from formal to early algebra
Charles Hohensee and Siobahn Young

Grand Ballroom Salon 5
A mathematician’s experience flipping a large-lecture calculus course
Erin Glover

City Center B
Implementing inquiry-oriented instructional materials: A comparison of two classrooms
Hayley Milbourne

Marquis Ballroom A
Partial unpacking and the use of truth tables in inquiry-based-transition-to-proofs course
Jeffrey Pair and Sarah Bleiler

Marquis Ballroom B
A study of connectivism as a support for research on meaning-making for mathematics
Luciane Santos, Ivanete Siple and Gabiela Lopes

Marquis Ballroom C
The effects of using spreadsheets in business calculus on student attitudes
Melissa Mills
1:45 – 2:15 pm  

**SESSION 13 – THEORETICAL REPORTS**

*Grand Ballroom Salon 5*

**Examining individual and collective level mathematical progress**

*Chris Rasmussen, Megan Wawro and Michelle Zandieh*

*Marquis Ballroom C*

**Shape thinking and students’ graphing activity**

*Kevin Moore and Patrick Thompson*

*Marquis Ballroom A*

**Value judgments attached to mathematical proofs**

*Eyob Demeke*

*Marquis Ballroom B*

**Conceptualizing equity in undergraduate mathematics education: Lessons from K-12 research**

*Aditya Adiredja, Nathan Alexander and Christine Andrews-Larson*
2:25 – 2:55 pm  **SESSION 14 — THEORETICAL REPORTS**

**Grand Ballroom Salon 5**  
Neural correlates for action-object theories  
Anderson Norton

**Marquis Ballroom A**  
Conceptualizing the notion of a task network  
Ami Mamolo, Robyn Ruttenberg-Rozen and Walter Whiteley

**Marquis Ballroom B**  
An extended theoretical framework for the concept of the derivative  
David Roundy, Tevian Dray, Corinne A. Manogue, Joseph F. Wagner, and Eric Weber

**Marquis Ballroom C**  
Frames of reference  
Surani Joshua, Stacy Musgrave, Neil Hatfield and Patrick Thompson

2:55 – 3:25 pm  **COFFEE BREAK**
3:25 – 3:55 pm  

**SESSION 15 – PRELIMINARY REPORTS**

*City Center A*

“What if we put this on the floor?”: Mathematical play as a mathematical practice  

*J. Brooke Ernest*

*Marquis Ballroom A*

Mathematicians’ ideas when proving  

*Melissa Troudt, Gulden Karakok, and Michael Oehrtman*

*Grand Ballroom Salon 5*

Extending multiple choice format to document student thinking  

*Michelle Zandieh, David Plaxco, Megan Wawro, Chris Rasmussen, Hayley Milbourne, and Katherine Czeranko*

*Marquis Ballroom B*

The influence of function and variable on students' understanding of calculus optimization problems  

*Renee LaRue and Nicole Engelke*

*Marquis Ballroom C*

A comparison of self-inquiry in the context of mathematical problem solving  

*Todd Grundmeier, Dylan Retsek and Dara Stepanek*
4:05 – 4:35 pm  
**SESSION 16 – CONTRIBUTED REPORTS**

**Marquis Ballroom A**
Commognitive conflicts in the discourse of continuous functions
*Gaya Jayakody*

**Marquis Ballroom B**
Cluster analysis of STEM gender differences
*Ian Mouzon, Ulrike Genschel and Xuan Hien Nguyen*

**Grand Ballroom Salon 5**
The transition from AP to college calculus: Students' perceptions of factors for success
*Megan Ryals and Karen Keene*

**Marquis Ballroom C**
Bundles and associated intentions of expert and novice provers: The search for and use of counterexamples
*Shiv Karunakaran*
4:45 – 5:15 pm  **SESSION 17 – CONTRIBUTED REPORTS**

**Marquis Ballroom C**

Students’ understanding of composition of functions using model analysis

*David Miller, Nicole Engelke Infante and Solomon Adu*

**Grand Ballroom Salon 5**

Mathematics majors’ example and diagram usage when writing calculus proofs

*Juan Pablo Mejia-Ramos and Keith Weber*

**Marquis Ballroom B**

Students’ generalizations of single-variable conceptions of the definite integral to multivariate conceptions

*Steven Jones, Allison Dorko and Eric Weber*

5:30 – 6:30 pm  **PLENARY SESSION**

**Grand Ballroom Salons 2-4**

Nicole McNeil

6:30 pm  **DINNER ON YOUR OWN**
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location</th>
<th>Title</th>
<th>Presenters</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:35 – 9:05 am</td>
<td>Session 18 – Contributed Reports</td>
<td>Marquis Ballroom A</td>
<td>Exploring practices and beliefs related to the teaching of mathematical ways of thinking and doing at university</td>
<td>Alon Pinto</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marquis Ballroom B</td>
<td>John’s lemma: How one student’s proof activity informed his understanding of inverse</td>
<td>David Plaxco</td>
</tr>
<tr>
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<td>Marquis Ballroom C</td>
<td>Teachers’ meaning for average rate of change in the U.S.A. and Korea</td>
<td>Hyunkyoung Yoon, Cameron Byerley and Patrick W. Thompson</td>
</tr>
<tr>
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<td></td>
<td>Grand Ballroom Salon 5</td>
<td>Studying student’s preferences and performances in a cooperative mathematics classroom</td>
<td>Sayonita Ghosh Hajra and Natalie Hobson</td>
</tr>
</tbody>
</table>
9:15 – 9:45 am  **SESSION 19 – PRELIMINARY REPORTS**

**City Center A**

The simple life: An exploration of student reasoning in verifying trigonometric identities

*Benjamin Wescoatt*

**Marquis Ballroom A**

The transfer of knowledge from groups to rings: An exploratory study

*John Paul Cook, Brian Katz and Milos Savic*

**Marquis Ballroom C**

Undergraduate students’ understandings of functions and key calculus concepts

*Caroline Hagen*

**Grand Ballroom Salon 5**

Gains from the incorporation of an approximation framework into calculus instruction

*Jason Martin and Michael Oehrtman*

**City Center B**

Studying the understanding process of derivative based on representations used by students

*Sarah Dufour*

**Marquis Ballroom B**

The effectiveness of clickers in large-enrollment calculus

*Xuan Hien Nguyen, Heather Bolles, Adrian Jenkins and Elgin Johnston*

9:45 – 10:15 am  **COFFEE BREAK**
10:15 – 10:45 am  
**SESSION 20 – THEORETICAL REPORTS**

*Marquis Ballroom A*

**Bidirectionality and covariational reasoning**

*Kevin Moore and Teo Paoletti*

*Marquis Ballroom B*

**Integrated mathematics and science knowledge for teaching framework**

*Shawn Firouzian and Natasha Speer*

*Grand Ballroom Salon 5*

**A theoretical perspective for proof construction**

*John Selden and Annie Selden*

*Marquis Ballroom C*

**Adding explanatory power to descriptive power: Combining Zandieh’s derivative framework with analogical reasoning**

*Kevin Watson and Steven Jones*
10:55 – 11:25 am  **SESSION 21 – CONTRIBUTED REPORTS**

**Grand Ballroom Salon 5**

Mathematicians’ views of mathematical practice

*Elise Lockwood and Eric Weber*

**Marquis Ballroom A**

How Might Students Come to See First Order Differential Equations as Functions of Two Variables

*George Kuster and Morgan Dominy*

**Marquis Ballroom B**

Investigating the effectiveness of an instructional video game for calculus: Mission Prime

*Keri Kornelson, Yu-Hao Lee, Sepideh Stewart, Scott Wilson, Norah Dunbar, William Thompson, Ryan Ralston, Milos Savic and Emily Lennox*

**Marquis Ballroom C**

Proof expectations of students: The effects on proof validation

*Ashley L. Suominen, Hyejin Park and Annamarie Conner*
11:35 – 12:05 pm  
**SESSION 22 — CONTRIBUTED REPORTS**

**Grand Ballroom**
**Salon 5**

**Instantiation practices during conjecturing activity: Implications from the use of technology**

*Jason Belnap and Amy Parrott*

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**Marquis**
**Ballroom A**

**An analysis of students’ difficulties with proving in light of the structure of proof construction**

*Tetsuya Yamamoto*

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**Marquis**
**Ballroom C**

**Examining proficiency with operations on irrational numbers**

*Sarah Hanusch and Sonalee Bhattacharyya*

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**Marquis**
**Ballroom B**

**Painter’s paradox: Epistemological and didactical obstacle**

*Chanakya Wijeratne and Rina Zazkis*

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12:05 – 1:50 pm  
**LUNCH & PANEL DISCUSSION**

**Grand Ballroom**
**Salons 2-4**
1:50 – 2:25 pm

**SESSION 23 – CONTRIBUTED REPORTS**

*Marquis Ballroom A*

Modeling outcomes in combinatorial problem solving: The case of combinations

*Elise Lockwood, Craig A. Swinyard and John S. Caughman*

*Marquis Ballroom C*

Exploration of undergraduate students’ and mathematicians’ perspectives on creativity

*Gail Tang, Houssein El Turkey, Milos Savic and Gulden Karakok*

*Grand Ballroom Salon 5*

Guiding reinvention of conventional tools of mathematical logic: Students’ reasoning about mathematical disjunctions

*Paul Dawkins and John Paul Cook*
2:30 – 3:00 pm  
**SESSION 24 – PRELIMINARY REPORTS**

*City Center A*  
**Pre-service teachers’ conceptual understanding of arithmetic in base-ten and bases other than ten**  
*Benjamin Wescoatt and Iwan Elstak*

*Marquis Ballroom A*  
**The purpose of reading a proof: A case study of Lagrange’s Theorem**  
*Eyob Demek and May Chaar*

*Grand Ballroom Salon 5*  
**Calculus students’ understanding of making predictions using slope and derivative**  
*Jennifer Tyne*

*Marquis Ballroom B*  
**Secondary mathematics teachers’ perceptions of real analysis in relation to their teaching practice**  
*Nicholas Wasserman, Matthew Villanueva, Juan Pablo Mejia-Ramos and Keith Weber*

*Marquis Ballroom C*  
**Creating opportunities for students to address misconceptions: Student engagement with a task from a reform-oriented calculus curriculum**  
*Sarah Enoch and Jennifer Noll*

3:00 – 3:30 pm  
**COFFEE BREAK**
3:30 – 4:00 pm

**SESSION 25 – PRELIMINARY REPORTS**

*City Center A*

Marginalizing, centralizing, and homogenizing: An examination of inductive-extending generalizing among preservice secondary educators

*Duane Graysay*

*City Center B*

Impacts on learning and attitudes in an inverted introductory statistics course

*Emily Cilli-Turner*

*Marquis Ballroom A*

Calculus students' understanding of logical implication and its relationship to their understanding of calculus theorems

*Joshua Case*

*Marquis Ballroom B*

A mathematics teacher educator’s use of technology in a content course focused on covariational reasoning

*Kevin Laforest*

*Grand Ballroom Salon 5*

Calculus students' meanings for difference

*Stacy Musgrave, Neil Hatfield and Patrick Thompson*

*Marquis Ballroom C*

Public versus private mathematical activity as evaluated through the lens of examples

*Tim Fukawa-Connelly*
4:10 – 4:40 pm  
**SESSION 26 – CONTRIBUTED REPORTS**

**Grand Ballroom**  
**Salon 5**  
**Undergraduate students’ construction of existence proofs**  
*Kyeong Hah Roh and Yong Hah Lee*

**Marquis Ballroom A**  
**Examining the pedagogical implications of a secondary teacher’s understanding of angle measure**  
*Michael Tallman*

**Marquis Ballroom B**  
**The equation has particles! How calculus students construct definite integral models**  
*Kritika Chhetri and Michael Oehrtman*

**Marquis Ballroom C**  
**Determining what to assess: A methodology for concept domain analysis as applied to group theory**  
*Kathleen Melhuish*
4:50 – 5:20 pm  

**SESSION 27 – CONTRIBUTED REPORTS**

*Grand Ballroom Salon 5*

**Semantic and logical negation: Students’ interpretations of negative predicates**

*Paul Dawkins and John Paul Cook*

*Marquis Ballroom A*

**Students’ reasoning when constructing quantitatively rich situations**

*Teo Paoletti*

*Marquis Ballroom B*

**An analysis of proof-based final exams**

*Mindy Capaldi*
5:20 – 6:15 pm

**POSTER SESSION**

*Grand Foyer*

Unifying concepts in the introductory linear algebra course

*Spencer Payton*

Analyzing data from student learning

*Bernard Ricca and Kris Green*

An exploration of students’ conceptions of rational functions while working in a CAS-enriched dynamic environment

*Derek Williams*

Creating online videos to help students to overcome exam anxiety in statistics class

*Anna Titova*

Students’ generalizations from single variable function to multi variable function in the context of limit

*Sarah Kerrigan, Erin Glover, Eric Weber and Allison Dorko*

Multiple representations of the group concept

*Annie Bergman, Kate Melhuish and Dana Kirin*

The role of examples in understanding quotient groups

*Carolyn James*

Psychometric analysis of the Calculus Concept Inventory

*Matt Thomas, Jim Gleason, Spencer Bagley, Lisa Rice, Nathan Clements and Diana White*
Student understanding of solution
Rebecca Walker

Beyond good teaching: The benefits and challenges of implementing ambitious teaching
Kathleen Melhuish, Erin Glover, Sean Larsen, and Annie Bergman

Can mathematics be a STEM pump?
William Bond and John Mayer

Some preliminary results on the influence of dynamic visualizations on undergraduate calculus learning
Julie M. S. Sutton

Investigating backward transfer effects in calculus students
Siobahn Young

A study of mathematical behaviors
Nadia Hardy

Effects of engaging students in the practices of mathematics on their concept of mathematics
Duane Graysay, Shahrzad Jamshidi, and Monica Smith Karukaran

6:30 – 9:00 pm
DINNER AND PLENARY

Grand Ballroom
Salons 2-4

Matthew Inglis