

# Topic Study Group No. 2: Mathematics Education at Tertiary Level

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## The Programme

Research in mathematics education at the tertiary level has experienced tremendous growth over the last decades (Biza, Giraldo, Hochmuth, Khakbaz, & Rasmussen, 2016; Rasmussen & Wawro, 2017). Evidence of this growth includes the continued success of the *Research in Undergraduate Mathematics Education conference in the United States*, now at its 20th annual conference; the university mathematics research contribution to the *Espace Mathématique Francophone* since 2006; and since 2011 the working group on *University Mathematics Education* in the *Congress of European research in Mathematics Education* conference. In 2015 the *Australian Mathematical Society* established a *Special Interest Group in Mathematics Education*, which has among its goals the promotion of inquiry and discussion about tertiary mathematics education. The first biennial conference of the *International Network for Didactic Research in University Mathematics* took place in 2016. Furthermore, in 2015 the new *International Journal of Research in Undergraduate Mathematics Education* published its first issue.

Reflecting this growth, a total of 64 papers and 23 posters were accepted for presentation at TSG 2. There were four main sessions with 14 papers, including two invited talks, one by Elena Nardi and one by Greg Oates. There were 50 short oral

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presentations in eight different sessions. Session blocks were organized around more or less coherent themes, including mathematical practices, teaching, professional and curriculum development, connections to engineering, transition to university, preservice teachers, student thinking, and research related to specific courses such as calculus, differential equations, and linear algebra. All talks and authors organized by session type are presented below. As a whole, these talks represent a rich and diverse collection of interests and theoretical approaches characteristic of a maturing discipline.

#### 1st Main Session—Mathematical Practices

- Symbolizing and brokering in fostering inquiry, Megan Wawro, Michelle Zandieh, Chris Rasmussen
- University students' behavior working with newly introduced mathematical definitions, Valeria Aguirre Holguín
- Learning how to axiomatise through paper folding, Dmitri Nedrenco

#### 2nd Main Session—Teaching

- Teaching mathematics to non-mathematicians: what can we learn from research on teaching mathematicians? Elena Nardi
- University mathematics lectures: teaching the same topics but different mathematics, Alon Pinto
- Using a theoretical perspective to teach a proving supplement for an undergraduate real analysis course, Annie Selden, John Selden
- Exploring lecturers' perceptions of using technology to teach mathematics at tertiary level, Jayaluxmi Naidoo

#### 3rd Main Session—Professional and Curriculum Development

- Mathematicians and mathematics education: collaborating for professional development, Greg Oates, Tanya Evans
- Holistic approach to curriculum review of undergraduate mathematics, Pee Choon Toh, Weng Kin Ho, Kok Ming Teo, Khiok Seng Quek, Tin Lam Toh, Eng Guan Tay, Romina Ann S. Yap
- Using technology to develop formative assessment resources for first year undergraduate modules, Ann O'Shea, Sinead Breen, Conor Brennan, Frank Doheny, Fiona Lawless, Christine Kelly, Ciaran Mac an Bhaird, Seamus McLoone, Eabhnat Ni Fhloinn, Caitriona Ni She, Brien Nolan
- The transition from secondary to tertiary mathematics education—a Swedish study, Christer Bergsten, Eva Jablonka, Hoda Ashjari

#### 4th Main Session—Student Thinking

- Students' thinking modes and the emergence of signs in learning linear Algebra, Melih Turgut, Paul Drijvers
- Exploring students' interactions in an online forum that accompanied a course in linear Algebra, Igor' Kontorovich

- Mathematical argumentation of first-year students: the influence of conceptual knowledge, Kathrin Nagel, Kristina Reiss

#### 1st Oral Communication Session Strand A—Linear Algebra

- Difficulties in mathematics experienced by students in a trans-disciplinary engineering study, Evangelia Triantafyllou, Olga Timcenko
- Ideas of mathematical literacy for cultivating students' understanding of concepts of linear Algebra, Ryuichi Mizumachi
- A task design to introduce the concepts of eigenvectors and Eigen values. An embodied approach, María José Beltrán-Meneu, Marina Murillo-Arcila
- Déjà vu in mathematics: what does it look like?, Robyn Pierce, Caroline Bardini

#### 1st Oral Communication Session Strand B—Teaching

- The art of mathematical chatter, Anne D'Arcy-Warmington
- Why students are not motivated to learn mathematics?, Seyed Hadi Afzali Borujeni, Azimehsadat Khakbaz
- “What we need to show is that  $t$  is well-defined”: gesture and diagram in abstract Algebra, Andrew Francis Hare
- Scripts in mathematics tutorials, Juliane Püschl

#### 2nd Oral Communication Session Strand A—Differential Equations and Calculus

- A case study on the impact of investigating multivariable calculus concepts through geometry and multiple representation, Aaron D Wangberg, Brian Fisher, Elizabeth Gire, Jason Samuels
- Student reasoning about functions, limits, and rate of change in introductory calculus, Caroline Julia Merighi
- Research and practice of college mathematics course assessment in Sichuan University, Jianren Niu, Liang Yang
- How do students of economics understand the concept of marginal cost? Frank Feudel
- About doing geometric approach in differential equations: difficulties and a coherent method, Younes Karimi Fardinpour
- Instrumental action schemes in differential equations using a computer Algebra system, maxima, Fereshteh Zeynivandnezhad

#### 2nd Oral Communication Session Strand B—Teaching

- The practice, guarantee and effect on the second classroom platform in university mathematics teaching, Chen Li, Chen Chaodong
- A comparative study of university students' math achievement of small-class teaching and large-class teaching, Chao dong Chen, Jian ren Niu
- Using journals to support learning: case of number theory and proof, Christina M Starkey, Hiroko Warshauer, Max Warshauer

- Knowledge of rational and irrational numbers of two undergraduate students, Geraldo Claudio Broetto, Vânia Maria Santos-Wagner
- The activity-based learning of mathematics in a technical higher education institution, Elena G. Yevsyeyeva
- Motivating university students to learn mathematics, Azimehsadat Khakbaz, Seyed Hadi Afzali Borujeni

### 3rd Oral Communication Session Strand A—Professional and Curriculum Development

- The future of mathematics teaching: analysis of the expectations of undergraduates in the federal district, Brazil, Jéssica de Aguiar França, Regina da Silva Pina-Neves, Raquel Carneiro Dörr
- Principles for designing invention tasks for undergraduate mathematics, Ben Davies, Caroline Yoon, John Griffith Moala, Wes Maciejewski
- Meaningful learning in mathematics education for the humanities and social sciences students, Mitsuru Kawazoe, Masahiko Okamoto
- Lecturer education: a course design, Ignasi Florensa, Marianna Bosch, Josep Gascón

### 3rd Oral Communication Session Strand B—Preservice Teachers

- An investigation into the efficacy of flipped classroom for tertiary mathematics, Weng Kin Ho, Kok Ming Teo, Lu Pien Cheng, Puay San Chan
- Interactive videos: a 21st century necessity for student engagement, Haitham S. Solh
- Systemic integration of programming in undergraduate mathematics: from implementation to theory, Chantal Buteau, Eric Muller
- Undergraduate math students' interactions with programming: developing instruments in institutions, Laura Rose Margaret Broley

### 4th Oral Communication Session Strand A—Transition to University

- Development of diagnostic self-assessments as a base for individual support for first-year students, Christoph Neugebauer, Sebastian Krusekamp, Kathrin Winter
- Didactical elaboration of multimedia learning materials by recent technological advancements exemplified by computer aid, Tobias Mai, Silvia Becher
- exploration of transfer of first year undergraduate mathematical learning to science, Yoshitaka Nakakoji, Rachel Wilson
- The algebra-to-calculus transition, William Crombie
- What first year university students' recommendations for freshmen reveal about their learning strategies, Robin Göller
- Issues in the transition from secondary to tertiary mathematics, Michael Surman Jennings, Merrilyn Goos, Peter Adams

## 4th Oral Communication Session Strand B—Connections to Engineering

- Challenges involved when reforming traditional courses in mathematics for engineers, Frode Rønning
- Analysis of typical mathematical competences required to solve tasks in basic engineering courses, Joerg Kortemeyer, Rolf Biehler
- Tree-structured online exercises in mathematics for engineering students: design and evaluation, Robert Ivo Mei
- Learning behaviour, academic success in engineering mathematics, and lecturers' ratings, Birgit Griese, Michael Kallweit
- Mathematical self-efficacy of engineering students at the introductory phase of studies, Ronja Kürten
- A preliminary analysis of the effectiveness of student-produced videos on the relevance of mathematics in engineering, Birgit Loch, Wendy Scott, Michelle Dunn

## Posters

- Procedural knowledge as a predictor for success in German math exams for first year engineering students, Mike Altieri
- Mathematics graduate teaching assistants' longitudinal transitions in beliefs about mathematics teaching and learning, Mary Beisiegel
- Algebraic thinking in the understanding and solution of geometric problems amongst year university students, Luis Weng San, Bhangy Cassy
- Results of us national study on calculus, Jess Ellis and Chris Rasmussen
- Studifinder: mathematical e-learning materials for the transition from secondary school to university, Yael Fleischmann, Alexander Börsch, Rolf Biehler, Christoph Colberg, Tobias Mai
- Concept and application of mathematizing to the process of classification, Alfonso J. González-Regaña, Verónica Martín-Molina, José María Gavilán-Izquierdo
- How, when, where and why do students use lecture recordings?, Roland Gunesch
- Digital media as motivating tool for learning descriptive statistics, Mathias Hattermann, Alexander Salle, Stefanie Schumacher, Daniel Heinrich
- A commognitive perspective on students' engagement with the concept of group: the case of students F and M, Marios Ioannou
- Students' perception of group discussions and presentations in a math education course, Seong-A Kim, Jeong-Gyoo Kim, Sunhee Lee
- Perception vs reality: using tutorial videos to aid tutor reflection, Heather Lonsdale, Deborah King
- A comparative analysis of three comprehensive initiatives to redesign developmental mathematics college curriculum, Carolyn Masserang
- Supporting internalisation of mathematical syntax using blocks, Anthony Morphet

- Revision activities of undergraduate mathematics students, Philip Walker, Eabhnat Ní Fhloinn
- Autonomy in mathematics in the secondary-tertiary transition, Pierre-Vincent Quéré, Ghislaine Gueudet,
- Mathematical competencies visible through assessment for engineering students, Kristina Raen
- University teaching assistants' teaching related beliefs, Johanna Rämö, Juulia Lahdenperä, Susanna Oksanen
- Bremath—redesign and implementation of university maths courses for future high school teachers, Ingolf Schäfer
- Assignments and written exams in an ICT learning environment, Karsten Schmidt
- Explicating strategies—planning an intervention to increase the strategic knowledge of university freshmen, Thomas Stenzel
- description and initial results of the preservice teachers seminar “Überpro\_wahrscheinlichkeitsrechnung”, Gero Stoffels
- Artin's braid group as an introductory example for group theory approaches at the university of hamburg, Sophie Stuhlmann
- Lecturers' pedagogical routines and expectations on students' engagement in closed-book examinations, Athina Thoma

## References

- Biza, I., Giraldo, V., Hochmuth, R., Khakbaz, A., & Rasmussen, C. (2016). Research on teaching and learning mathematics at the tertiary level: State-of-the-art and looking ahead. In *Research on Teaching and Learning Mathematics at the Tertiary Level*. Berlin: Springer International Publishing.
- Rasmussen, C., & Wawro, M. (2017). Post-calculus research in undergraduate mathematics education. In J. Cai (Ed.), *Compendium for Research in Mathematics Education*. National Council of Teachers of Mathematics: Reston, VA.

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