

# ICME\_2021 TSG Agenda

## TSG29: Preservice Mathematical Teacher Education at Secondary Level

Class: A

### Session 1 (Tuesday 13<sup>th</sup> July, 14:30-16:30 Beijing Time)

1. **Time:** 14:30 – 14:45

**Title of the Paper:** Measuring prospective secondary mathematics teachers' knowledge

**Author:** Kim Beswick

**Institution and Country/Region:** University of New South Wales; Australia

**Short abstract of the paper:** This presentation reports on the knowledge for teaching mathematics of 100 pre-service secondary mathematics teachers from six Australian universities in the context of increasing accountability for initial teacher education programs. Knowledge was conceptualised as comprising mathematical content knowledge, pedagogical content knowledge and beliefs. Rasch measurement techniques were used to obtain and validate performance measures on each of these aspects as well as on the overall teacher knowledge scale. Differences in performance were found on each of the three subscales and between sub-groups of participants according to highest mathematics studied, course type, mode of study, anticipated graduation year, and confidence to teach secondary mathematics. The findings contribute to an evidence base for initial teacher education and suggest areas in which future efforts to improve the preparation of secondary mathematics teachers might best be directed. The PCK and Content knowledge items have been used in preservice teacher education, professional learning for mathematics teachers, and to gain insight into teachers' beliefs. Examples of items will be shared and discussed.

2. **Time:** 14:45 – 14:57

**Title of the Paper:** Developing preservice teachers' ability to enact formative assessment for mathematical practices.

**Author:** Jacqueline Coomes

**Institution and Country/Region:** Eastern Washington University, USA

**Short abstract of the paper:** This case study investigated preservice secondary mathematics teachers' (PSMTs') developing understanding of formative assessment (FA) as a way to leverage mathematical practices for student learning. In this part of an ongoing design study, we sought to understand how PSMTs developed pedagogical content knowledge that helped them identify and capitalize on students' mathematical practices. Qualitative data came from PSMTs' responses to a learning sequence designed to help them develop nuanced and disciplinary-specific understandings of FA. Analyses suggest a trajectory for PSMTs learning to use FA in problem-solving environments. However, future research is needed to better understand PSMTs' development of pedagogical content knowledge for mathematical practices.

3. **Time:** 14:57 – 15:05

**Title of the Paper:** Developing prospective teachers' knowledge to promote students' mathematical reasoning: design of a teacher education experiment.

**Authors:** Ana Henriques, Hélia Oliveira, Leonor Santos, and Henrique Guimarães

**Institution and Country/Region:** Universidade de Lisboa, Portugal

**Short abstract of the paper:** To reason mathematically in a fluent way is an important skill to be developed by all students in order to learn with understanding and have success in mathematics. However, to promote students' mathematical reasoning it is required that teachers understand what reasoning means and how to create learning contexts that promote students' reasoning in their teaching practices. That is, teachers need to develop appropriate mathematical and didactical knowledge. This paper reports about the design principles and their operationalization for a pre-service teacher education experiment aiming to develop prospective middle school and secondary teachers' mathematical and didactical knowledge to promote students' mathematical reasoning. These instructional principles were informed by research literature and defined within three categories: General framework; Instructional approach; and Principles for materials to support teacher education.

4. **Time:** 15:05 – 15:13

**Title of the Paper:** A case study on applied lesson study for Korean secondary pre-service teachers.

**Author:** Na Young Kwon

**Institution and Country/Region:** Inha University, South Korea

**Short abstract of the paper:** This study describes a case that Korean secondary pre-service mathematics teachers engage in Lesson Study and discusses how this Lesson Study helps to learn teaching. Through reviewing literature, an applied Lesson Study for pre-service teachers was developed, which has a cycle of Preparation-Plan-Conduct-Revise-Re-conduct/Reflect. In this study, 9 groups of pre-service teachers engaged in the applied Lesson Study. As results, pre-service teachers reported noticing the understanding of students' mathematical knowledge and the importance of experiencing with students in classroom settings. They also mentioned challenges on scheduling and difficulties of sharing ideas or communicating with peers for developing lessons.

5. **Time:** 15:30 – 15:40

**Title of the Paper:** Developing an identity as a mathematics teacher: connecting with the community of teacher graduates

**Authors:** Judy Anderson and Debbie Tully

**Institution and Country/Region:** The University of Sydney, Australia

**Short abstract of the paper:** For preservice teachers, their role models are usually the teachers who taught them mathematics at school, and the teachers who supervised them during field experience placements. Relying on a few role models is risky since it may

lead to limited exposure to innovative practices and creative approaches to the teaching and learning of secondary mathematics. The broader the experiences of preservice teachers to a range of pedagogies, the greater chance they will appreciate the diversity of possibilities when teaching mathematics, they will develop more reflection on practice, and they will develop an identity as a mathematics teacher which best suits their talents. One strategy used at our university to build a community of practice was to introduce preservice teachers to alumni teachers at an annual conference designed to discuss current issues and to share experiences and practices.

6. **Time:** 15:40 – 15:48

**Title of the Paper:** Emotional awareness and support for preservice teachers during micro-teaching

**Author:** Réka Szász

**Institution and Country/Region:** Budapest Semesters in Mathematics Education, Hungary

**Short abstract of the paper:** The paper examines a technique where emotion cards are used in order to give emotional support to preservice teachers during micro-teaching. The activity was introduced at a study abroad program where preservice secondary teachers learn about guided discovery in mathematics. Micro-teaching involves designing a lesson for a fictional group of students integrating the guided discovery approach, and teaching it to fellow preservice teachers who play the role of students. The task often triggers a high level of anxiety from PSTs, so an emotional support activity was introduced, where PSTs were asked to share their emotions with the group before and after micro-teaching with the help of emotion cards. Results indicated that emotion sharing using emotion cards was helpful for PSTs as an immediate emotional support, and also helped PSTs grow as teachers.

7. **Time:** 15:48 – 15:56

**Title of the Paper:** Should school and university mentors agree in their feedback to pre-service mathematics teachers?

**Author:** Viren Ramdhany

**Institution and Country/Region:** University of Johannesburg, South Africa

**Short abstract of the paper:** The practicum experiences of pre-service teachers (PSTs) take place under supervision of school and university mentors. The development of PSTs is monitored by school mentors in real-world conditions, all the while learning to teach in context; while university mentors clinically supervise and assess the extent to which the students are mastering their professional practice according the measures promoted in the university setting. Crucially, the university and school mentors operate in different institutional spaces where educational ideologies and beliefs may differ. In this study, 4 PSTs were tracked during their practicums. Each PST was interviewed via semi-structured interviews and asked about their mentoring experiences. In addition, the mentors' feedback sessions with the students were recorded. One PST in particular, received patently contradictory messages from his school and university mentors,

regarding his practice during an observed lesson, suggesting that the mentorship space is a site of conflict between the school and university mentors, in terms of the ideologies they promote and the demands they make on PSTs. This difference, which could lead to conflicting mentors' feedback to the pre-service teachers, could also promote greater learning among PSTs.

8. **Time:** 15:56 – 16:04

**Title of the Paper:** Teacher candidates' and mentor teachers' perspectives of using co-planning and co-teaching during clinical experiences in secondary mathematics

**Authors, Institution(s) and Country/Region:**

Ruthmae Sears & **Cynthia Castro-Minnehan**, University of South Florida, USA

Laurie Riggs, Cal Poly Pomona, USA

Pier Junor Clarke, Georgia State University, USA

Jamalee Stone, Black Hills State University, USA

Charity Cayton & Maureen Grady, East Carolina University, USA

Jennifer Oloff-Lewis, Chico State University, USA

Patricia Brosnan, Ohio State University, USA

Marilyn Strutchens, Auburn University, USA

**Short abstract of the paper:** This paper will describe teacher candidates' and mentor teachers' perspectives about using co-planning and co-teaching during secondary mathematics clinical experiences. Data were garnered from six universities across the United States. The data were garnered from a professional development survey, pre-survey, just-in-time survey, post survey and MCOP2. The quantitative items were analyzed using measures of central tendencies, and the qualitative analysis was analyzed using thematic results. The results suggest that the instructional pairs generally perceived co-teaching to be beneficial despite time constraints, and that the use of co-teaching strategies increased equitable learning opportunities.

9. **Time:** 16:04 – 16:12

**Title of the Paper:** Mentor teachers as inductors of preservice mathematics teachers at secondary schools- a southern African perspective

**Author:** Kakoma Luneta

**Institution and Country/Region:** University of Johannesburg; South Africa

**Short abstract of the paper:** Skills and professional induction at any level is critical to the eventual effective disbursement of knowledge and skills for mathematics preservice teachers. Research asserts that professionals that are well inducted in their profession, acclimatise and settle down into the profession faster professionally and socially. The induction however must be conducted by mentor teachers that have undergone professional development programs around mathematics teacher induction and mentorship. This study reports on a mentor training program that was conducted for 8 school teachers that underwent an intensive one week mentorship training on what was regarded as the four basic pillars of mentorship namely: teacher induction, coaching, counselling and professional development for mathematics teachers. The four basic

pillars of the mentoring program were developed from a document analysis of various mentoring programs both local and international that identified them as critical components of a successful mentoring program for mentor teachers. The program incorporated mentoring for effective mathematics instructions as the core module.

## **Session 2 (Wednesday 14<sup>th</sup> July, 19:30-21:00 Beijing Time)**

### **1. Time: 19:30 – 19:45**

**Title of the Paper:** Transforming secondary mathematics teacher preparation: a multi-dimensional problem

**Authors:** W. Gary Martin and Marilyn E. Strutchens

**Institution and Country/Region:** Auburn University, USA

**Short abstract of the paper:** The Mathematics Teacher Education Partnership (MTE-Partnership), a coalition of over 90 universities and their school partners, was formed to identify and address the multi-dimensional issues faced by secondary mathematics teacher preparation programs in the U.S. using a Networked Improvement Community design. Research Action Clusters were formed to address problems related to providing effective clinical experiences, developing candidates' mathematical knowledge relevant to teaching, and recruitment of candidates into mathematics teacher preparation programs and subsequently retaining them in the profession. Additional cross-cutting themes have emerged related to ensuring equity across the mathematical teaching preparation experience and developing the institutional changes needed to support overall program transformation.

### **2. Time: 19:45 – 19:57**

**Title of the Paper:** Teacher educators' use of technology to represent instruction

**Authors:** Daniel Chazan and Patricio Herbst

**Institutions and Country/Region:** University of Maryland and University of Michigan; USA

**Short abstract of the paper:** Teacher educators used two tools designed to support their work. Each tool is structured around an innovation in representing instruction; one supports the representation of what happens in classroom instruction, usually in K-12 settings, the other supports representation of what is intended to happen in online instruction, most often in university teacher education classes. This paper begins to explore what sorts of aspects of classroom interaction teacher educators wanted to represent and how having a digital tool for planning on-line student experiences facilitated collaboration on both teaching and research.

### **3. Time: 19:57 – 20:05**

**Title of the Paper:** Integrating computational making tools in mathematics thinking activities

**Authors:** Immaculate Namukasa, George Gadanidis and Derek Tangredi

**Institution and Country/Region:** Western University; Canada

**Short abstract of the paper:** Policy makers are currently interested in integrating computational thinking (CT) and making activities, such as programming, in teaching in mathematics classrooms. This paper reports on a study in which researchers mobilized findings from classrooms in the education of teacher candidates at one university in Canada. Teacher education candidates participated in 2-hour course-based workshops. The researchers, in collaboration with the course instructors, offered learning tasks that utilized CT and making tools for meeting specific mathematics method learning goals. The tasks were adopted from the classroom study, and included tasks such as exploring mathematics coding apps and coding of mathematics simulations. During the workshops, teacher candidates were prompted to reflect on their engagement and to discuss pedagogical considerations, such as conceptual analyses of the tasks. Written, observation and reflection data was analyzed to investigate participants' learning and views. The study has implications for preparing teachers to critically integrate CT and making in teaching.

4. **Time:** 20:05 – 20:17

**Title of the Paper:** Instrumental genesis and the growth of preservice secondary mathematics teachers' technological content knowledge

**Author:** Xiangquan Yao

**Institution and Country/Region:** Pennsylvania State University; USA

**Short abstract of the paper:** Technological content knowledge is an essential yet less studied component of the TPACK framework. Relying on the theory of instrumental genesis, this study reports three types of technological content knowledge emerging in the process of instrumental genesis when preservice secondary mathematics teachers engaged in problem-solving with the Geometer's Sketchpad.

5. **Time:** 20:17 – 20:27

**Title of the Paper:** A situated approach to assess prospective mathematics teachers' professional competencies

**Authors:** Le Thi Bach Lien & Tran Kiem Minh

**Institutions and Country/Region:** Quang Binh University and Hue University; Vietnam

**Short abstract of the paper:** This study investigates prospective mathematics teachers (PMTs)' competencies for teaching mathematics from a situated perspective. We used the teacher competence model as a main theoretical framework. This model aims at resolving the common dichotomy between cognitive and situated perspectives in the study of teachers and their work. In this model, teacher competence is seen as a continuum starting from cognitive and affect-motivation aspects moving to situation-specific skills that lead to performance in the classroom. In this study, we have also developed a framework for evaluating teachers' noticing competence based on lesson analysis after observing videos. More specifically, we used a qualitative analysis to bring out the characteristics of Vietnamese PMTs' professional competencies for teaching the derivative in real-world

contexts. Finally, implications for the professional learning of Vietnamese mathematics teachers are also discussed

6. **Time:** 20:27 – 20:35

**Title of the Paper:** Direct & indirect effect sizes on secondary mathematics teacher candidates' content knowledge & pedagogical content knowledge as measured by national examinations: a structural equation modeling multi-cohort longitudinal study

**Authors:** Jeremy Zelkowski and Tye Campbell

**Institution and Country/Region:** The University of Alabama; USA

**Short abstract of the paper:** National examinations in teacher licensing exists across the globe. Professional organizations have made recommendations of coursework, knowledge, practicum experiences, and dispositions to enter the teaching profession. This six-year, five-cohort study applied path analysis, a derivative of structural equation modeling, as a new methodology to examine the direct and indirect effect sizes of program coursework, grades, assessments, and clinical observations of teaching on national license exams in the United States for secondary mathematics teacher candidates. The models explained 69% of the variance in Praxis II Mathematics Content Knowledge Exams and 42% of the variance in edTPA Pedagogical Portfolio Assessment scores. The total effect sizes range from medium to large depending on the specific measures. Our study presents the first large scale, structural equation model, as it relates to mathematics teaching professional organization recommendations for mathematics teacher education in the US. We recommend replication studies in different settings and countries.

### **Session 3 (Saturday 17<sup>th</sup> July, 21:30-23:00 Beijing Time)**

1. **Time:** 21:30 – 21:42

**Title of the Paper:** A case study on the development of pedagogical design capacity of mathematics prospective

**Authors:** Meiyue Jin

**Institution and Country/Region:** Liaoning Normal University, China

**Short abstract of the paper:** Since 2011, Ministry of Education of the People's Republic of China has promulgated "Teacher Education Curriculum Standard(Trial)", "Interim Measures for Primary and Secondary School Teacher Qualification Examinations", "Teacher Education Revitalization Action Plan," and "Implementation of Excellent Teacher Training Plan 2.0's Opinions". These documents emphasize prospective teachers' practical skills. To improve and develop the pedagogical design capacity of mathematics prospective teachers (PTs), the research try to construct a mathematics pedagogical design capacity model by a literature analysis, explore the key factors that would affect the development of the capacity of PTs, inquire the effective approach to capacity development through the action study of six PTs, set up the reasonable course system, and renew the course content. Through five years of research and practice, we construct a two-dimension pedagogical design capacity model that consists of 27 sub-dimensions 54 modules, find that MPCK is the main factor affecting PT pedagogical design capacity,

establish the center course system that consists of "Middle School Mathematics pedagogical Design", "Middle School Mathematics Teaching Case Development", "Research in Middle School Mathematics " and "Research Methods on Mathematical Education ", and design MPCK-centered course content. The study also shows that lesson study based on PCK is an effective teaching method, observation-theory-practice-reflective practice under faculty and school advisors are best practicum ways, and an action learning community led by an expert teacher is very necessary.

**2. Time:** 21:42 – 21:57

**Title of the Paper:** Using multiple scripting tasks to probe preservice secondary mathematics teachers' understanding of visual representations of function transformations

**Authors:** James A. Mendoza Álvarez, Theresa Jorgensen, and Janessa Beach

**Institution and Country/Region:** The University of Texas at Arlington, USA

**Short abstract of the paper:** In this paper, we use multiple scripting tasks as research tool to investigate preservice secondary mathematics teachers' (PSMTs') mathematical knowledge of function transformations and their capacity to connect multiple representations of functions. Mathematically similar scripting tasks focused on visual representations of function transformations were given at three intervals during a 15-week semester in a course on functions for PSMTs. PSMT responses to these scripting tasks were analyzed using thematic analysis to identify four prevalent themes in their responses. In addition, we noted the PSMTs' willingness to validate student thinking before directing them to rule following or redirecting student thinking. The resulting themes reveal the extent to which PSMTs address visual representations from the student perspective and PSMTs' tendency to "search for rules" in their explanations.

**3. Time:** 21:57 – 22:09

**Title of the Paper:** Tertiary and secondary mathematical knowledge for prospective teachers: a comparison on teacher employment tests for secondary mathematics in Korea and china

**Authors:** Xiaoying Chen and Bomi Shin

**Institution and Country/Region:** Chonnam National University, South Korea

**Short abstract of the paper:** The purpose of this study is to explore alternatives to set items of teacher employment test for examining teachers' mathematical knowledge by comparatively analyzing the test items in Korea and China. With the reorganized framework, we analyzed the test items of two countries in 2009-2019. As a result, we found that tertiary mathematics items were not connected to the secondary mathematics content in both countries' tests; we suggest that advanced secondary mathematics could be essential alternatives to examine teachers' mathematical knowledge.

**4. Time:** 22:09 – 22:17

**Title of the Paper:** Investigating the professional learning of pre-service mathematics education students using reflection and collective feedback to enhance teaching

**Author:** Benita Portia Nel

**Institution and Country/Region:** University of the Western Cape, South Africa

**Short abstract of the paper:** Mathematics teacher educators grapple with finding ways to support student teachers on how to transfer what is explained and discussed in lectures, into the classroom. Research alludes to the difficulty to transfer professional training from the laboratory to the field (in this case the classroom) and addressing the dilemma that teacher quality does not necessarily translate into teaching quality. A qualitative study was conducted where three final year Mathematics student teachers reflected collectively on their classroom practice with the knowledgeable other during the seven week practice teaching period. The research question was: Do Mathematics student teachers adjust their teaching after receiving feedback from a knowledgeable other in conjunction with their peers? If so, what kind of adjustments are observed? In this article, I argue that there is value in collective reflections. Students developed in their design and use of technology as teaching aid, in their time management, in talking at a slower pace and on how to reflect. Evidence of collective learning through reflection were noticed when the participants incorporated the feedback given to others, in their own lessons.

5. **Time:** 22:17 – 22:25

**Title of the Paper:** Concept cartoon design in preservice teacher training: an opportunity to learn from the practice

**Author:** Cristina Ochoviet

**Institution and Country/Region:** Consejo de Formación en Educación; Uruguay

**Short abstract of the paper:** This paper presents what five mathematics student teachers learnt after they designed and put into practice a particular type of open-ended tasks: the concept cartoons. In Uruguay the mathematics education/ teaching practice courses are a fundamental component of teacher training. In the last year of the mathematics teacher career, the student teachers are responsible of teaching mathematics in one secondary school group along one year. Most common errors of their own secondary students were discussed in the group of student teachers. Using this information gained from the student teachers' own practice the student teachers designed open-ended concept cartoons and put them into practice in their own secondary school groups. The results show that working with open-ended concept cartoons is an excellent opportunity to learn from the practice because they provoke powerful insights about how secondary students learn mathematics as well as the process of becoming a teacher.

6. **Time:** 22:25 – 22:35

**Title of the Paper:** Physical representations and understanding of multivariate functions

**Authors:** M. Kathleen Heid and Matthew Black

**Institution and Country/Region:** Pennsylvania State University, USA

**Short abstract of the paper:** Even after extensive work with  $\mathcal{R}$ -to- $\mathcal{R}$  functions students frequently operate at only the action or process levels when working with functions of two variables. Research has suggested that students who have a deeper understanding of

planar slices of surfaces representing functions of two variables have an overall better understanding of multivariate functions. The study of student understanding of multivariate functions has not yet focused on strategies for helping students extend their knowledge of univariate functions to functions of two and more variables. The strategy for enhancing students' understanding of multivariate functions used in this study centered on students' engagement in constructing physical models of functions of two variables from planar slices of the 3-dimensional graphs of those functions. This study analyzes students' understandings of functions of two variables before and after they engaged in constructing these physical models as reflected in their interactions with representations of multivariate functions in a range of representational registers.