

## **Topic Study Group 30**

### **In-Service Mathematical Teacher Education and Mathematical Teacher Professional Development at Primary Level**

TSG-30 Working Team<sup>1</sup>

#### **1. Introduction**

The entire organizing team worked together before the congress in planning and organizing TSG-30 since 2018. There are 36 proposals submitted, and finally 4 accepted and presented as long-oral reports and 15 accepted and presented as short-oral reports. The TSG-30 was well attended in two 90-minute sessions and one 120-minute session in July 2021, which indicates strong interest in this topic by congress delegates. This report provides an overview of the aim and focus of TSG-30 and a summary of the presentations and discussions that occurred throughout the sessions.

#### **2. Aim, Focus, and Themes**

As set by the organization team, the general aim of TSG-30 was, in the international mathematics education community, to provide a venue for congress participants to share research, policy, design or practice that foci on in-service mathematical teacher education and mathematical teacher professional development at primary school level.

The focus of TSG-30 was a discussion of research related to in-service mathematical teacher education and mathematical teacher professional development. In-service mathematics teacher education and professional development are integral parts of teachers' life-long learning process, and take many different formal or informal formats with various foci and requirements within and across education systems. The situation becomes especially complex at primary school level, where teachers can be generalists in many education systems but content specialists in some other systems. Understanding and researching in-service mathematical teacher education and mathematical teacher professional development at primary level, therefore, call for

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<sup>1</sup>Working team:

Chair: Yeping Li (USA), Texas A&M University. E-mail: [yepingli@tamu.edu](mailto:yepingli@tamu.edu)

Co-Chair: Leonor Santos (Portugal), University of Lisbon. E-mail: [mlsantos@ie.ul.pt](mailto:mlsantos@ie.ul.pt)

Team Members:

Munira Amirali (Pakistan), Aga Khan University

Xingfeng Huang (China), Shanghai Normal University

Masakazu Okazaki (Japan), Okayama University

special attention to policy, design, and practice situated in special system and sociocultural contexts. For example, it is not difficult to notice contrasting practices in which mathematics teachers work and learn in different ways through various forms of collaborations in the East versus in the West. Efforts to understand what in-service mathematics teachers may do in and for improving their teaching and expertise have led to ever-increased interest in exploring and examining different programs, activities, and the nature of various collaborations and processes through which primary school teachers are engaged to learn. Consistently, new theoretical perspectives have also been developed and proposed about in-service teachers' professional development (e.g., practice-based professional education of teachers, locating teacher learning in communities, lesson study in Japan and China, communities of teachers working in contact with communities of researchers and evolving in their professional practices). It is important to understand through research the nature of different programs and activities, the focus and process of various teachers' knowledge learning and professional development, the extent of teachers' learning effects, the roles of policy and administrative support, and specific system and sociocultural factors associated with different teacher education programs and activities.

With this focus, TSG-30 was intended to provide an international gathering place for all interested parties (e.g., mathematics educators, teacher educators, school teachers, educational researchers, etc.) to share and disseminate findings from their research on in-service mathematical teacher education and mathematical teacher professional development at primary level, with the use of various theoretical perspectives and methodologies, and to exchange ideas in research, development, and evaluation of in-service mathematical teacher education and mathematical teacher professional development at primary level.

In TSG's call for contributions, the following five themes were outlined:

1. Theoretical perspectives and methodological advances in research on in-service mathematical teacher education and mathematical teacher professional development at primary level;
2. Research on the design and/or implementation process of specific programs, approaches, and practices, such as the use of video clips and IT, for in-service mathematical teacher education and mathematical teacher professional development at primary level;
3. Research on documenting the effectiveness of specific programs, approaches, and practices for in-service mathematical teacher education and mathematical teacher professional development at primary level;
4. Research on comparing and documenting system and sociocultural factors contributing to in-service mathematical teacher education and mathematical teacher professional development at primary level;
5. Issues concerning possible (dis)connections between research and practice in in-service mathematical teacher education and mathematical teacher professional development at primary level.

The original plan was then to organize accepted proposals for presentations in theme-based sessions. Unfortunately, due to the unexpected pandemic that started in early 2020, the organizers had to not only postpone the Congress from July 2020 to July 2021, but also to offer all the sessions in a hybrid format due to the international travel restrictions. At the same time, however, the hybrid format itself won't be able to solve the issue of time zone differences for international contributors as they may not be able to join a specific session. In fact, many international contributors decided not to join the Congress to present, even though their proposals were accepted. At the end, there were 19 accepted proposals remaining with the contributors agreed to participate and present during the Congress. Thus, the session organization was no longer to follow specific themes, but mainly to accommodate presenters' availability and preference to present at certain times.

Given the three sessions (two 90-minute sessions and one 120-minute session) that were allocated for TSG30, the first 90-minute session on July 13<sup>th</sup> was devoted to four long-oral presentations (LO), and the other 90-minute session on July 16<sup>th</sup> and the 120-minute session on July 17<sup>th</sup> were organized for the 15 short-oral presentations (SO) (see Tab. 1 on the next page). In the following sections, we briefly summarize the paper presentations and discussions during these sessions.

### **2.1. Session 1**

The first long oral presentation (Huang & Zhang)<sup>[1]</sup> shared the scope of a program that involved mathematics teachers from Shanghai and Britain that, in a collaborative environment, taught two weeks in the other country. Taking the Anthropological Theory of the Didactic as a theoretical framework, this strategy provided the professional development of the teachers participating in the project. The study focused on two primary teachers from Shanghai that had their teaching experience in Britain. The results revealed that they encountered difficulties in the implementation of the lesson (the approach they used in their country was not suitable in this new context of practice), which led them to reflect on their practice and to adjust their didactic tasks and techniques in time for teaching improvement.

The long presentation by Livy et al.<sup>[2]</sup> was to understand how the lesson structure of teaching a challenging task might impact on a Year 2 teacher's pedagogical approaches for teaching mathematics. An inquiry-based approach of teaching students with a challenging task was explored in three phases: Launch the task (without telling); Explore the task (students' attempt on the task by themselves); and Summarise (the teacher's selection of particular students to share their work during the lesson to support student learning). The results revealed that the work sample chosen by the teacher in the summarise phase helped students to learn from each other, and permitted the teacher to experience success with her own teaching by building knowledge of pedagogy from practice.

Tab. 1. List of papers presented

<b>Paper and author(s):</b>	
<b>Session 1</b>	
[1]	Chinese teachers' learning as transformation of didactic praxeologies in a cross-cultural teacher exchange programme. <b>Xingfeng Huang and Yunji Zhang</b> (China). (LO)
[2]	Developing teachers' classroom actions and pedagogical knowledge through the facilitation of teaching a challenging task. <b>Sharyn Livy, Janette Bobis, Ann Downton, Sally Hughes, Maggie Feng, Melody McCormick, James Russo, and Peter Sullivan</b> (Australia). (LO)
[3]	Changes in mathematical knowledge for teaching and belief on practices through professional development based on reasoning-modeling approach. <b>Kyong Mi Choi, Jihyun Hwang, Jessica Jensen, Dae Hong, and Wesley Cox</b> (USA). (LO)
[4]	Are elementary in-service teachers confident and well prepared in mathematics they teach? — the case of fraction division. <b>Yeping Li</b> (USA), <b>Huirong Zhang, and Naiqing Song</b> (China). (LO)
<b>Session 2</b>	
[5]	Mathematical reasoning and teacher education. <b>Leonor Santos, Ana Henriques, Joana Mata-Pereira, and Lurdes Serrazina</b> (Portugal). (SO)
[6]	In-service teacher education for promoting mathematics reasoning in primary school. <b>Lurdes Serrazina and Joana Brocardo</b> (Portugal). (SO)
[7]	Growing through inquiry: a story of three primary teachers investigating their practice. <b>Derek J. Sturgill</b> (USA). (SO)
[8]	Math teachers competence assessment to develop personalized professional learning. <b>Ilze France, Dace Namson, Liga Cakane, and Ilze Saleniece</b> (Latvia). (SO)
[9]	Assessing the efficacy of the math for all professional development program for primary teachers and their students. <b>Babette Moeller, Matt McLeod, Teresa Duncan, Jason Schoeneberger, John Hitchcock, and Marvin Cohen</b> (USA). (SO)
[10]	Drawing on the didactical suitability criteria to analyse a lesson study enhancing teachers competence of didactical reflection. <b>Viviane Hummes, Adriana Breda, Elvira García-Mora, Vicenç Font, Javier Diez-Polomar</b> (Spain), and <b>Maria José Seckel</b> (Chile). (SO)
[11]	Insights on Shanghai in-service primary mathematics teachers' acquisition of pedagogical content knowledge through teaching research group activities: a case study. <b>Hong Yuan</b> (USA). (SO)
<b>Session 3</b>	
[12]	Kyozaikenkyu as well-formed story making for developing quality mathematics lessons. <b>Masakazu Okazaki, Keiko Kimura, and Keiko Watanabe</b> (Japan). (SO)
[13]	Teaching as professional learning: small steps towards sustainable mathematics teacher professional development. <b>Ban Heng Choy and Jaguthsing Dindyal</b> (Singapore). (SO)
[14]	Improvement of a preschool teacher's reflection on pedagogical content knowledge during a professional development programme in Japan. <b>Nagisa Nakawa and Nanae Matsuo</b> (Japan). (SO)
[15]	Teachers views of the effects of the fostering inquiry in mathematics project. <b>Jill Cheeseman</b> (Australia). (SO)
[16]	Developing teachers' knowledge of fractions: a case from Karachi, Pakistan. <b>Munira Amirali</b> (Pakistan). (SO)
[17]	Contingencies as moments of collaboration: a report on investigating and supporting mathematics teachers' knowledge. <b>Shikha Takker and K. Subramaniam</b> (India). (SO)
[18]	Re-conceptualizing primary mathematics in-service teacher professional development in nigerian context. <b>Lawan Abdulhamid</b> (South Africa) and <b>Balarabe Yushau</b> (Nigeria). (SO)
[19]	Development of critical lenses among teachers in lesson study. <b>Tan Saw Fen</b> (Malaysia). (SO)

The long presentation by Choi et al.<sup>[3]</sup> shared a programme with its main objective to develop teachers' mathematical knowledge for teaching (MKT) and beliefs (B) on instructional practices. Using the Reasoning and Modelling approach, the study aimed

to understand if this programme has the effects as expected and in which way the 22 participating teachers grew in these two domains. The results suggested that there were significant changes in mathematical knowledge for teaching and beliefs on instructional practices.

The last long presentation, by Li et al.<sup>[4]</sup>, focused on both in-service Chinese teachers' (ITs) confidence about their knowledge and the extent of their conceptual knowledge for teaching (MCKT) on the topic of fraction division. The results revealed how these ITs' confidence may or may not be supported by their knowledge for teaching fraction division, an important topic they need to teach as part of the curriculum standards in China. The results also illustrated the importance of specifying knowledge components in mathematics instruction in order to help build and support ITs' confidence for classroom instruction.

## 2.2. *Session 2*

Santos et al.<sup>[5]</sup> shared the project REASON (Mathematical Reasoning and Teacher Education) that investigated ways to support primary and secondary prospective and practicing teachers' development of mathematical and didactical knowledge to promote students' mathematical reasoning. The presentation highlighted that, when systematic intervention was carried out with prospective and in-service mathematics teachers, their capacity to engage students in mathematical reasoning was evident. The initial result showed that the tasks developed were helping teachers to build their knowledge, skills and capacity to teach students to promote their reasoning skills.

Serrazina & Brocardo<sup>[6]</sup> reported part of the research developed by the project REASON (Mathematical Reasoning and Teacher Education). They highlighted the key findings of the project with primary school teachers (grades 1–6) following a Design-Based Research approach. The presentation included examples from the training material used in developing teachers' understanding of the nature of tasks that promote mathematical reasoning among students. Also, the students' work indicated that teachers were able to implement their learning acquired in the project to promote mathematical reasoning in their class.

Sturgill<sup>[7]</sup> presented the research findings from working with three Grades 4–6 teachers of mathematics who taught in the Midwestern United States in the classroom inquiry projects. The study highlighted that classroom inquiry, a structured form of teacher research, is a powerful tool for improving teachers' knowledge for teaching and their practice. The study findings included improvement in teachers' knowledge of teaching and student learning, knowledge of classroom inquiry and action research, and students' engagement with the support and time to enact their respective inquiry projects.

France et al.<sup>[8]</sup> presented a study that aimed to examine 25 mathematics teachers' competencies in the context of Latvia's curriculum reform in general education, with a particular focus on teachers' preparedness to develop student cognitive skills and ways to stimulate more appropriate and individualized teacher professional development. Based on the study findings, four groups of teachers were identified,

each requiring individualized professional development to ensure implementation of reform-relevant ideas into the school practice.

Moeller et al.<sup>[9]</sup> shared Math for All (MFA), an intensive professional development (PD) program for in-service teachers. They reported on a randomized controlled trial (RCT) of MFA involving 32 schools, 98 4th and 5<sup>th</sup>-grade general and special education teachers, and approximately 1,500 4th and 5<sup>th</sup>-grade students. The findings indicated that MFA had statistically significant, positive effects on teachers' self-reports of their preparedness and comfort with teaching. A school-level analysis found a moderate MFA effect on student achievement. Quasi-experimental analyses of a subgroup of teachers being observed showed initial evidence of MFA impacts on their classroom practices.

Hummes et al.<sup>[10]</sup> discussed the combination of two major instruments for professional mathematics teachers' development: the lesson study (LS) and the didactical suitability criteria (DSC). Drawing on a literature review, presenters argued that combining LS and DSC offers teachers the opportunity to draw on a consensual structured approach covering the main educational dimensions embedded within their classroom practice.

Yuan<sup>[11]</sup> focused on one of the job-embedded and expert-assisted professional development programs. The study examined Shanghai in-service primary mathematics teachers' acquisition of pedagogical content knowledge (PCK) through participating in Teaching Research Group (TRG) activities. The study findings showed that teachers developed their PCK by creating supplementary teaching materials, studying students' thinking, and teaching mathematical thinking by working closely with teaching research coordinators during TRG activities; and writing reflection reports afterwards. The study has implications for teachers' community of practice which, in turn, improves students' learning of mathematics.

### **2.3. Session 3**

Okazaki et al.<sup>[12]</sup> shared how teachers' in-depth study of instructional material can be examined in the context of lesson study. In particular, the four levels of teachers' instructional material study were reported, which were identified as a result of the studies that compared three types of teachers who were different in their experiences.

Choy and Dindyal<sup>[13]</sup> discussed teachers' professional development in the in-service training program in Singapore. They conceived the aspects of the professional development in terms of Desimone's framework, and focused on the first phase of needs analysis. As a result of analysis, they clarified the teachers' insufficient understanding of the connections among mathematics, students' learning difficulties, and teaching approach. Thus, they suggested the importance of positioning every teaching action as opportunities for professional development and of exploring teaching approach in terms of mathematics and students' learning.

Nakawa and Matsuo<sup>[14]</sup> reported a pre-school teacher in Japan who improved her mathematical abilities in teaching through experiencing PD program based on the ALACT model under the guidance of the researchers. The results showed that the

teacher could develop knowledge of content and teaching and knowledge of content and curriculum in the framework of mathematical knowledge for teaching through the program.

Cheeseman<sup>[15]</sup> reported the change in the teachers' views through participating in the professional development project FliM that focused on problem solving and inquiry. The results showed that the teachers believed they had improved professional skills, knowledge, pedagogies, enthusiasm, and confidence in their teaching of mathematics with young children through the FliM project.

Amirali<sup>[16]</sup> shared the urgent situation in Pakistan, where primary school teachers are struggling to teach basic mathematical concepts as they have been recruited as the "primary school teachers" rather than "subject specialist teachers". Teachers lose the opportunities of choosing grades they want to teach as the administrators would assign mathematics teaching to those whom they think are able to teach mathematics, especially in grades IV and V or even higher grades. Moreover, the researcher also pointed out the basic situation in Pakistan that after the schooling, teachers who teach mathematics received very limited training in mathematics by themselves.

Takker and Subramaniam<sup>[17]</sup> pointed out that contingencies arising in the context of teaching practice are important moments in the teacher-teacher educator collaboration. These moments would require teacher educators to revisit their goals and use these moments as learning opportunities for all participants. Researchers discussed two episodes (connection between a method and the algorithm & teaching the missing ideas in the textbooks) and found out when teachers sought supports, that dynamic contingent situations emerged. If researchers wanted to respond well to those situations, that would mean they needed more flexibility in their roles and had the knowledge and awareness to deal with. Moreover, these contingent situations created possibility for teachers to try alternative practices and for the researchers to take a more active role in the practice of teaching, and also challenge teachers' existing knowledge of the content, students and specific topics.

Abdulhamid and Yushau<sup>[18]</sup> presented a re-conceptualization of mathematics teacher professional development that highlights the policy implications for addressing the gaps among Nigerian primary mathematics teachers in their fundamental understandings of basic mathematics. Despite the fact that huge rollout of PDs in Nigeria that focused on teachers' content knowledge and content-specific pedagogy, the researchers found that PDs typically were not based on the research and teachers' specific needs. They called for the need to disaggregate the levels at which in-service mathematics teacher professional development interventions could usefully start across lower (grade 1–3), middle (grade 4–6) and upper (grade 7–9) basic teachers, and the need for a longer period of PD, with interim assessments.

Fen<sup>[19]</sup> presented a study that explored the development of teachers' critical lenses when they were conducting lesson study within two lesson study groups. The two lesson study groups, comprised of 6 teachers and 3 teachers respectively, conducted five lesson study cycles. Teachers from both lesson study groups developed student and curriculum developer lenses. But those teachers only developed curriculum developer and student lenses within this study, rather than the researcher lens as the

development of their critical lenses might be affected by the knowledgeable others, anticipation of students' responses and difference in experience and seniority among the participating teachers. Researchers pointed out that when planning to set up lesson study group in a specific school, administrators might want to focus on the experience and seniority of teachers which showed great importance to teachers' professional development.

### **3. Closing Remarks**

Among the main points discussed and summarized across these three sessions we highlight the following ones:

- Efforts to explore and document effective programs and approaches to improve mathematical teachers' knowledge for teaching and related beliefs in diverse system and cultural contexts;
- The search for possible approaches and solutions to address the weak mathematical training that many primary school teachers often have in diverse system and cultural contexts, and possible policy implications;
- The changes in teacher professional development needs in the context of educational reforms, including curriculum and in-service learning, and efforts to address such changes;
- The development of new conceptions (or re-conceptions) of what teachers need to know and be able to do in teaching, and teacher professional development;
- The development and use of various assessment and analytical tools to document possible changes in teachers' knowledge, beliefs, and/or practices through participating in professional development programs.

Naturally, in such a broad topic as mathematical teacher education and mathematical teacher professional development at primary level in diverse system and cultural contexts, many questions remain to be addressed. The diversity of approaches and foci presented suggests many different perspectives that contributors took to develop, search, and document effective programs or approaches, which aspects of professional development were to be focused, what may need to be developed and implemented to address the critical needs in teacher professional development in various contexts, and how professional development may be positioned to facilitate educational reforms. The participants shared a strong interest in various topics covered in the TSG's presentations through online discussions across these sessions.