# Topic Study Group 28

## Preservice Mathematical Teacher Education at Primary Level

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**ABSTRACT** The rationale of TSG-28 was to engage participants in reflection on, and discussion of, the theoretical, empirical and practical issues. Twenty-five papers were reported, from twelve countries showing a great diverse cultural. The papers were grouped in four themes: Noticing, Preservice Teachers' Learning, Preservice Teachers' Knowledge, and finally one group with various issues (Other: University-school partnership, beliefs, and textbooks).

*Keywords*: Preservice primary teachers; Noticing; Knowledge; Learning; Beliefs; University-school partnership.



## 1. Background and Rationale of TSG-28

It is a multi-faceted task to prepare preservice teachers of mathematics (PSTs) to conduct high-quality teaching. Many agree that teaching competence is not based merely on PSTs' academic qualifications, and consequently the concern for problems of practice has grown in programmes for teacher education. This is evidenced, for instance, in attempts to reconsider the knowledge needed in instruction; to work with representations of practice in college-based parts of programmes; to have prospective teachers rehearse and plan for instructional activity while at college; and to capitalize on prospective teachers' field experiences. This links research and development in mathematics teacher education (MTE) to scholarship on teaching and raises issues of (1) what high-quality instruction entails in different contexts and (2) how prospective teachers may develop their capacity to conduct teaching accordingly under different circumstances. In spite of the common interest in preparing PSTs for practice, it is still contentious how best to do so, and the answer to this question may vary across contexts. The rationale of TSG-28 was to engage participants in reflection on, and discussion of, the theoretical, empirical and practical issues.

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Twenty-five papers were reported in this TSG (add two posters), from twelve countries showing a great diverse cultural. The papers were grouped in four themes: Noticing, Preservice Teachers' Learning, Preservice Teachers' Knowledge, and finally one group with various issues (University-school partnership, beliefs, and textbooks). TSG-28 had assigned two time slots of 120' and two time slots of 90'. Authors of papers presented key points from their work and for each theme one member of the team synthesized the relevant aspects and underlined differences and similarities (Tab. 1), and all the contributions to TSG-28 are listed in Tab. 2 (on the next page).

Tab. 1. Themes and countries

| | Noticing | PSTs' Learning | PSTs' Knowledge | Other | TOTAL |
|---|---|---|---|---|---|
| Germany | 1 | | | | 1 |
| USA | 3 | 1 | 1 | 2 | 7 |
| Spain | 1 | | 3 | 1 | 5 |
| Turkey | 2 | | | 1 | 3 |
| UK | | 1 | | | 1 |
| Canada | | 2 | | | 2 |
| South Africa | | 1 | | | 1 |
| China | | | | 1 | 1 |
| Netherlands | | | 1 | | 1 |
| Malaysia | | | 1 | | 1 |
| Chile | | | 1 | | 1 |
| Malawi | | | 1 | | 1 |
| **TOTAL** | **7** | **5** | **8** | **5** | **25** |

## 2. Noticing

Mathematics teacher noticing is a set of core practices through which teachers interact with the different aspects of a teaching situation. Conceptualizing it and understanding how it develops are the focus of some papers discussed. The studies about noticing focused on three aspects: factors influencing the preservice teachers' reasoning process involved in noticing; on the relationships between different skills such as attending to, interpreting and decision making; and on the design principles of tasks to enhance noticing.

Firstly, the papers discussed how PSTs attend to the students' answers to mathematics problems and which factor might or might not influence their interpretations. This set of papers makes explicit the relationship between the PSTs' reasoning process and their decision making. So, Laschke et al.[4] examines the explicit criteria that PSTs refer to when confronted with an unexpected student solution of a probability problem and to which extent these criteria are influenced by students' social status background. The findings showed that although PSTs mostly used content-specific criteria, also implicit criteria were relevant as evaluations of student work were biased by students' social background.

Tab. 2. List of papers presented

| **Paper and author(s)** |
|---|
| ***Noticing*** |
| [1] A study on written feedback on preservice teachers' teaching practices and its impact on noticing. *Müjgan Baki and Zeynep Medine Özmen.* |
| [2] Designing tasks for support preservice primary teachers' noticing of geometrical thinking. ***Melania Bernabeu****, Mar Moreno, and Salvador Llinares* (Spain). |
| [3] Relationships between preservice teachers' knowledge and their responses to students errors: Making word problems for the concept of division. ***Qintong Hu*** (China)*, Lynn Hodge, and Shande King* (USA). |
| [4] How preservice teacher judge and unexpected student solution — explicit and implicit criteria. ***Christin Laschke****, Bettina Rösken-Winter, and Sven Schüler* (Germany). |
| [5] An analysis of preservice teachers' noticing of student pattern generalization strategies. ***Ji-Eun Lee*** *and Mi Yeon Lee* (USA). |
| [6] Prospective teachers' noticing of student's algebraic thinking: Pattern generalization. ***Zeynep Özel****, Mine Işiksal-Bostan, and Reyhan Tekin-Sitrava* (Turkey). |
| [7] Developing preservice teachers' noticing of productive struggle with video analysis. *Hiroko Warshaue,* ***Christina Starkey****, Christine Herrera, and Shawnda Smith* (USA). |
| ***Preservice teachers' learning*** |
| [8] Preservice Mathematics Teacher Education for the Montessori Teachers. ***Kinful Lartebea Aryee****, Immaculate Kizito Namukasa, and Marja Bertrand* (USA). |
| [9] Tracing threads of awareness in initial teacher education: peer-collaboration. ***Gwen Ineson, Julie Alderton****, Chronoula Voutsina, Kirsty Wilson, Gina Donaldson, and Tim Rowland* (UK). |
| [10] Preservice teachers designing meaningful digital learning environments using makerspaces for math. ***Anjali Khirwadkar*** *and Candace Figg* (Canada). |
| [11] Exploring pre-service teachers' mathematics learning experiences and self-efficacy in teaching primary level mathematics. ***Sangyeon Park*** (USA). |
| [12] Where the journey to reflective practice begins: A case of preservice teachers. ***Chikiwa Samukeliso*** *and Graven Mellony* (South Africa). |
| ***Preservice teachers' knowledge*** |
| [13] Exploring how prospective teachers pose problems: The case of $\mathbf{8} \times (-\mathbf{2})$. ***Miguel Angel Montes****, Juan Pedro Martin, Maria Isabel Pascual, Nuria Climent, and Jose Carrillo* (Spain) |
| [14] Integrating EDTPA Preparation in a methods of teaching elementary mathematics course. ***Norma J. Boakes*** (USA). |
| [15] Contribution of a didactic course on the development of primary preservice teachers' knowledge of Measurement and Geometry. ***Israel García-Alonso****, Josefa Perdomo-Díaz,* ***Diana de las Nieves Sosa-Martín*** (Spain). |
| [16] Using Technology for virtual representations of Teaching for developing math talk during problem solving. ***Melva R. Grant*** *and Signe Kastburg* (USA). |
| [17] Torpedo: A Digital learning environment for developing mathematical problem-solving ability in primary teacher education. ***Marjolein Kool*** *and Ronald Keijzer* (The Netherlands). |
| [18] Design of a learning unit for preservice elementary school teachers: definition of the boundary of a 2D Shape. ***Alejandro López****, Salomé Martínez, Aldo Ramírez, and Ricardo Salinas* (Chile). |
| [19] Explanatory talk in the teaching of number concepts and operations to preservice teachers: A case of one mathematics teacher educator. ***Justina Longwe-Mandala*** (Malawi). |
| [20] Preservice teachers' conceptual understanding of fraction: Implications for improving curriculum Standards and classroom practices. ***Suhaidah Tahir****, Masami Isoda, Munirah Ghazali, and Dominador Dizon Mangao* (Malaysia). |
| ***University-school partnership, reliefs, and textbooks*** |
| [21] In what ways does a mathematics curriculum based on the theory of multiple intelligences affect the attitudes and beliefs of preservice elementary school teaches toward mathematics? ***Mark Arvidson*** (USA). |
| [22] Mathematics workshops: Changing the perceptions of both inservice and prospective teachers with regard to mathematics. V*alentina Celi* (France)*, José Ignacio Cogolludo, Raquel García Catalán, Elena Gil Clemente,* ***Inmaculada Lizasoain*** (Spain)*, Ana María Millán Gasca, and Luigi Regoliosi* (Italy). |
| [23] School University Partnership in Mathematics Teacher education: How Prospective Mathematics Teachers view their experiences. ***Rukiye Didem Taylan****, Zelha Tunç-Pekkan, and Mustafa Özcan* (Turkey). |
| [24] Building a university-school partnership: from early missteps to emerging success. ***Ryan G. Zonnefeld*** *and Valorie L. Zonnefeld* (USA). |
| [25] Features of exemplary lessons over different decades: A comparative analysis of eleven elementary mathematics lessons in China. ***Dongchen Zhao*** *and Yunpeng Ma* (China). |

Other three papers focused on how PSTs decide what to do next in teaching based on their interpretations of students' mathematical thinking. Lee and Lee[5] examine the characteristics of elementary PSTs' attention to students' work in order to suggest how to follow up in supporting the students' progress. They conclude the lack of sophistication in the analysis of student thinking influence how PSTs decide about the teaching. Hu et al.[3] revealed the difficulties of PSTs to pose word problems for the measurement model of the concept of division and respond to students' errors. Also, Özel et al.[6] indicated that PSTs had difficulties in interpreting students' algebraic thinking, but they could support the student's algebraic thinking when the solution was incorrect by asking follow-up questions. These studies underline two aspects. First, the complex relationships between the skills of attending to students' mathematical thinking and how to support the student's progress. Secondly, the relationship between PSTs' knowledge and their reasoning processes

The findings of these studies suggest the important role of professional tasks in PST noticing skills in mathematics education. A third set of papers focused on aspects to enhanced noticing. Bernabeu et al.[2] provide designing principles for the tasks in primary teacher education that are designed to enhance the core practices which constitute professional noticing. The authors consider three dimensions: a sociocultural perspective of PSTs' learning, the necessary introduction of information about the development of students' mathematical thinking (e.g. learning trajectories of mathematical topics), and practical registers from mathematics teaching (e.g., a set of students' answers indicating different features of students' development). Baki and Özmen's paper[1] underlines the impact on noticing of the written feedback that preservice teachers received. Finally, Starkey et al.[7] underlined the role of providing PSTs with a framework about noticing. Their findings suggest that the use of a productive struggle framework helped PSTs develop a language for discussing.

## 3. Primary Level Preservice Teachers' Learning

Five papers focused on PSTs' learning using different theoretical frameworks and with specific foci. One common aspect of these papers is to identify specific intervention (or contexts) that influence PSTs' learning.

Inesson and colleagues' study[9] draws on aspects of enactivism and the notion of reflective spection to trace threads between PSTs' retrospection of their own learning and pro-spection of their approach to teaching. The findings suggest the importance of collaboration in 'seeing' what others 'see' and its influence on PSTs' own teaching. Aryee and colleagues' study[8] underlines the role played by the Montessori mathematics-for-teaching training on how teachers organize and prepare classroom learning environments. Samukeliso and Mellony[12] focused on the PSTs' reflective practice to identify its influence on learning. Park's study[11] underlines the role played by the mathematics content courses in reforming the PSTs' self-perceived competence in the mathematical concepts and in teaching mathematics to students. Finally, Khirwadkar and Figg's study[10] focuses on how to prepare PSTs for teaching in digital classrooms to create meaningful digital learning experiences. This study introduces makerspaces to PSTs and analyses how PSTs connect mathematics teaching and makerspaces experiences.

Globally these studies underline different types of activities influencing the PSTs' learning and their approaches to teaching. Some of these activities are the collaboration in seeing what others see when analyzing mathematical tasks as tools for teaching; the nature of their own experience as mathematics learners influencing on their self-perceived competence; participating in a training with a specific approach (e.g. Montessori teacher education system); and participating in a reflective practice in the context of video-based lesson analysis.

## 4. Primary Level Preservice Teachers' Knowledge

PSTs' knowledge and features of learning environments aimed to improve the PSTs' knowledge was the focus of eight papers. What PSTs should learn and in which environments are presented from different perspectives and relationships. For example, PSTs' knowledge about posing problems or about the knowledge necessary to teach mathematics (and how we can measure them). Other papers focus on the features of learning environments for enhancing the reflective activities and its relation with problem solving ability, or to learn to facilitate productive math talk during problem solving.

Montes et al.'s study[13] focuses on how prospective teachers pose problems involving a specific operation with negative numbers. The findings showed inconsistencies in the problems posed by the prospective teachers (regarding the relationship between negative numbers and the contexts). Also, Tahir et al.[20] analyzed PSTs' conceptual understanding and pedagogical content knowledge in teaching fractions. Boakes' study[14] presents how to prepare the PSTs for the mathematical aspects of the performance-based assessments that measure PSTs' pedagogical competencies. Garcia-Alonso et al.[15] reported the results of a study aimed to measure the primary PSTs' geometric and measurement knowledge. Globally, these studies support the hypothetical relationship between teacher's knowledge and the development of teaching skills (such as planning the mathematical lessons).

Features of different approaches to improve PSTs' knowledge are the foci of other group of papers. Kool and Keijzer[17] presented a digital learning environment (TORPEDO) for developing PSTs' mathematical problem-solving abilities. The environment enhanced the PSTs' reflections after solving non-routine mathematics problems. The relationship between how PSTs perceived that the reflection contributed to their problem-solving ability was analyzed. Also, Grant and Kastburg[16] analyzed how the participation in a virtual teaching (classroom simulation environment) help PSTs to facilitate productive math talk during problem-solving. The teach-reteach approach to microteaching within a simulated representation of practice using avatars as students seem to support the PSTs' knowledge of how facilitate productive math talk during problem-solving. Lopez et al.[18] presented the features of a learning environment (learning unit) aimed at developing the specific mathematical knowledge involved in the construction and use of a definition of the boundary of 2-D shapes.

Finally, Logwe-Mandala[19] studied the talk of a mathematics teacher educator teaching number concepts and operations to PSTs as a key feature of the learning environments in teacher education programs. Globally, these studies present features of learning environments and the activities generated in them to improve the different dimensions of PST knowledge.

## 5. Others: University-School Partnership, PST Beliefs, and Textbooks

The foci of five contributions were on contextual and institutional factors such as partnership between university and school; cognitive factors such as beliefs and attitudes, and finally characteristics of the lessons from a textbook. The issue of how to change the PSTs' beliefs and attitudes toward mathematics and its teaching reflects the recognition that PSTs sometimes do not hold productive beliefs or do not have attitudes compatible to support students in primary education. So, some studies have the goal to change PSTs' beliefs and attitudes. Lizasoain and colleagues[22] presented a mathematical workshop to bring the PST mathematical training closer to the school classroom reality. The workshop has as a goal to influence the PSTs' confidence and beliefs about the nature of mathematics and their attitudes towards the mathematics teaching. Arvidson[21] reported a course based on Multiple Intelligences aimed to change the attitudes toward mathematics showing the difficulties of this change.

The school-university partnership in Primary Mathematics Teacher Education is a key issue to the success of the primary teacher training. School-University partnership is the focus of two papers. Taylan and colleagues[23] reported a model of university-school partnership addressed to integrate theoretical knowledge of teaching with school–based practical knowledge. Different forms of school and university partnership experiences and PSTs' views of these experiences are described together. Zonnefeld and Zonnefeld[24] reported the trajectory of how to build the university-school partnership (from early missteps to emerging success).

Finally, Zhao and Ma[25] reported a comparative study on exemplary lessons of primary mathematics over different decades in mainland China using five dimensions in order to identify the influence of the mathematics education reforms. This study reported how mathematics teaching can be reflected in mathematics lessons and how this can influence the practices of primary level teachers.

## 6. Final Remarks and Future Implications

In TSG-28, we discuss research and development work on MTE, including the underlying assumptions about classroom practice and PSTs' and school students' learning. We also discuss the potentials of, and challenges for, the research endeavour itself, that is, questions concerned with the use of different theoretical frameworks and methodologies.