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# **An introduction to TWG13: Early years mathematics**

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## **Introduction**

Our working group is dedicated to the mathematics learning of children aged 2 to 8 years old. The studies within our group have shown that this learning can occur in various settings, including kindergarten, preschool, primary school, and more informal environments, such as the children's homes. In this line, we examine how children, teachers, and other caregivers engage with mathematics both implicitly and explicitly. Our working group encompasses a diverse array of subjects, related to various areas of mathematics and employing various theoretical and methodological approaches. This broad scope has been a defining characteristic of our working group.

## **Overview**

Thirty-seven participants from seventeen countries presented 29 papers and 2 posters in TWG13 during the CERME13 conference. These were organized into seven themes, namely: the connections between algebra, numbers, and geometry; representations in early years mathematics; inquiry and problem-based approaches; mathematical reasoning in early years mathematics; studies on young students' performance; studies on preservice and in-service kindergarten teachers, and supporting playful learning for all students.

Each session was devoted to one of these themes and contained paper and poster presentations, followed by a discussion on the presentations, as well as a general discussion on questions related to the theme of the session. Next, we present the main questions related to each theme and the main outcomes of the discussions that took place.

## **The connections between algebra, numbers, and geometry**

Four papers were presented in this session, by Rodal and Storeli, Cheeseman and Downton, Počuča and Milinković, and by Barkai, Levenson, Tsamir, and Tirosh. The questions discussed were related to task design, especially when made for research purposes. We have agreed that an a priori task analysis can be useful. Such analysis might focus on linguistic aspects (e.g., task wording), that might affect their interpretation by the students, but might also include a consideration of the classroom contexts. Whenever possible, a piloting of the tasks is a good way to examine their plausibility within

the particular context. We have also discussed on the importance of the task sequencing, and how it may be related to the underlying theoretical framework(s).

### **Representations in early years mathematics**

In the second session, three papers and one poster were presented, centred around representations in early years mathematics. The authors of the papers were Downton and Maffia, Bjørnebye, Helseth and van Bommel, and Sjödahl and the authors of the poster were Voutsina and Stott. The presentations included inquiries in young children's representations of multiplicative semantic structures, aesthetics in embodied task design in mathematics, the intersection of programming and mathematics, and children's awareness of the cultural rules of numerals. The session entailed discussions about what is considered to be "mathematics" and how this may differ depending on the perspective we are taking (the researcher's, the teacher's or the child's). Furthermore, in the early years, mathematics is often integrated with movement, music, natural science experiences and other domains of knowledge, which leads to the question what "doing" mathematics means and that this is necessary to make explicit to the children by connecting, e.g., sensual experiences with intellectual ones.

### **Inquiry and problem based approaches**

This session included three papers and one poster, focused on inquiry and problem-based approaches in early years mathematics. The authors of the papers were Silva, Costa and Domingos, Tzekaki and Papadopoulou, van Bommel, Palmér and Ebbelind, and the authors of the poster were Dufour and Julien. Some discussions reflected on how different models of inquiry enable the analysis of both the aims and the outcomes of research. One of the issues that came up was the need for the teacher to set up opportunities that may lead to mathematical explorations, instead of designing a highly structured environment that may limit the opportunities for creative engagement and mathematical thinking. Our discussions also addressed aspects of integrating problem solving in preschools in different countries and teachers' training; we acknowledged that context affects what children think while doing mathematics.

### **Mathematical reasoning in early years mathematics**

Five papers addressed mathematical reasoning, covering different mathematical topics and different perspectives on reasoning itself. The authors were: Kleven; Tatsis and Maj-Tatsis; Bundgaard; Eriksson and colleagues; Krummenauer and colleagues. While it appeared to be a common assumption that the education for mathematical reasoning begins in the early years, there are different theoretical understandings on what reasoning is and its relationship to argumentation. The participants discussed about the importance of explicitness in the researchers' understandings and use of the construct of 'reasoning' in mathematics education research, especially in the context of the early years. For instance, many researchers agree on the importance of including non-verbal communication as a form of communication for young children's argumentations. Such explicitness is important for comparing research results and for communicating them to stakeholders, such as curriculum developers or textbooks publishers. The discussions also acknowledged the contextual factors affecting methods and results of the relevant studies, including cultural values (e.g., possible

different conceptualizations of equity and/or cooperation) and the specific tools used (manipulatives, drawings, etc.).

### **Studies on young students' performance**

Five papers addressed the issue of students' performance when engaging with mathematical activities. The authors of the papers were Matsuo, Nakawa and Watanabe, Nováková, Eroglu, Slezáková and Jirotková and Kelz. The first discussion centred on what is meant by "playful" activities in different countries and how such activities can be designed to suit the culture of that country. For example, in Japan, preschool children do not formally learn mathematics; thus, it is necessary to design mathematical activities through guided play. In Sweden early childhood teachers employ play-responsive teaching where children, together with the teacher, can develop new understandings through play without losing the child's power of action (agency) or the play's narrative. A second issue related to students' performance was how we, as researchers, use children's mistakes to assess what they do know and how can we guide teachers to use children's mistakes as a jump start for learning. First, it was acknowledged that knowing a child's reasoning that led to a mistake, is more important than the actual mistake. Thus, when researching children's knowledge, interviews are crucial. Furthermore, analyzing children's mistakes may also help identify children with potential mathematical difficulties in the future. In turn, analyzing children's mistakes can help plan early interventions.

### **Studies on preservice and in-service kindergarten teachers**

Five presentations were given by Karbaschi Vee, Cooke, Levenson and George, Björklund and Palmér, and Lembrér. The questions discussed were related to the strategies preschool teachers use to support children's learning, and how to improve the knowledge teachers need to develop those strategies. We agreed that children develop their understanding in a process such as "I, You, We" (I do, we share and together we discuss and come to a conclusion) during challenging mathematical learning situations. Therefore, the educators need to learn how to find effective ways to engage young children in mathematics in a variety of learning environments. There were also questions about the interrelations of preschool teachers and parents regarding mathematics education. We also discussed the different ways in which parents in different countries were involved in their children's mathematics education. Workshops organized by kindergarten teachers could provide a fruitful collaboration with them.

### **Supporting playful learning for all students**

Four papers were presented in the session, by Walla, Karlsson, Bayraktar and Brandt, and Lavie and Dvir. Playful learning was a concept that appeared throughout the sessions, and it is a topic that is being discussed thoroughly in the last CERME conferences within TWG13. Together with this, the issue of the analysis of interactions came to the fore, either as part of teacher education or as part of a research project. Various tools have been presented as means for the analysis of interactions, such as the commognitive theory or the participation theory. Another issue stressed was that all students should be provided with opportunities to participate in mathematical explorations; one way to achieve this is by making the teachers aware of the importance of students' equitable participation.

## Summary and future directions

The presentations and discussions that took place within TWG13 revealed that early childhood mathematics education (including learning opportunities, activities, environments, teachers, and training) is an area of increasing interest that remains open for research. Mathematical processes, such as representations, inquiry, problem-solving and reasoning, are attracting increasing interest, but topics such as technology, teachers' training, and school-family connections have also appeared in the works of the group.

We acknowledge that mathematics in early childhood education is often integrated with other domains of knowledge; this is especially the case in play-based learning or in activities that entail an interdisciplinary approach. Such contexts lead to a variety of data, which need to be interpreted accordingly. This results in a wide range of theoretical and methodological approaches by the researchers. Specifically, we have observed both the adaptation of theoretical constructs coming from mathematics education research at higher grades and the reformulation of theoretical constructs coming from areas such as ethnomathematics or linguistics. This variety entails some risks, but, at the same time, renders early years mathematics education a vibrant and evolving field of research.

The works in TWG13 have also demonstrated the need for considering contextual factors in the analysis and interpretation of research data. As we write elsewhere (Maj-Tatsis & Levenson, 2023), cultural differences do not have to be an obstacle; instead, we can view culture as a valuable component that enhances our research and broadening our horizons when it comes to early mathematics research.

The studies in TWG13 have shown that further research is more than necessary in areas such as teacher-student, parent-student and even parent-teacher interactions. By acknowledging the complexity of the child-school-family system we can design studies that will be useful for the teachers, but possibly for the policy makers, since the importance of early years mathematics education is endorsed by most – if not all – educators.

## References

- Maj-Tatsis, B., & Levenson, E. (2023). Introducing CERME Thematic Working Group 13 – Early Years Mathematics. ERME column. *European Mathematical Society Magazine*, 127, 50–52. <https://doi.org/10.4171/MAG/114>