Introduction to TWG13: Early years mathematics

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Introduction

In CERME14, presented research about Early Years Mathematics has concerned the mathematics education of children 1 year old (e.g. see the contribution by Björklund & Palmér) up to 7 years old (e.g. see the contribution by Benz et al.). Researching mathematics education during the early years is a complex endeavour and depends on several cultural and institutional constraints. In many European countries, children attend early childhood education, yet the conception of schooling and mathematics in early years varies significantly across different countries as it is testified by the 22 contributions in our group, presented by authors from 14 different countries in the European area (Czech Republic, Denmark. Germany, Greece, Israel, Italy, Latvia, Norway, Portugal, Spain, Sweden, UK) and outside of Europe (Australia, Jamaica, South Africa). Furthermore, transition from childcare to more formal schooling may differ across countries. In TWG13, contributions pay attention to how mathematics is approached more or less explicitly by children, teachers, and other caregivers. The studies within this working group show that mathematical learning occurs in various settings, including kindergarten, preschool, primary school, as in informal environments.

Overview

During CERME14, the 22 contributions (20 research reports and 2 posters) published in the proceedings were presented in seven thematic sessions and were discussed between the participants. A wide range of topics was covered: different areas of mathematical teaching-learning are addressed, and different theoretical and methodological approaches are adopted. In the following, we summarize the wide variety of topics addressed in TWG13 by clustering the contributions presented in CERME14 proceedings.

Numbers and structure

This section examines how young children develop structural awareness in early mathematics, particularly in relation to number concepts. Lindgren and colleagues explore part-whole relationships through a playful distribution task, demonstrating how artefacts become mathematically meaningful when structured with verbal communication, gestures, and finger representations. Sprenger and

colleagues investigate how children describe quantities using ten-frames, identifying four distinct descriptive strategies and highlighting the role of peer interaction in shaping mathematical language and understanding. Elofsson and colleagues focus on children's reasoning with repeating patterns, showing how systematic variation in unit size and repetition—carefully guided by teachers—supports generalization and the development of early multiplicative thinking. Their work underscores the importance of strong pedagogical content knowledge. Together, these studies provide complementary perspectives on structural thinking in early mathematics—through number decomposition and recomposition, visual structuring and peer interaction, and pattern-based generalization—emphasizing the richness of young children's mathematical experiences when instruction is intentional, well-designed, and responsive to their ways of seeing.

Additive problems

Research about additive problems highlighted that tools, gestures, and language support early mathematics learning, hence children often struggle to apply part-whole concepts to arithmetic. Young children verbalise their reasoning inconsistently, and research is needed to understand their cognitive processes. In a study conducted in Germany, Benz and colleagues explored how word problem features—like structure, unknown elements, and visual representations—affect how young children solve addition and subtraction tasks in an online assessment. The results suggest that spatial reasoning consistently emerges as a key factor in problem-solving.

Seo, with colleagues, examined whether spatial abilities—specifically spatial visualisation and visuospatial working memory—help predict how well six- to seven-year-olds in England solve one-step addition word problems. Findings suggest that spatial visualisation plays a role in tackling more complex, dynamic problem types, highlighting a spatial-mathematical link in early arithmetic learning.

Roesch and Hartmann presented a study about children's use of their fingers for addition and subtraction tasks. Although, the sample was small, the results showed that finger use was more common when manipulatives were not provided and particularly beneficial for subtraction tasks.

Multiplicative problems

All studies highlight the role of language, manipulatives, and structured activities in supporting early multiplicative thinking. They collectively suggest that multiplicative reasoning can emerge before formal instruction, but is shaped by age, context, and language. These findings have implications for curriculum design and teacher training in early mathematics education.

Pitta and colleagues demonstrate that structured interventions can support children in kindergarten in transferring multiplicative strategies to novel contexts. Björklund and Palmér identify developmental shifts in toddlers' partitioning strategies, highlighting the emergence of unitizing and equal distribution. Downton and colleagues reveal that linguistic background significantly influences children's interpretation of multiplicative comparison tasks.

Mathematical learning within child and care-givers interactions

Within the 'Early years mathematics' TWG, there are contributions paying attention to how mathematics is approached more or less explicitly by children in informal contexts and in relation with their parents and other caregivers. Graven reports about parents' confidence within the Family Maths Storytime Programme (FMSP), designed for providing opportunities for play-based home numeracy learning among South African children. Voutsina and colleagues present the 'Written Numbers in Everyday Life' project, implemented with families of 3–5-year-old children in the UK and Jamaica. Both contributions provide insights into the wide-ranging opportunities for learning that arise when parents are prompted and supported.

Learning difficulties and disabilities

Research under this theme underlines the importance of family-school partnerships for supporting the early mathematics development of children with intellectual disabilities and specific learning difficulties.

Charitaki and colleagues describe profiles of home numeracy support for preschool children with intellectual disabilities in Greece and underscore the importance of communication and reciprocal support between parents and educators, particularly for families who face systemic barriers that can affect the level of home numeracy support that they can offer. The importance of parent-teacher collaboration is also emphasised by Helmane and colleagues who reveal variations (both similarities and discrepancies) in parents' and teachers' evaluations of the mathematics skills of 4–6-year-old children with and without specific learning difficulties, in Latvia.

The role of play

Two studies, conducted in the context of preschool education in Sweden, contribute to current debates about the role of play in mathematics learning in the preschool years.

Lundvin and colleagues analyse preschool teachers' talk about play and mathematics teaching through the lens of Play-Responsive Teaching theory (PRT). Discrepancies between teachers' talk and PRT, but also teacher's alignment with the position that play and teaching are 'going into one another', emphasise the need for developing shared understandings in relation to play and mathematics teaching within preschool education practice and policy. Comparing instructional sequences that integrate play and mathematics with sequences where mathematics teaching is separated from play, Karlsson highlights the benefits of combining both approaches, for supporting children's exploratory as well as structured learning of mathematics, within a balanced learning environment.

Digital tools and technology

Three papers directed specific attention to digital tools and technology in early mathematics education. Walla and colleagues presented a study on guardians' views on digital tools in Swedish preschools, while Vee and colleagues presented a study on Norwegian preservice teachers' views on the use of digital technology in early childhood institutions. Both of these presentations initiated a discussion on observed differences between countries regarding if and how to use digital tools and

technology and whether and how digital competence is part of mathematics curricula in early childhood education.

Nogueira and colleagues added to the discussion their study on robot programming, concluding that robot programming activities can be used in early childhood education to develop children's itineraries and map-reading skills through activities that not only are highly motivating but also stimulate both cognitive and social skills.

All three papers were further discussed in terms of the risk of digital tools becoming "just play"; raising the question how teachers are supported to use digital tools and technology for mathematics education. A conclusion was that more research is needed and pre- and in-service preschool teachers need professional development regarding digital tools and technology, to be prepared to meet parents, pre-service teachers and children.

Other topics

The topics mentioned above do not comprehend all the numerous issues addressed within the group. Other relevant examples are given by contributions about first graders' mathematical creativity described by Cohen and Levenson in terms of fluency, flexibility, and originality, and younger children's argumentation by Nosrati and colleagues who investigated the factors that may aid or hinder the development of an argument. TWG13 also included contributions about kindergarten teachers, such as their mathematical awareness investigated by Bundgaard, and teachers' level of professional readiness as investigated by Nováková.

Conclusion and future perspectives

The collection of studies presented in TWG13 during CERME14 emphasizes how young children develop mathematical understanding through structured, playful, linguistic and socially rich experiences.

In the last editions of CERME we have registered an increasing number of studies about parental involvement. Home numeracy environments appear to play a relevant role, especially (but not only) for children with learning difficulties. The role of the cultural and linguistic background as embedded in the home, kindergarten, and school environments should remain central in future research about the development of structural thinking, spatial reasoning, and initial arithmetical learning.

The discussion about play-based learning-teaching is ongoing and more theoretical and empirical contributions might fuel it in the future. Digital tools show promise but require clear educational aims and teacher preparation. Future research should explore how to better support teachers and families, integrate play and digital tools effectively, and tailor learning for diverse developmental needs.