ERME column

regularly presented by Jason Cooper and Frode Rønning

In this issue, with a contribution by
Bożena Maj-Tatsis and Esther Levenson

CERME Thematic Working Groups

We continue the initiative of introducing the CERME working groups, which we began in the September 2017 issue, focusing on ways in which European research in the field of mathematics education may be interesting or relevant for people working in pure and applied mathematics. Our aim is to enrich the ERME community with new participants, who may benefit from hearing about research methods and findings and contribute to future CERMEs.

Introducing CERME Thematic Working Group 13 – Early Years Mathematics

Group leaders: Bozena Maj-Tatsis, Esther Levenson, Martin Carlsen, Andrea Maffia, and Marianna Tzekaki,

Introduction

Thematic Working Group 13 was established in 2009 at CERME6 and focuses on the mathematics learning of 2–8-year-olds. Learning may take place in (pre-)kindergarten, primary school, and other less formal settings. Therefore, the group focuses on how mathematics is approached implicitly and explicitly by children, teachers, and other responsible adults. A wide range of topics is covered in TWG13, spanning different areas of mathematics and different theoretical and methodological approaches. This wide span is a characteristic feature of TWG13, and one that has been documented at other conferences as well (e.g., the POEM[1] conferences, see [6]). See also [8]. In the next section we present some of the theoretical underpinnings of the papers that have been accepted for presentation in TWG13 over the years.

[1] Perspective On Early Mathematics Learning (see https://www.gu.se/en/education-communication-learning/welcome-to-poem)

Theoretical considerations

One might ask why it is important to investigate the mathematics learning of such young children. The studies within TWG13, together with the accompanying literature, have provided some answers to this question, which can be summarised in three main points. Firstly, mathematics is explicitly or implicitly included in most kindergarten curricula. Thus, in order to plan high-quality mathematical experiences for young children, there is a need to investigate the learning situations that are being provided for children, as well as how to improve and plan for mathematical learning situations. Secondly, mathematics is present in many aspects of children's out-of-school experiences. Therefore, it is worth investigating whether informal learning takes place in such situations. Thirdly, there are connections between the mathematics encountered in pre-school and the mathematics encountered in primary school. Therefore, early mathematical experiences become important for a child's the later mathematics achievement.

The above have led to a change in the focus of early-years mathematics research during the last decades – which in turn is reflected by various national and international programs focusing on early years mathematics. Clements and Sarama [7] express this switch quite eloquently:

> … researchers have changed from a position that young children have little or no knowledge of or capacity to learning mathematics … to theories that posit competencies that are either innate or develop in the first years of life [7, p. 462].

At the same time, it is noteworthy that "not all countries have a mandatory or even recommended curriculum for this age, nor do all have compulsory or financially supported education for young children" [8, p. 107].

Research interests discussed within TWG13

The studies discussed within TWG13 may be divided into three major themes: children's conceptions and mastery of early mathematical skills; providers of early mathematics education; and the settings of early mathematics learning.

EMS MAGAZINE 127 (2023) — DOI 10.4171/MAG/114

Regarding children's mathematical conceptions and skills, it is important to note that early-years mathematics does not does not reduce counting, calculations, shapes and measures. Mathematical processes such as problem solving, reasoning [9], early generalisations and abstraction [12, 14], are present and may be nurtured among young children. Additionally, children's intuitions about mathematical concepts may provide a solid base for the later development of these concepts throughout education. Readers of this magazine may also find it interesting to know that even formal aspects of mathematics, such as definitions, may be discussed and developed in first grade [2].

The first providers of early mathematics education are parents, most of whom are not themselves mathematicians or mathematics teachers. An important question that arises is to what extent can or should parents be involved in their children's mathematical development. This question gives rise to several research questions such as, do parents believe that young children should learn mathematics? Do parents, or other responsible adults have the knowledge to promote children's early numeracy? How may parents and other responsible adults provide opportunities for young children to engage in mathematics at an early age [10]? In school, it is the teacher who plans and implements mathematical activities, as well as evaluates students' knowledge. However, most preschool, kindergarten, and first- and second-grade teachers are not specialists in mathematics. Thus, an important area of research for TWG13 is the study of teachers' knowledge, beliefs, and self-efficacy for teaching mathematics to young children [11]. This knowledge includes knowledge of content (e.g., knowing the definition of a triangle), knowledge of tasks (e.g., what types of activities will promote children's knowledge of triangles), and knowledge of children (e.g., how might a child describe a triangle). Beliefs also impact on teaching [3]. Teachers with a problem-solving view on mathematics may highlight different counting strategies, while teachers with an instrumentalist view may encourage fixed algorithms. Moreover, teachers who themselves suffer from mathematics anxiety may favour resources with immediate use, e.g., a textbook or a worksheet.

The settings and contexts in which children learn vary greatly. Within a school setting, teachers may set up inquiry-based contexts, where children are encouraged to explore, discuss, and justify their thinking to others. Other settings enable children to learn mathematics through bodily movement. For example, whole-body movement can promote children's use of a counting-on strategy [5]. Finger movement on a tablet was found to develop multiplicative awareness [1]. Within TWG13, there has always been much discussion regarding formal versus informal settings, including play contexts. Play is considered vital in mathematics in the early years and can be structured to promote learning [13]. This is especially true for toddlers, ages 2 to 3 [4].

Concluding remarks

As we have mentioned, there are significant differences between the organisation of pre-school education across Europe, complicating the comparison of research conducted in different countries. During CERME12, we discussed how cultural differences need not be a barrier. Instead, we can consider culture as an enriching element in our research and widen our perspectives of early-years mathematics research, for example, by comparing early mathematics learning in out-of-school contexts. Another promising direction for future study concerns affective factors in learning and teaching early years mathematics.

In conclusion, we acknowledge that there exists a plethora of theories related to early mathematics education. As discussed in CERME12, theories cannot be static; they need to be continuously developed and adapted, e.g., by empirical studies [10]. When analysing preschool activities, it is difficult to investigate separately the children, the adults, and the specific activity. The situation under investigation is complex and there is a need to grasp this complexity. Future studies may consider networking theories. Additionally, qualitative and quantitative methodologies could be used complementarily, in order to reach well-verified theories. We invite mathematicians and mathematics educators interested in promoting a mathematical disposition from a young age, to join us at the upcoming CERME13.

References

[1] S. Bakos and N. Sinclair, Pips (times) Pods: Dancing towards multiplicative thinking. In *Proceedings of the Eleventh Congress of the European Society for Research in Mathematics Education*, edited by U. T. Jankvist, M. van den Heuvel-Panhuizen and M. Veldhuis, Freudenthal Group & Freudenthal Institute, Utrecht University and ERME, 2209–2216 (2019)

[2] M. G. Bartolini Bussi and A. Baccaglini-Frank, Using pivot signs to reach an inclusive definition of rectangles and squares. In *Proceedings of the Ninth Conference of the European Society for Research in Mathematics Education*, edited by K. Krainer and N. Vondrová, ERME, 1891–1898 (2015)

[3] C. Benz, Numbers are actually not bad. In *Proceedings of the Sixth Congress of the European Society for Research in Mathematics Education*, edited by V. Durand-Guerrier, S. Soury-Lavergne and F. Arzarello, CERME6, INRP and ERME, 2547–2556 (2009)

[4] C. Björklund, Aspects of numbers challenged in toddlers' play and interaction. In *Proceedings of the Tenth Congress of the European Society for Research in Mathematics Education*, edited by T. Dooley, G. Gueudet, Institute of Education, Dublin City University, Ireland, and ERME, 1821–1828 (2017)

[5] M. Bjørnebye, T. Sigurjonsson and T. Solbakken, Perception, cognition and measurement of verbal and non-verbal aspects of the cardinal concept in bodily-spatial interaction. In *Proceedings of the Tenth Congress of the European Society for Research in Mathematics Education*, edited by T. Dooley, G. Gueudet, Institute of Education, Dublin City University, Ireland, and ERME, 1829–1838 (2017)

[6] M. Carlsen, I. Erfjord and P. S. Hundeland, Mathematics education in the early years. *Results from the POEM4 Conference, 2018*, Springer Nature (2020)

[7] D. H. Clements and J. Sarama, Early childhood mathematics learning. In *Second Handbook of Research on Mathematics Teaching and Learning*, edited by F. K. Lester, Information Age, 461–555 (2007)

[8] E. S. Levenson, M. G. Bartolini Bussi and I. Erfjord, Early years mathematics. In *Developing Research in Mathematics Education: Twenty Years of Communication, Cooperation and Collaboration in Europe*, edited by T. Dreyfus, M. Artigue, D. Potari, S. Prediger and K. Ruthven, Routledge, 106–114 (2018)

[9] B. Maj-Tatsis and K. Tatsis, Investigations in magic squares: A case study with two eight-year-old girls. In *Proceedings of the Ninth Conference of the European Society for Research in Mathematics Education*, edited by K. Krainer and N. Vondrová, ERME, 1954–1960 (2015)

[10] B. Maj-Tatsis, M. Tzekaki, M. Carlsen, A. Maffia and E. Levenson, Early Years Mathematics: Introduction to TWG13. In *CERME12 Proceedings* (in press)

[11] P. Tsamir, D. Tirosh, E. Levenson and R. Barkai, Shedding light on preschool teachers' self-efficacy for teaching patterning. In *Proceedings of the Eleventh Congress of the European Society for Research in Mathematics Education*, edited by U. T. Jankvist, M. van den Heuvel-Panhuizen and M. Veldhuis, Freudenthal Group & Freudenthal Institute, Utrecht University and ERME, 2365–2372 (2019)

[12] M. Tzekaki and E. Papadopoulou, Generalization in early arithmetic. In *Proceedings of the Eleventh Congress of the European Society for Research in Mathematics Education*, edited by U. T. Jankvist, M. van den Heuvel-Panhuizen and M. Veldhuis, Freudenthal Group & Freudenthal Institute, Utrecht University and ERME, 2373–2381 (2019)

[13] B. van Oers, Emergent mathematical thinking in the context of play. *Educ. Stud. Math.* **74**, 23–37 (2010)

[14] P. Vighi, Game promoting early generalisation and abstraction. In *Proceedings of the Eighth Conference of the European Society for Research in Mathematics Education*, edited by B. Ubuz, Ç. Haser and M. A. Mariotti, ERME, 2238–2247 (2013)

Bożena Maj-Tatsis is a lecturer in the Institute of Pedagogy at the University of Rzeszów, Poland. Her research interests include creativity in mathematics education through open-ended and realistic problems. She is also interested in analysing the learning processes in the early years of mathematics instruction. She is editor-in-chief of the journal Didactica Mathematicae and chair of the IPC of the Contemporary Mathematics Education conference.

bmaj@ur.edu.pl

Esther Levenson is a senior lecturer and researcher in the Department of Mathematics, Science, and Technology Education at Tel Aviv University, Israel. Her research interests include collective mathematical creativity in the classroom and early years mathematics education. She is on the editorial board of Educational Studies in Mathematics and the Journal of Mathematics Teacher Education. Currently, she is researching mathematical creativity for low-achieving students and students with learning disabilities.

levenso@tauex.tau.ac.il