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EDITORIAL

Early Childhood Mathematics Teaching and Learning

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It is widely acknowledged that young children start learning mathematics and develop mathematical competencies much prior to school. Consequently, these predominantly informal learning processes have been the focus of research over the last 60 years. Starting with Piaget and his work on early number concept development (Piaget 1957) early numeracy competencies has been traditionally the field of developmental-psychological research. In mathematics education this is in contrast a rather young research domain—particularly in Germany. This is rather surprising, as it was the German educator Friedrich Fröbel who in the 1850s observed young children at play and created a complex and intensely mathematical pedagogy for young children that was based on the use of geometric forms and the manipulation of symmetries (see Balfanz 1999). His approach was characterized by "both an emphasis on child nurturing that did not threaten prevailing views of child rearing and a series of organized activities that were intellectually complex and inherently mathematical" (ibid., p. 5). Furthermore, the term "kindergarten" that is widely used internationally, was also coined by Fröbel.

In Germany, the mathematics educators Schmidt and Weiser (1982) were among the pioneers in terms of research on early years mathematics. They conducted individual interviews with 24 kindergarten children in order to investigate their counting abilities and their understanding of number. Based on their findings they derived recommendations for mathematics teaching and learning in grade 1.

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Globally, in the 1980s mathematics educators started large-scale projects as well as qualitative studies to investigate the contents, contexts and concepts of young children's learning of mathematics and their implications for the training of early childhood educators and early primary teachers (e.g. Steffe et al. 1983; Steffe 1982; Bobis 1996; Young-Loveridge 1999; Clarke et al. 2002; Thomas et al. 2002). Their work has inspired researchers in mathematics education in many countries—resulting in an increasing number of international publications as well as the foundation of working groups on early childhood mathematics at international conferences such as CERME and ICME. However, the vast body of research on mathematics learning prior to school is focusing on early number learning and understanding while Fröbel almost 200 years ago based his concept on space and shape. To date research leading to the development of detailed competency development models that go beyond the development of understanding of numbers and sets and integrate the different content areas of early childhood mathematics is still needed and provides numerous challenges for future work in this area for both mathematics educators and educational psychologists.

In addition to the growing body of mathematics education research in early childhood, professional organizations of mathematics teachers in a number of countries (in many cases jointly with respective professional associations of early childhood specialists) have produced widely acknowledged resources such as "Learning Mathematics in the Nursery: Desirable Approaches" published in 1998 by the Early Childhood Mathematics Group of the Association of Teachers of Mathematics in the United Kingdom as well as position papers and statements of early childhood mathematics e.g. the "Position paper on Early childhood mathematics" published by the Australian Association of Mathematics Teachers and Early Childhood Australia (2006) and "Early childhood mathematics education: Promoting good beginnings" a joint position of the National Association for the Education of Young Children and the National Council of Teachers of Mathematics (NAEYC/NCTM 2002/2010). These papers stress three key positions that can be found in other corresponding documents as well—the mathematical potential in and capability of young children (1) and the importance of the individual development of early mathematical skills for later (formal) school mathematics learning (2), and the crucial role that families, early childhood educators and primary teachers play for children's mathematics learning and development (3).

Internationally, research in early childhood mathematics has become a wide (interdisciplinary) field and concerns the mathematics teaching and learning of children aged 3 to 8—hence it includes home, kindergarten, pre-school and school settings. Its scope involves the following research areas identified by the Working Group on "Early years mathematics" in the call for papers for CERME 8 in 2013:

- *the role of natural language in early years mathematics*,
- *the role of play in early years mathematics*,
- *the role of manipulatives and ICT tools in the teaching and learning of early years mathematics*,
- *the transition between manipulation and different kinds of representations*,
- *designing and implementing tasks for early years mathematics*,
- *the transition between pre-primary and primary school in early years mathematics*,

- *ways to learn to become a learner at school*,
- *early years mathematics and learning disorders (e.g. dyscalculia): early identification and intervention*,
- *challenges in early years mathematics for teacher education and development*,
- *theoretical approaches to the study of teaching and learning of early years mathematics* (Bartolini Bussi et al. 2012).

The evident focus[1] on early years mathematics in practice and research in Germany in the 21st century correlates with political initiatives highlighting the importance of early education and the enhancement of young children (Jugendministerkonferenz 2002) as well as the widely discussed findings of the 2003 PISA study. In this context, Ehmke et al. (2005) describe a significant relation between the duration of time spent in kindergarten and the mathematical achievement of 15-year-olds leading to an increased awareness of the importance of early childhood education. In the first decade of this century state wide curriculum documents for early childhood education were developed and implemented across all 16 German states and subsequently the established practice in kindergartens—or with respect to early mathematics learning and teaching rather the lack of respective activities in many places, the training and professional development of early childhood educators and primary teachers with respect to early years mathematics and last but not least research in this area became the focus of attention of mathematics educators.

While research in early childhood mathematics in Germany is a fairly young field of research, it is also a very active research domain in which mathematics education researchers and developmental psychologists share genuine research interest and acknowledge and appreciate each others' work. Since the turn of the century there is a growing number of studies investigating various aspects and contexts of early mathematics learning and teaching. It is an explicit goal of this issue to make recent studies by German/Austrian researchers in early childhood mathematics, their different theoretical frameworks, their specific quantitative as well as qualitative methodologies, their findings and respective implications for further research and practice available to an international audience. Hence, the papers in this volume portray the wide scope of current German/Austrian research in early childhood mathematics as well as their connection to the international body of research that has been published in this area.

The first paper by *Hedwig Gasteiger* takes a theoretical approach and is concerned with the evaluation of concepts for early mathematics education in prior to school settings. She argues that the individual enhancement of kindergarten children that lead to the development of mathematical ideas which form the foundation for future (school) mathematical learning is a highly complex task and develops research-based strategies that enable early childhood educators to support individual mathematical learning processes.

[1] It should be noted that already in the 1970s early childhood (mathematics) education was in the focus of educational policies and approaches to early childhood mathematics during that time were mostly limited to the final year of kindergarten and closely related to the New Math movement and consequently predominantly pre-numeric. However, this attempt (as well as the New Math reform in schools) failed because of its rather formal approach, which was not at all connected to the experiences of young children in their everyday life and play.

The complex relationship between kindergarten educators and mathematics is focus of investigation in the second paper by *Christiane Benz*. She reports and discusses findings of a large-scale questionnaire study with (prospective) kindergarten educators with respect to their emotions, attitudes and beliefs about mathematics, the teaching and learning of mathematics, and early childhood mathematics and addresses the challenges in early years mathematics for (kindergarten) teacher education and development.

The following three papers address studies on children's developing understanding in various content-areas of early years mathematics.

Petra Langhorst, *Antje Ehlert* and *Annemarie Fritz* investigate the development of the part-whole concept in 4- to 8-year old children. While it is widely acknowledged that the understanding of part-whole relationships is based on schemas and develops over time, the authors aim to better understand this process by examining the developmental connection between children's non-numerical and numerical understanding of this concept according to their age.

Miriam Lüken's starting point is the widely adopted understanding of mathematics as the science of pattern and structure. She reports the findings of a longitudinal study on young children's structure sense and provides empirical evidence that early, i.e. prior to school, structure sense is a predictor for mathematical competencies at the end of grade 2.

A longitudinal study based on quantitative as well as qualitative data is also the methodological approach chosen by *Michael Gaidoschik* in order to investigate the development of calculation strategies in grade 1. His particular research interest is to what extent deriving facts helps to automatize facts and how that can be used in the classroom to foster children's early arithmetic learning.

In the last paper *Götz Krummheuer* applies the theoretical framework of socio-constructivism to the detailed analysis of interaction processes between kindergarten children/second graders and their (kindergarten) teachers introducing and elaborating the concept of the interactional niche in the development of mathematical thinking.

In summary, all studies presented here contribute valuable information with respect to the key question that is guiding research as well as practice in early years mathematics: "How do we as early childhood educators and parents build on the natural curiosity and inquisitiveness of young children and support them in developing sophisticated mathematical concepts and the specific vocabulary associated with these concepts (Raban 2012, iv)? Each of the papers illuminates relevant issues in this context and also documents the necessity of further research. While the expectation and the goal are evident, there are many paths that need to be explored in order to ensure "that all young children have access to powerful mathematical ideas and learning in their early years, and to learning that nurtures success and positive dispositions" (AMT and ECA 2006). We trust that the six papers of this Special Issue will provide stimulating new insights and provoke further questions and research in this relevant field of mathematics education.

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