Editorial: Children's conceptual development of mathematics

This special issue of SAJCE was planned as a precursor to a book about assessment of mathematical competence in multilingual societies (see the article by Henning in this issue about the origin of the collaborative work of two teams). It consists primarily of articles by researchers in Germany, some of whom collaborate with South Africans in their search for a way to capture children's mathematical knowledge in the early years of schooling.

The South African articles will be forthcoming in Volume 4 of the journal.

Studies from the past three decades have provided substantial evidence that children are born with core cognitive 'modules' of mathematical knowledge that give them a rudimentary understanding of the world (Carey, 2009; Spelke & Kinzler, 2007; Dehaene, 2011). According to this field of research, the brain is equipped with core cognitive systems, which allow for initial representations of numerosities for mathematical learning (Dehaene, 1997; 2011; Carey, 2009). These core systems serve as building blocks for the development of new cognitive skills (Spelke, 2000, 1233; Gelman, 2011), which are developed and differentiated in further learning.

Each child has to understand different basic concepts of number during the process of learning how to think arithmetically. These different concepts allow us to translate real world problems into arithmetical calculations and to develop efficient strategies for complex arithmetical problems. Although every child is born with some innate knowledge, children struggle with the basic concepts that are needed to participate in formal schooling. This leads to the question, at what point do children acquire these different concepts and how do these concepts influence later learning? There have been numerous studies indicating that long before formal schooling children understand several essential arithmetical concepts. Thus, the primary school cannot treat pupils as blank slates. Instead, basic arithmetical concepts are a major predictor of successful learning during the early years of schooling. The more children already understand by the time they enter formal education, the more rapidly they will be able to engage with the challenges of the maths curriculum. Similarly, children with limited conceptual knowledge will struggle with the onset of formal schooling.

Arndt *et al*. focus on the question of whether innate arithmetical proficiency is important for later achievement in school. There have been many studies with findings suggesting that innate core system abilities improve during development. Several studies have shown that kindergarten children can solve addition, subtraction, doubling and halving problems using the core system for the *approximate* representation of numerical magnitude. However, there is little research regarding the question how this knowledge predicts later success in school.

Peucker & Weißhaupt describe the development of early arithmetical concepts from early childhood to preschool age. Based on developed core knowledge, they discuss cardinality and the part-part-whole concepts, as being key concepts to numerical development. Teaching in kindergarten and later on in school should focus

on the concepts of cardinality and part-part-whole, to support developmental learning in children.

Fritz, Ehlert & Balzer assess whether a hierarchical structure imposes itself on acquisition of early arithmetical concepts. The empirical confirmation of their developmental model allows for describing a hierarchical sequence of central concepts, which are dependent on each other. The availability of their model allows researchers and teachers to allocate the performance of a child to a certain developmental level. One can determine the developmental step children need to progress to the next level. Therefore, training programmes can be planned adaptively.

Langhorst, Ehlert & Fritz report on a training programme, *Mina and the Mole* for children aged 4-8, which can be applied as from kindergarten (Grade R). It is based on the theoretical framework of the developmental model of arithmetic concepts presented by Fritz, Ehlert and Balzer. The authors report the findings of a longitudinal study with German kindergartners. Their paper focuses specifically on the phonological aspects of the math training. Considering the dominant linguistic focus of the training, it is of special interest whether the training constitutes a disadvantage for linguistically weak children.

Scherer focuses on activities for the mathematics classroom in the early grades. The selected problems and games should help children develop their conceptual knowledge. They are designed to suit the heterogeneity of students with very different learning needs. Several students can work on the same problems, as each of them will find certain aspects of the problem to be solvable on different levels of competence.

Ehlert & Fritz introduce the training programme, MARKO-T, which was developed for extracurricular individual training. It is an adaptable programme for educationally impaired children with considerable mathematical deficiencies. The effectiveness of the training programme is examined in an evaluation study with German third-graders with learning disabilities. The focus is on the question whether educationally impaired children with very poor mathematical abilities can be supported and whether effects are sustainable.

Henning tells the story of the German-South African cooperation, which is the basis for this special issue. The focus of this cooperation is the assessment of children's competence in mathematics in the foundation phase. A first goal is the translation and standardisation of a mathematics competence test for 4-8 year-olds in several African languages.

This goal and the realisation of this issue could only be achieved through the vision and the steady support of Elizabeth Henning. We would like to thank her very much for that.

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Annemarie Fritz & Graham Dampier