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EDITORIAL

Innovative approaches in early childhood mathematics

Congratulations to the European Early Childhood Education Research Association (EECERA) Special Interest Group on Mathematics Birth to Eight Years for the genesis of this special issue of the *European Early Childhood Education Research Journal* (EECERJ). The idea for a special issue about early childhood mathematics emerged first at the EECERA meeting in Barcelona in 2015 and solidified into a firm proposal in Dublin in 2016. It has been a long time coming but we are very proud of its final form. Thank you to the members of the SIG who have contributed, not only through writing but through their enthusiastic backing, and thank you to other contributors from outside the SIG. The result is an excellent collection of papers based on rigorous, sensitive and timely research on innovative approaches to early childhood mathematics.

Ever since Friedrich Fröbel (1862) invented the kindergarten, mathematics has been a part of early childhood pedagogy. Fröbel was aware of the educational potential in play and games and developed his '*Spielgaben*' (German = play gifts, in English called Froebel Gifts) – toys that embody mathematical ideas such as symmetry, shape, and number (Fröbel and Lilley 1967; von Marenholtz-Bülow 1887). He knew that mathematics is an important part of every child's daily life which helps them to understand the world around them. In the twentieth century, working with mathematics in early childhood was mostly play based and rather implicit, and learning occurred incidentally. In Nordic and Central European countries that follow a social pedagogy tradition (Bennett and Taylor 2006), pre-school focused primarily on social skills and care rather than education (Hemmerling 2007). This has changed in recent decades, especially after the 'PISA-Shock' which led to an international systematisation in education, a global standards movement with a shift in policy focus from educational inputs to learning outcomes, and an increase in educational research and measurement (Gruber 2006).

Nowadays, early childhood mathematics is in the international spotlight. Partly this is the result of a myriad of studies that seem to show that early childhood mathematics achievement is a strong predictor of success or otherwise in future school mathematics, other school subjects and life itself (Duncan et al. 2007; Geary et al. 2013; Carmichael, MacDonald, and McFarland-Piazza 2014). As a result, across the globe, there is greater encouragement for early childhood professionals in both prior-to-school and school settings to engage with their children in mathematics learning, with one aim being to ensure that the children's standards of achievement are higher by the time they meet the first national or international assessment of their careers. As Peter Moss (2014) has noted one of the results of such 'encouragement' has been the 'schoolification' of prior-to-school education and moves away from play-based pedagogies – a tendency that many early childhood professionals meet with scepticism (Broström 2017).

Another influence on early childhood mathematics education, which is related to the standards-based arguments, is the advent of the political and advocacy juggernaut known as STEM (Science, Technology, Engineering, and Mathematics). There is a danger that, as a result of STEM advocacy, mathematics will be seen to be the 'servant' of science, technology, and engineering and that all mathematics will need to be drawn from these other disciplines or apply to them. However, mathematics, particularly mathematical thinking, has a nature and approach which demand respect in its own right (Hardy 1940; Devlin 2012). At the early childhood level,

mathematics provides opportunities for investigation and discovery that are not limited to applications to 'real' life but also stimulate creative and innovative thinking in both young children and their educators (Shen and Edwards 2017). Mathematics must not become simply a servant of science but rather be an approach to thinking and reasoning for young children's present and future (Katz 2010).

The first decade of this century saw the development of two position statements on early childhood mathematics – one in the U.S.A. and one in Australia – which are still pertinent today. The first resulted from a joint project between the National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM), two U.S.-based professional associations which did not have a history of working together and furnishes a strong position for early childhood mathematics education.

> The National Council of Teachers of Mathematics and the National Association for the Education of Young Children affirm that high-quality, challenging, and accessible mathematics education for three-to-six-year-old children is a vital foundation for future mathematics learning. In every early childhood setting, children should experience effective, research-based curriculum and teaching practices. Such high-quality practice in turn requires policies, organizational supports, and adequate resources that enable teachers to do this challenging and important work. (NAEYC & NCTM 2002/2010, 1)

In Australia, the equivalent professional associations – Early Childhood Australia (ECA) and the Australian Association of Mathematics Teachers (AAMT) took the following position:

> The Australian Association of Mathematics Teachers and Early Childhood Australia believe that all children in their early childhood years are capable of accessing powerful mathematical ideas that are both relevant to their current lives and form a critical foundation for their future mathematics and other learning. Children should be given the opportunity to access these ideas through high quality child-centred activities in their homes, communities, prior-to-school settings and schools. (ECA & AAMT 2006, 1)

We have chosen to include these statements in this editorial partly because they originate outside the European context of EECERA and can be compared with perhaps more familiar documents for many readers, but, more importantly, because they reiterate the importance of early childhood mathematics education for both the present and the future learning and advocate for the children, educators and approaches involved in this learning (see also Moss, Bruce, and Bobis 2016). The papers presented in this special issue of EECERJ investigate and reflect many of the issues and challenges raised by the position statements and the current trends and tensions in early childhood mathematics education. They provide a strong collection of current research for the consideration of all in the early childhood education field.

The 10 papers in this special issue emanate from seven countries – Switzerland, Sweden (three papers), Spain, Portugal, Norway, Northern Ireland, and Australia (two). The papers address many of the 'trending' topics in early childhood mathematics education and provide important insights to these topics.

The first three papers in this issue address various aspects of the important mathematical idea of 'mathematization', 'a term coined by the eminent Dutch mathematics educator, Hans Freudenthal, in the 1960s to signify the process of generating mathematical problems, concepts and ideas from a real world situation and using mathematics to attempt a solution to the problems so derived' (Perry and Dockett 2008, 81). Björklund, Magnusson, and Palmér (Sweden) use the framework of Developmental pedagogy (Samuelsson and Carlsson 2008) to relate this idea to the common early childhood pedagogical approach of play. They highlight the need for teachers to interact with children during their play in order to help them understand their worlds and to mathematize. The analysis reveals four different lines

of action that teachers can use to stimulate children's learning based on their play experiences. Through such an analysis, they develop a way of considering play and learning not in dichotomous opposition to each other but in harmonious mathematization. From the other side of the world, MacDonald, Fenton, and Davidson (Australia) investigate the mathematics arising from an experience in which many children across the world engage – shopping. In particular, they consider what mathematics children and their families notice, explore, and talk about as they participate in family shopping experiences. All six of Bishop's (1988) cultural mathematical practices were noticed, suggesting that shopping may be one example of an experience which could be used by both families and early childhood professionals as a starting point for mathematizing play in the sense introduced by Björklund, Magnusson, and Palmér. The third paper in this group also emanates from Sweden and, like the first two, relies on the analysis of videorecorded data in its investigation of children's mathematising in their spatial play. Gejard and Melander use the notion of mathematizing as 'participation in mathematical discourse' (Sfard 2008, 128) to conduct a fine-grained study of the mathematical discourse when two pre-school children play with a magnetic construction toy. They emphasise that their findings, while preliminary, do point to informing early childhood professionals about the extent and nature of children's geometrical thinking and 'the richness of children's spontaneous mathematical interactions and the number of geometric aspects that arise in their interaction'. These three papers all consider various facets of mathematization, emphasise the importance of the study of children's interactions and discourse, and use videorecorded recorded data. They set the scene for the remaining papers through their quality, similarities, and diversity.

Papers 4 and 5 in the special issue focus on different aspects of student teachers and how they interact with the mathematics education in their teacher preparation courses. Thiel and Jenßen (Norway) highlight affective aspects of early childhood student teachers' interactions with mathematics. In particular, they investigate the student teachers' mathematical self-efficacy and anxiety and the interaction between these in relation to achievement in their course. The study utilises a strong quantitative approach and is replete with detailed statistical explanations not often seen in the early childhood field. From a methodological aspect, the paper is important because it challenges readers to engage with the quantitative approaches. From an early childhood mathematics education aspect, the study uncovers some unexpected results which question some of the 'conventional wisdom' concerning affect and achievement. An interesting feature of the Thiel and Jenßen paper is the use of student teachers' assessed work as part of the data generation. Similarly, Figueiredo, Gomes, and Rodrigues (Portugal) utilise written assignments from the participant student teachers. In this paper, student teachers responded to a video stimulus by considering both the pedagogical approaches and the mathematical content in the stimulus and suggesting ways of enhancing or continuing the learning shown. The results of this study have some useful consequences for newly developing early childhood teacher education approaches in Portugal, both in terms of the pedagogical content knowledge of prospective early childhood professionals and the specific pedagogical needs of young children. There would appear to be a clear danger that early childhood pedagogies might be subsumed by others seen as appropriate for older children. This could provide yet another example of 'schoolification' in early childhood teacher education.

Notions of representation of mathematical ideas have been canvassed by some of the papers already considered. The next two papers, however, have a specific focus on such representation, although from quite different perspectives. The paper from Northern Ireland authored by Moffett and Eaton reports on the Promoting Early Number Talk (PENT) project and, in particular, the impact perceived by a small group of participating teachers on their own practice and their children's learning about number representation. The paper provides a detailed

historical overview of U.K. work from the 1980s on in children's representations of mathematical concepts and thinking and relates this to the impact of a resource book by Casserly, Tiernan, and Moffett (2014) designed to promote early number vocabulary. Findings include that young children's own mathematical representations can provide a 'bridge' between informal and more formal representations and that the valuing and utilisation of children's existing knowledge and skills will best assist children's further learning. Although a relatively 'small' study, this paper does provide a positive stimulus for the approach and further research. Quite a different approach to writing about children's representation is taken by Palmér and van Bommel. They analysed how children in Swedish pre-school classes both represent and systematise their thinking about a combinatorial problem, using Hughes (1986) to classify the representations and Mulligan and Mitchelmore (2009) for the systematisations. The mathematical content of the chosen problem-solving task is quite unusual for early childhood settings, but the study reveals important insights into how children develop abstract thinking. The development of children's systematisations and abstract representations seems to be synchronised, but only if the children's interpretation of the task is taken into account.

Palmér and van Bommel utilise a problem-solving situation in an area of mathematics unfamiliar to most young children (and, incidentally, to many of their educators). In the next paper, Ramírez-Uclés, Castro-Rodríguez, Piñeiro, and Ruiz-Hidalgo (Spain) ask a fundamental question about such situations or, more specifically, the tasks which create a problem-solving situation. Through an analysis of the literature, the authors have determined that real-life tasks suitable for problem-solving with pre-school children should have the following characteristics (wording derived from the paper): The solution is not just a short answer, solvers know who needs the result and why, solving the problem is a multi-stage process, and ideas and procedures from several areas need to be integrated. The findings also show the value of children working in groups to try to solve the problems and the importance of an educator or teacher working with the groups of children in order to stimulate and sustain activity.

As has been intimated earlier, the potential links between play and learning are fertile grounds for investigation in early childhood mathematics education. In the study from Switzerland by Vogt, Hauser, Stebler, Rechsteiner, and Urech, six-year-old children were assigned to one of three 'treatment' groups described as a training program, a play-based approach using card and board games, and a control group. While a detailed analysis of the results is provided in the paper, the major findings are that while the training program benefited children with lower mathematical competency, the play-based approach seemed to benefit all groups of children, regardless of their competency level. As well, the educators preferred the play-based approach, partly because the results reinforced their own beliefs about the appropriateness of the pedagogical approaches.

The final paper for this special issue emanates from the *Let's Count* program (Gervasoni and Perry 2017) as does the earlier paper by MacDonald et al. Perry and Dockett (Australia) use Bronfenbrenner's bioecological framework (Bronfenbrenner and Morris 2006) to analyse responses from early childhood professionals and adult family members about their involvement in the program. There is a particular emphasis on the proximal processes which arise from interactions. Analysis of the data shows that the processes of noticing, exploring and talking about the mathematical activities of pre-school children had major impact on the mathematical attitudes and confidence of the adults involved with these children as well as on the mathematical learning of the children. The paper concludes with recognition from the analysis of the data that 'supporting children's mathematical development involves

working collaboratively with those who are in a position to facilitate meaningful, ongoing, regular, reciprocal and increasingly complex interactions with mathematics at their core'.

This special issue of EECERJ is a major achievement of the EECERA SIG Mathematics Birth to Eight Years. We are particularly proud of the diversity of authors, topics, approaches, and countries represented in the collection. Clearly, early childhood mathematics education is an important component of the field and one which engenders much quality research. It is important that such research continues.

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