Swedish Preschools, Play and the Learning of Mathematics

Troels Lange, Tamsin Meaney, Eva Riesbeck and Anna Wernberg
Malmö University

Recently, attention has been focussed on the mathematics learnt in preschools and how this contributes to children's subsequent learning in schools. This paper explores the dilemma of trying to increase preschool children's learning of mathematics, whilst allowing their play to guide that learning. In Sweden, the revised curriculum for preschools specifies more mathematics to be covered. Yet, like other countries, Sweden traditionally has seen preschools as places where learning arises from children's play. We suggest two avenues for further research that would contribute information to increasing the likelihood of play supporting mathematics learning.

Mathematics and preschools in Swedish society

An analysis by Greg Duncan and colleagues of six longitudinal studies suggested that early mathematics knowledge is the most powerful predictor of later learning including the learning of reading (Duncan et al., 2007). Combined with concerns about preschools inhibiting children learning deep mathematics (Clements & Sarama, 2007), this has led to preschool mathematics education becoming a focus in recent years (Barber, 2009; Perry, Young-Loveridge, Dockett, & Doig, 2008). For Sweden, there is a dilemma of wanting both to ensure that children begin school with stronger mathematical understandings and to adhere to the philosophy that preschool children should learn through play. This is a dilemma that some see as irreconcilable (Lee & Ginsburg, 2009; Carr & May, 1996). In this paper, we explore this dilemma and suggest two possibilities for further research that could contribute to it being resolved.

Although it is not compulsory for young children in Sweden, by 2008, more than 90 percent of children aged 2 to 5 years attend preschools (Broman, 2010). Unlike other Western countries which also expanded the number of preschools to meet parental demands, the systematic intervention of the government in providing not just physical spaces but also highly educated staff is considered unique to Sweden (Broman, 2010).

Originally in Sweden, play was considered the foundation for preschool children's learning experiences. In the revised version of the preschool curriculum, play still retains a central role as the medium through which children are expected to learn.

> Play is important for the child's development and learning. Conscious use of play to promote the development and learning of each individual child should always be present in preschool activities. Play and enjoyment in learning in all its various forms stimulate the imagination, insight, communication and the ability to think symbolically, as well as the ability to co-operate and solve problems. (Skolverket, 2011, p. 6)

In Swedish, to play in a situation without rules is "lek" and this is the form of play mentioned in the curriculum. Play is acknowledged as being difficult to define (Samuelsson & Carlsson, 2008). Docket and Perry's (2010) definition combines many of the features identified by Samuelsson and Carlsson (2008):

> The process of play is characterised by a non-literal 'what if' approach to thinking, where multiple end points or outcomes are possible. In other words, play generates situations where there is no one 'right' answer. … Essential characteristics of play then, include the exercise of choice, non-literal approaches, multiple possible outcomes and acknowledgement of the competence of players. These characteristics apply to the processes of play, regardless of the content. (Dockett & Perry, 2010, p. 175)

Although play retains a place of importance in the curriculum, there has been a shift in government documents suggesting that preschools should prepare children for school, through a focus on literacy, numeracy and other subjects (Broman, 2010). For example, the revised version of the preschool curriculum, (Skolverket, 2010), implemented in July, 2011 increased the attention on mathematics. In the 1998 version, one objective stated that children "utvecklar sin förmåga att upptäcka och använda matematik i meningsfulla sammanhang, utvecklar sin förståelse för grundläggande egenskaper i begreppen tal, mätning och form samt sin förmåga att orientera sig i tid och rum" (develop their ability to discover and use mathematics in meaningful contexts, develop their understanding of the basic properties of the concepts number, measurement and shape and their ability to orient themselves in space and time) (Skolverket, 1998, p. 9; our translation). In the revised curriculum, this was expanded to "develop their understanding of space, shapes, location and direction, and the basic properties of sets, quantity, order and number concepts, also for measurement, time and change, develop their ability to use mathematics to investigate, reflect over and test different solutions to problems raised by themselves and others, develop their ability to distinguish, express, examine and use mathematical concepts and their interrelationships, develop their mathematical skill in putting forward and following reasoning," (Skolverket, 2011, p. 10).

The emphases in the revised curriculum suggest that children can learn through play and so there is no dilemma. Nevertheless, as described in the next section, some researchers indicate that this combination may not be achievable.

Mathematics, play and direct teaching

Play, as defined above, involves children exploring their world through fantasy, and physical manipulations, using 'what if' thinking. They make choices and so control what occurs. In preschools, there are predominantly two kinds of play, free play, in which children uses the resources around them without adult intervention, and guided play where a teacher sets up a situation but allows children's own interests to guide the play and the learning. As well, direct teaching can occur in preschools. The teacher not only sets up the situation but prescribes what actions the children are allowed to carry out. Children may still enjoy this learning but they can make limited, if any, choices about what they do.

Concerns have been raised about whether children are able to explicitly explore mathematical ideas during free play:

> Children do indeed learn some mathematics on their own from free play. However, it does not afford the extensive and explicit examination of mathematical ideas that can be provided only with adult guidance. … Early mathematics is broad in scope and there is no guarantee that much of it will emerge in free play. In addition, free play does not usually help children to mathematise; to interpret their experiences in explicitly mathematical forms and understand the relations between the two. (Lee & Ginsburg, 2009, p. 6)

On the other hand, an adult watching or participating in child-initiated play can develop children's mathematical ideas by stimulating their curiosity and language use (Doverborg, 2006). Björklund (2008) showed that adults were important in setting the parameters for children's opportunities to engage with mathematical ideas. Nordahl (2011, p. 13; our translation) provided an example of this guided play from her research where she monitored the play of children aged between 1 and 3 years:

> Nancy, Minnie (2.5 years) and Jonna (3 years) build with wooden blocks. Minnie builds towers of as many blocks as she can, and when it collapses she laughs delightedly and then simply starts again. Jonna first builds a base and then continues on top of this.

Eva (förskollärare):	Vad bygger du Jonna?
Jonna:	Jag bygger vårt hus, det har fyra våningar. Där bor jag (pekar) på trean.
Eva:	Oh, jag bor på ettan, mitt hus har bara en våning.
Eva	*vänder sig till Mimmi som balanserar upp ännu en kloss på sitt torn:* Du bygger riktigt högt.
Mimmis	*torn rasar och hon skrattar förtjust och utbrister:* Inte mer!

Eva (preschool teacher):	What do you build Jonna?
Jonna:	I build our house, it has four floors. I live there (points) on the third.
Eva:	Oh, I live on the first, my house has only one floor.
Eva	*turns to Minnie who balances yet a block on her tower:* You build really high.
Mimmi's	*tower collapses, and she laughs delightedly and exclaims:*

			No more!
Eva:	Nä det har du rätt i nu är det inte högt längre (skrattande).	Eva:	No you're right now, it is not high anymore (laughing).
Nancy	*bygger bara ett lager och med ”hålrum” emellan – nästan som en ritning.*	Nancy	*builds only one layer and with "cavities" between - almost like a drawing.*
Eva:	Det är ett stort hus du bygger, Nancy.	Eva:	It's a big house you build, Nancy.
Nancy:	Nej inte stort. Långt.	Nancy:	No, not big. Long.
Eva:	Ja jättelångt. Lika långt som du nästan.	Eva:	Yes very long. As long as you almost.
Nancy	*blir förtjust och lägger sig ned bredvid och konstaterar samtidigt att hon behöver fylla på med klossar.*	Nancy	*is delighted and lies down next to and acknowledges that she needs to fill up with blocks.*

In this example, the adult encourages Jonna’s use of ordinal terms and provides opportunities for Mimmi and Nancy to use comparative terms to do with height and length. The role of the teacher is crucial in reinforcing the use of these mathematical terms. Nevertheless, the children control the play.

On the other hand, if a teacher does not recognise the potential mathematics within a situation, then they are unlikely to extend children’s curiosity or language use. In Sweden, concern was expressed about preschool teachers’ use of resources designed by Fröbel, the German pedagogue, instrumental in setting up preschools in the nineteenth century. Doverborg (2006) cited a study by Leeb-Lundberg (1972) which found that deep mathematical understanding was required for teachers to support children’s use of some of Fröbel’s equipment. When this was not provided in their teacher education, it was impossible for teachers to develop children’s mathematical understanding.

In 2003, 100 preschool teachers in Sweden were surveyed about their teaching on mathematics. Only 3 teachers explicitly addressed the curriculum goals in their planning (Doverborg, 2006). Many felt that learning occurred naturally as part of children’s everyday lives and so did not have to be planned for. Nordahl (2011) reported similar anecdotal experiences:

> My colleagues … often perceive mathematical development to only occur in the form of "learning to count." This has meant that they have not noticed when the children's mathematical development took place. Instead, they may even have impeded it by interrupting or trivialising the mathematical discoveries of pre-school children, such as size perception. (p. 11, our translation)

Doverborg (2006) also felt that preschool teachers needed to see mathematics as more than “sifferskrivning och ramsrakning (writing numerals and reciting counting rhymes)” (p. 7; our translation).

A consequence of these concerns, especially in English-speaking countries, has been the implementation of a number of direct teaching programs in

preschools. An American project, *Big Math for Little Kids*, was founded on the view that children needed to be presented with activities in a cohesive manner, but that these activities should be joyful and contribute to developing children's curiosity about mathematics (Greenes, Ginsburg, & Balfanz, 2004). Repetition of the activities provided opportunities for the mathematical ideas to be extended. For Greenes et al. (2004), the development of mathematical language was a key to helping children reflect on their learning.

Preschool mathematics programs of this type are generally sequenced with an expectation that children move along development progressions. For example, in another American project, *Building Blocks*, a set of activities were provided, based on learning trajectories for children (Sarama & Clements, 2004). Teachers who understood the learning trajectories were better able to provide "informal, incidental mathematics at an appropriate and deep level" (p. 188). Papic, Mulligan and Mitchelmore (2011) implemented an intervention program on repeating and spatial patterning in one preschool over a six month period. Children were grouped according to how they performed on an initial diagnostic interview and then provided with tasks for their level. A combination of individual and group time was provided. Children progressed to the next level if they showed competency in their current level. Papic et al. (2011) found that, after one year at school, the children performed better on a general numeracy assessment than children from a control group.

Yet, many feel that direct teaching in early childhood settings could lead to "learned helplessness and a feeling of failure" (Farquhar, 2003, p. 21). Many preschool and early school programs, such as those described by Papic et al. (2011) and Clarke, Clarke and Cheeseman (2006), include assessing children before, or as, they enter school on their mathematical knowledge. Such assessments risk children being labelled as "behind" or "at-risk" at a much earlier age. Although designed to support teachers to target their teaching to the children's levels, this early assessment has the potential to lower teachers' expectations about children's capabilities. It may also affect children's perception of themselves as learners of mathematics. Learning through play, where the children themselves have control and can adjust it to the competencies of participants is less likely to result in these sorts of consequences.

It is also unclear whether direct teaching in preschool has a lasting impact on children's academic performances. In a study of children from 3 preschools with different pedagogical approaches, children varied in academic performance at different ages (Marcon, 2002). At the last stage of the study when children moved into their sixth year of school, children who had attended a preschool that was academically focused showed the least progress. "Grades of children from academically directed preschool classrooms declined in all but one subject area (handwriting) following the Year 6 transition" (Marcon, 2002, p. 20).

Historically preschool programs often were established for children perceived as being "at-risk" of academic failure (Samuelsson & Carlsson, 2008). In recent years, the role of preschools in overcoming academic disparities has become prominent again (Clements & Sarama, 2007, p. 462). Yet, Clements and Sarama's suggestion that poor Black Americans came to school with pre-mathematical understandings and were unable to generalise, whilst other children started school with mathematical understanding has been heavily criticised by Martin (2010).

A program, designed for children thought to begin school "at-risk" of academic failure was *Building Blocks* (Sarama & Clements, 2004). Yet achievement gains of children do not seem to be long-lasting. Clements et al. (2011) found that after the first year at school, the gains from participating in *Building Blocks* at preschool were reduced and after the second year there was no substantial gain at all. They detailed other studies which showed similar results.

The correlation between mathematics knowledge on entering school and later learning has resulted in many calls for direct teaching of mathematics in preschools (Clements & Sarama, 2007). Yet, the circumstances of children's lives contribute to the knowledge that they show at all ages. In reporting on a longitudinal project, in New Zealand, that followed about 500 children till they were 10 years old Wylie (2001) found that:

> children who started school with low literacy and mathematics scores were much more likely to improve their scores if their parents were highly educated, or if their family had a high income. Good quality early childhood education and experiences at home, or later out-of-school activities using language, symbols, and mathematics, also made improvement more likely. (p. 11)

The circumstances that meant that young children did not have "good quality childcare" may be the same circumstances that did not provide them with rich out-of-school activities. As Marcon (2002) warned there are many variables that affect children's later school achievement, not just their preschool programs.

Consequently, there is a need to be very cautious in making suggestions about how young children should engage in mathematics in preschools. It is not simple to increase children's mathematical understanding through play but there are a number of concerns about instituting a direct teaching approach. In order to better understand how teachers can develop children's mathematical understanding through play, there is a need to document what mathematics children currently engage with in preschools and how teachers support children's mathematical learning.

Research possibilities for resolving the dilemma

The dilemma of increasing children's mathematical knowledge prior to school, through using their play as the basis for learning is not simple to navigate. We

suggest two possibilities for research that could provide information to help navigate through this dilemma. The first is to document what mathematical ideas arise during both free and guided play. As well, although the importance of the adult in preschool children's play is well documented, there is a need to know more about how they develop children's mathematical curiosity and language. We discuss these ideas in the following sections.

What mathematical knowledge do young children use in play?

With the perception that mathematics in preschool should be about preparing children for school, most research has focussed on the development of number knowledge (see Clarke, Clarke, & Cheeseman, 2006). Yet, the abstract nature of number terms means they are more difficult to learn than relational terms such as heavy, empty, etc (Hore & Meaney, 2008). In an example of free play based around their eating of cornflakes, Björklund (2008) explored how children in a Finnish preschool discussed amounts in different ways, including using their body:

> Elisa (2:7) and Adam (3:1) are sitting at the table eating conflakes [sic]. Elisa says 'you have little, I have a lot' pointing first at Adam's plate and then at her own plate. Adam shows his index finger and thumb, measuring a couple of centimeters, saying 'this little', then widening the space between his fingers and says 'I have this much'. Elisa says 'look, I have much, much, much' and circles her finger over the plate. Adam continues 'later I want much, I want this much' showing his five fingers on one hand. When Adam gets more cornflakes he says 'I got much, Elisa!' Elisa answers 'I will also have much, much more, this much' and shows both her hands with all ten fingers shown. (p. 88)

Children have knowledge about a range of mathematical topics (Clements & Sarama, 2007). Documenting what is discussed and used in preschools and how it matches what is suggested in the curriculum may support teachers to broaden their conceptions of mathematics. This is likely to have a flow-on effect to their work with children. Presently, there is little research that systematically documents the mathematical activities that children engage in during guided and free play in preschools in Sweden (see Doverborg & Samuelsson, 2011). One project is that of Nordahl (2011) who used Bishop's (1988) 6 types of mathematical activities to classify the activities that 1-3 year olds engaged in at her preschool. She observed the children using numbers, different measurement ideas and shapes in their everyday play. However more research of this kind, especially with 4-5 year old pre-schooler children is needed.

How do preschool teachers develop children's mathematical curiosity?

Research with Swedish preschool teachers suggest that preservice and in-service teachers would benefit from professional learning which illustrates how

mathematical ideas can be discussed with children while they play (Nordahl, 2011; Doverborg, 2006). Currently, Delacour (2012) is investigating 4 preschool teachers' use of the revised curriculum (Skolverket, 2010) in planning and implementing lessons. Nevertheless, more research study is needed into how teachers recognise and then utilise the possibility for mathematical discussions.

To be able to recognise opportunities for mathematical discussions may require preschool teachers to make use of the mathematics understanding that children bring from home. In Australia, Clarke and Robbins (2004) worked with families in low socio-economic areas to document home practices that required numeracy understandings. They found that there were many activities and these were highly valued by families. For Clarke and Robbins (2004), "the challenge for preschool and early years teachers is to connect and build upon this rich base of mathematical experiences in ways that acknowledge and support the family's role" (p. 181). Nordahl (2011) also reiterated the need for Swedish preschool teachers to make use of children's everyday knowledge of mathematics.

Although the revised Swedish curriculum for preschools (Skolverket, 2011) implies that children's play can be the basis for learning mathematics, research both in Sweden and elsewhere suggests that this may not be simple to implement. This can lead to a dilemma where mathematics learning and children's play are constituted as two different possibilities, thus resulting in a dilemma. In this paper, we suggest two avenues for research that would provide valuable information resolving the dilemma. To develop and support children's mathematical learning through their play in Swedish preschools requires the documenting of the complexity of teachers' work and children's play in which mathematical ideas arise.

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