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Preschool children's collective mathematical reasoning during free outdoor play

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ABSTRACT

This paper illustrates how young children (age 1–5) use mathematical properties in collective reasoning during free outdoor play. The analysis of three episodes is presented. The results from the analysis of the argumentation show that the children used a variation of mathematical products and procedures, to challenge, support and drive the reasoning forward. When needed, they utilise concrete materials to illustrate and strengthen their arguments, and as an aid in order to reach conclusions. The children also use abstract social constructs, such as jokes, as part of their reasoning.

1. Introduction

There is a growing body of research in early mathematics education based on the evidence that young children are more capable of developing mathematical concepts and processes than previously thought (Clements & Sarama, 2007; Mulligan & Vergnaud, 2006). This has been encouraged by studies that focus on general mathematical processes such as problem solving, argumentation and justification (Perry & Dockett, 2008), modelling and statistical reasoning (English, 2012), and early algebraic reasoning (Papic, Mulligan, & Mitchelmore, 2011). This development of process and sense making of mathematical concepts can take place without explicit guiding (McMullen, Hannula-Sourmunen, & Lehtinen, 2013). It is more about situation, the opportunity to learn (Hiebert, 2003), and research has shown that children that are not stimulated to train processes of this particular kind do not develop such competencies (Bobis et al., 2005; Bobis, Mulligan, & Lowrie, 2008). What we learn is a result of the type of activities that we participate in, and it is within these activities children have a possibility to make sense of concepts and processes. This includes play.

Looking at Swedish research, little is known about how and which mathematical activities children engage in during play – free or organised – in preschools in Sweden (Doverborg & Samuelsson, 2011). Even though the view of play has changed in Western Europe with a 'schoolification' of early childhood education and care (Waller, Sandeseter, Wyver, Ärlemalm-Hagsér, & Maynard, 2010), play still has a central role as a medium in Swedish preschool curriculum. In the recent revised version of the curriculum we can read that play is considered important for the child's development and that conscious use of play in order to promote development and learning of each individual child should always be present in preschool activities (School Agency, 2011a). Play is significant to young children's overall social, emotional, cognitive, and physical development

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(Seo, 2003). But how can it be used to help children to make sense of mathematics? Ginsburg and Seo (1999) conclude that children's informal mathematics comprise on an implicit level much, but not all, of the mathematics teachers want to see on an explicit level. They continue by saying that

> "teachers should identify these ideas and use them as a foundation on which to construct a significant portion of their pedagogy. In doing this, teachers should recognize that children's invented strategies are not an end in themselves. Instead, the ultimate goal is to facilitate children's progressive mathematization of their immanent ideas (and to eliminate or modify misconceptions). Children need to understand mathematics in deep, formal, and conventional ways." (Ginsburg & Seo, 1999, p. 127)

In order to be able to recognise children's strategies and see what mathematics that lies behind the thinking, we need to know more about children's use of mathematical knowledge during play. Flottorp (2010) studies five year olds' verbal and non-verbal expressions as a mean to understand their sense making of mathematics during free play. His conclusion is that children are trying to create structures and seek meanings and this is a key part of their play, although there is no clarification what this sense making consists of. Lowrie (2005) studies a boy (age 7) who elaborates with different mathematical representations and when solving a mathematical problem in an out-of-school context. The boy shows indications of sense making and understanding of various mathematical ideas such as scale and proportion, but the situation was not created spontaneously from the child himself as it was part of a computer game. Looking at even younger children and unstructured play, Lee (2010) observes toddler's outdoor play and found evidence of mathematical knowledge and skill in these activities. The mathematical content was space, number, measurement, pattern, shape, and classification, but the knowledge and skills were predominately products and nothing is concluded about processes such as reasoning or problem solving. Through research we can see that young children's play often involves mathematical concepts, ideas and explorations (Perry & Dockett, 2008; Seo & Ginsburg, 2004), but we still do not know *how* these mathematical components are used. The purpose of this study is to look at preschool children's collective mathematical reasoning during outdoor play. More specifically, we study children's use of mathematics in their arguments. The research question posed is: How and in what way are mathematical components used in preschool children's reasoning during free outdoor play? Our starting point is that children are acting as collective learners in mathematics through participation in a social activity.

2. Background

We begin with a short background to Swedish preschools. Preschools in Sweden are childcare (age 1–5) before a non-compulsory preschool class (age 6; equivalent to year K in NSW, Australia, reception class in England, and Kindergarten in USA), the latter one often taken place at school rather than in a preschool. Around 80% of all one- to five-year-olds attend preschool. Most preschools are run by the municipality, but there are also organisers such as parent-cooperative or private companies. For all children age 3 and up (to grade 1), there is a right to 525 h free of charge each year. The compulsory school starts at age 7. The first preschool curriculum came in 1998 and is mandatory for all preschools independent of who runs it or in which municipality it is located; before that the purpose was mainly child minding. (For more information, see School Agency website: http://www.skolverket.se/om-skolverket/andra-sprak-och-lattlast/in-english/the-swedish-education-system/preschool/fees-1.72241.)

2.1. Mathematics and play

According to Perry and Dockett (2007) play has long been seen as an important element in preschool education, and Nicolopoupou (1993) concluded that the relationship between play, learning and development has been extensively studied through history. Although a lot of work in this area has been done, play is a difficult concept to define (van Oers, 2013; Samuelsson & Carlsson, 2008). One possible explanation for this difficulty is the subjective part of play, where it is up to the individual what is considered being play or not. This means that activities like games automatically are not a play situation; how the situation is perceived and interpreted lies within the participant. In an overview of research in play, Lifter, Mason, and Barton (2011) summarise different definitions and point out that a definition that is open and flexible is fruitful when conducting research in this area. They write that play can involve caregivers or peer (but does not have to), can involve display of affect and can be pretend play. Therefore, we start with a definition that includes "the exercise of choice, non-literal approaches, multiple possible outcomes and acknowledgement of the competence of players" (Dockett & Perry, 2010, p. 175). This definition allows for freedom in the participation of play, the opportunity to exercise self-control, which is in line with McLane's (2003) definition of play as a special mode of thinking and doing. We agree with Lifter et al. (2011) in their conclusion that play are activities that are spontaneous, occur naturally with interesting and engaging objects. Young children's play has many facets such as free or self-directed, structured or teacher-directed, symbolic, constructive, and imaginative (Hunting, 2010). Play can also involve abstract elaborations such as playing with words and using humour (Loizou, 2005). Compared to pedagogical play, which is more a case of an intentional learning, play is freely chosen (Edwards & Cutter-Mackenzie, 2013). It shares the same properties as non-formal learning as most often it takes place in informal situations (Eshach, 2006), but since the focus here is not on what children learn but how they construct reasoning, we will use play as a theoretical setting. For a longer discussion what play and freedom might encompass and history of research in play, see e.g. van Oers (2013) and Lifter et al. (2011).