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### ► To cite this version:

Hanna Palmér, Camilla Björklund. How do preschool teachers characterize their own mathematics teaching in terms of design and content?. CERME 10, Feb 2017, Dublin, Ireland. <hal-01938926>

**HAL Id: hal-01938926**

**<https://hal.science/hal-01938926v1>**

Submitted on 29 Nov 2018

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# How do preschool teachers characterize their own mathematics teaching in terms of design and content?

<sup>1</sup>Hanna Palmér and <sup>2</sup>Camilla Björklund

<sup>1</sup>Linnaeus University, Sweden; [hanna.palmer@lnu.se](mailto:hanna.palmer@lnu.se)

<sup>2</sup>University of Gothenburg, Sweden; [camilla.bjorklund@ped.gu.se](mailto:camilla.bjorklund@ped.gu.se)

*Preschool mathematics may look very different in different contexts. These differences concern both what mathematics children are offered to learn and how the learning of that mathematics is orchestrated. In this paper we present an ongoing study on how Swedish preschool teachers characterize their own mathematics teaching in terms of design and content. The target preschool teachers are those working with the youngest children aged one to three. We present two examples of how these preschool teachers describe and characterize their mathematics teaching in terms of design and content and we discuss possible contributions to research and practice.*

*Keywords: Content for learning, design for education, mathematics, preschool teachers.*

## Introduction

Preschool mathematics does not only prepare for future schooling but – and maybe even more important – provides “young children with rich and engaging intellectual stimulation” (Ginsburg, 2009, p. 405). From a time when young children were considered to be almost incapable of learning mathematics the question today is seldom whether or not mathematics belongs in preschool but rather how to organise mathematics teaching (Björklund, 2014; Cross, Woods & Schweingruber, 2009; Perry & Dockett, 2008). However, the recognition of importance and the increased attention do not automatically imply consensus regarding how preschool mathematics should be designed or what constitutes an appropriate content. Cultural issues may explain some of these differences but there are also differences within countries and seemingly similar educational contexts (Palmér & Björklund, 2016).

There are several studies where researchers observe, analyze and often evaluate mathematics teaching and teachers in preschool (see Sarama, Clements, Wolfe & Spitler, 2016; Tirosh, Tsamir & Levenson, 2015). More seldom are the preschool teachers asked about how they themselves analyze and/or evaluate the observed teaching. In this paper we present an ongoing study on how Swedish preschool teachers working with the youngest preschool children, those aged one to three, characterize their own mathematics teaching in terms of design and content. To what extent do their characterization coincide with researchers and other preschool teachers? Maybe preschool teachers use different words to describe “the same kind of” mathematics teaching or reverse, maybe they use the same words to describe “different kinds” of mathematics teaching. The aim is to find out how these preschool teachers themselves conceptualize their mathematics teaching practice. In this paper we will present the frame for analysis we intend to use, to investigate one of our research questions, that is:

- How do these preschool teachers characterize their teaching in terms of design and content?

Since the study is ongoing the focus of the paper is on the rationale of the study and methodological layout with only brief discussions of two examples. First in the paper we will give some background of preschool mathematics and Swedish preschool. After this we present the study followed by two examples of the empirical material we are to work with. Finally, we discuss what we believe this study will contribute with to research and practice.

## Preschool mathematics

Preschool mathematics is an issue of current debate and may look very different in different contexts. These differences are found both in *what* mathematics children are offered to learn and *how* learning of that mathematics is orchestrated (Cross, Woods & Schweingruber, 2009; Perry & Dockett, 2008). While some emphasise basic number facts and applying computational procedures (Westwood, 2011) others emphasise advanced mathematical activities focusing on a broad spectrum of content (Claessens & Engel, 2013; Seo & Ginsburg, 2004). Regarding *what* mathematics children learn in preschool numbers and quantity are often emphasised but also concepts of space, shape, pattern, and order are central in early mathematics learning (Sarama & Clements, 2009). However, there are studies showing that the depth and quality of how the content is made an object of learning varies, where for example spatial relations, shapes and patterns are rarely problematized (Björklund & Barendregt, 2016).

One way to characterize *how* mathematics is taught is to distinguish between naturalistic, informal and adult guided learning experiences (Charlesworth & Leali, 2011). Naturalistic learning experiences are initiated and controlled by the child. A naturalistic learning experience can turn into an informal learning experience if a teacher starts to interact with the child in a way that knowledge may be reinforced, applied or expanded. Adult guided learning experiences are those being pre-planned by the teacher involving some direct instruction. Björklund's (2014) study of meaning making of mathematical concepts highlights the complexity of designing preschool mathematics education. She found three ways in which teachers planned and acted to facilitate conceptual growth among 4- and 5-year-olds. One way of approaching mathematical concepts was to give the children individual traditional tasks to solve ("I give you  $x$  number of items, can you divide them into half?"). Another way of approaching the same concept was to "hide" the mathematical content in problem solving tasks, such as games and every-day tasks. The former approach, which was clearly goal-oriented and adult guided turned into a task of "doing" where the children primarily waited for their turn but not directing attention to the mathematical content rather than the joy of being given a task to solve. The latter, which also was carefully planned by the teacher to stimulate certain concept development, failed in establishing intersubjectivity because of the children's different attention to play the game and finish the task, rather than stop and reflect on the mathematical content within the tasks. Even though the children happily engaged in the activities, the mathematics was not in focus of attention. A third way of approaching mathematical content was framing a concept in narratives where the teacher could orchestrate the direction of a story and in that manner direct the children's attention towards an intended object of learning. It turned out that this approach appealed to the children and engaged them in problem solving where concept development was made possible. This third approach was also characterized as more perceptive to the children's suggestions and creative solutions. Thus, designing teaching for preschool mathematics is a delicate work, where abstract and "invisible" mathematical principles are to be

made explicit. Preschool didactics is to make the invisible visible to the child (Pramling & Pramling Samuelsson, 2011). Björklund's (2014) study is one example of this, since the focused attention has to be made common for both teacher and child, whereas the design of the activity may constrain or enable learning.

## Swedish preschool

Swedish preschool, in which the present study is conducted, is situated within a social pedagogy tradition (Bennett & Tayler, 2006) where care, socialisation and learning constitute a coherent whole and is part of the formal education system. Preschool is offered to children between the ages of one and six, and similar to other Nordic countries (Reikerås, Løge & Knivsberg, 2012), the youngest children attending preschool are increasing in number. In Sweden, 94% of all 4–5-year-olds are enrolled in preschool or similar pedagogical practice and 88% of all 2-year-olds attend preschool or an equivalent practice (National Agency for Education, 2016).

The preschool curriculum includes several mathematics-related goals, for example that preschool should strive to ensure that each child “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”. Another example is to ensure that each child “develop their ability to use mathematics to investigate, reflect over and test different solutions to problems raised by themselves and others” (National Agency for Education 2011, p. 10). These are however not goals for children to attain but instead provides direction for content and activities.

Based on the curriculum, each preschool chooses the approaches most appropriate for its own setting. Preschool teachers and child-minders are the two main types of pedagogues working in Swedish preschools. Child-minder is an upper secondary school education while to become a preschool teacher; one must complete a three and a half year university programme in preschool teacher education. Preschool teachers educated after 2001 have studied mathematics teaching in their degree, but the preschool teacher profession is mostly characterized as “educational generalists”, without specialization in any particular subject.

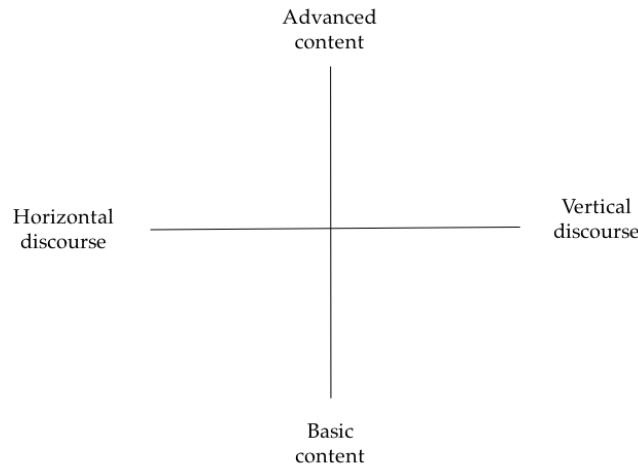
## Theoretical framing

Since we want to investigate how preschool teachers characterize their own teaching we needed to develop a framework that included the dimensions of *what* and *how*. To capture both these dimensions we have used Bernstein's (1999) notions *vertical and horizontal discourses* together with Claesson, Engel and Curran's notions (2014) *basic and advanced content*.

Bernstein (1999) uses the notions vertical and horizontal discourses to distinguish between different kinds of knowledge. A discourse characterized by coherence of content, hierarchically interconnected procedures, specialized language, systematically organized activities focused on general knowledge is a vertical discourse. A discourse characterized by location within communities, high relevance in the situation, every-day language, segmentally organized and maximized encounters with persons and habits is a horizontal discourse. In this study the notions of vertical and horizontal discourses is used to describe the dimension of *how*.

Claesson et al. (2014) define mathematics content as basic or advanced depending on whether the majority of children in the group focused on have mastered the content or not. Thus, basic

mathematics imply mathematics content that the majority of the children already know but that still is new for others while advanced mathematics is new content for the majority of the children. In this study the notions of basic and advanced is used to describe the dimension of *what*. However, basic or advanced will not be based on groups of children mastering some content or not, but on the preschool teachers' view of the content in each situation being characterized. Together these four notions can be used to characterize different contexts of mathematics in preschool as in Figure 1.



**Figure 1: Connecting horizontal and vertical discourse with basic and advanced mathematics.**

The two extremes basic and advanced content are to be understood as differences when it comes to which mathematics being focused on while the two extremes horizontal and vertical discourses are to be understood as differences when it comes to design. The axis basic and advanced content illustrates if the content is considered as basic or advanced, in other words if the children engaging in an activity will be familiar with and master the content or will it be a challenge. On the left side (horizontal discourse) it is sufficient that this content is part of every-day activities and routines with no need to make it explicit for the children. On the right side (vertical discourse) mathematics is the starting point with no need for applications. Thus, every-day is the starting point in the horizontal discourse and mathematics is the starting point in the vertical discourse. Along the line there is a gradual shift and somewhere in the middle there is a shift concerning everyday life or mathematics being the starting point for the design of preschool mathematics.

## The study

The authors of this paper have been part of a national network for several years that focus on toddler mathematics in preschool settings. A consortium of preschool teacher educators from different Nordic universities initiated the network with a special interest in the youngest children's mathematics learning and didactical challenges in early childhood education. There are approximately 30 active members in the network. On the network's spring-meeting 2016, the current study was presented and the members were invited to participate in generating data for analysis. Thus, the selection of participants is information-oriented and deviant (Flyvberg, 2002) which imply that we have chosen teachers that we know are interested in teaching also the youngest

children in preschool mathematics. This selection is based on the research focus not being *if* these teachers teach mathematics but instead how they characterize the mathematics they teach.

At the network meeting the study was presented verbally and afterwards the information was also e-mailed to the participants. Until the autumn-meeting 2016 the participants who wanted to (participation is of course voluntary) were supposed to document “eight situations where toddlers encounter mathematics” on a pre-prepared form. First they were asked to “describe the situation”. They got some extra help by the questions: Who was present? What mathematical content? What happened? Next they were asked to describe how the situation started. Was the situation spontaneous or planned? If the situation was planned, on what grounds? Then they were asked to describe their own as well as the children’s actions in the situation. What did they do and say? What did the child/children do and say? To find out how these preschool teachers themselves characterize the teaching situations they describe, they were asked to place the situation in a picture like Figure 1 above. If they wanted to they could motivate their placement. Having the preschool teacher to characterize the situations based on *what* and *how* makes it possible to examine what they associate with expressions as everyday mathematics, advanced content for toddlers etc which in turn may develop the professional language of preschool mathematics. Finally they were asked to estimate how common a situation like the described one, is for this/these child/ren.

## Two examples

The current study is ongoing and we have only a small sample so far and tentative results. Therefore, we will here present two examples of documentations submitted from two of the network members to illustrate the framework and how it can be used as an analytical tool.

### Example 1

The first described situation is about a child aged two years and ten months. She and one preschool teacher are sitting together. This situation was planned by the preschool teacher based on the child’s interest in sorting activities. The mathematics content is named as “sorting”.

The preschool teacher gives the girl a box with small plastic bears in different sizes and colors and asks the girl if she can sort them. The girl answers, “yes I can” and starts to pick in the box. She picks up one bear and at the same time naming its color. She says “blue, yellow, red and green. Do we have more colors? Yes we have more blue bears”.

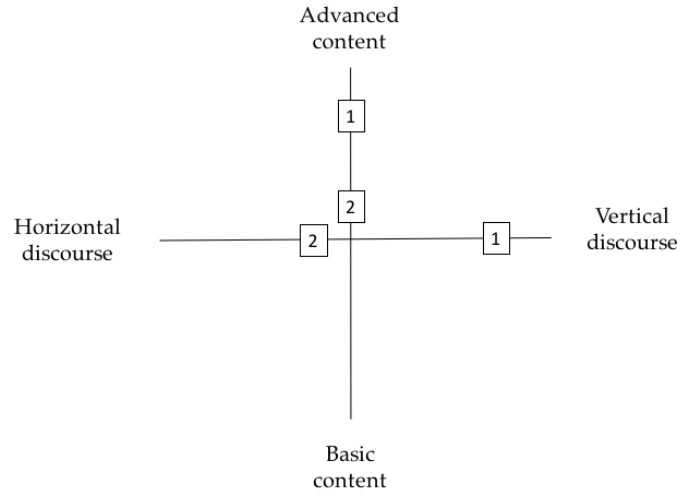
The preschool teacher describes her own actions as “confirming what she [the girl] was saying” as well as “keeping the other children who wanted to take the bears away”. She writes that she asked the child if she could count the bears. The child then answered, “yes I can but now I don’t want to because I want to wear a dress instead”.

This situation is described as occurring two or three times a week and is by the preschool teacher categorized as in Figure 2 below.

### Example 2

The second example is a described situation with a child aged exactly two years. The mathematics content is named “training volume”. The situation arose spontaneously outdoors. The girl is standing together with three other children in a puddle. She takes 2-3 shovels with water and pours

it into a bucket. Then she pours the water out again. This procedure is repeated over and over again for about 15 minutes. After about half the time another child aged two years and ten months starts to pour water into the same bucket. The only thing the first girl says during the 15 minutes is “pour in”, this as a call to the second child. The situation is described as occurring two or three times a week and is by the preschool teacher characterized as in Figure 2 below.



**Figure 2: Example 1 and 2 as placed in the figure by the preschool teachers.**

As mentioned, our selection of participants is information-oriented and deviant (Flyvberg, 2002) why our results will not reflect toddler mathematics in all Swedish preschools. However, the empirical material will provide some insight into the context in which the youngest children in Swedish preschool meet mathematics as well as which situations these preschool teachers think of as mathematical situations. In relation to the first example in this paper one could question the preschool teacher naming the mathematical content as “sorting” instead of describing sorting as an activity with the aim to make visible mathematical concepts as shape and size. Furthermore, one could consider if the content is to be deemed as advanced in relation to the explicit child in the situation. In relation to the second example one could question what the child is engaged in. Is she exploring volume or pouring water more as a scientific activity? Other questions that can be raised are if the invisible is made visible to the children in the situations as well as if focused attention becomes common for both teacher and child? Questions like this are about the situations constraining or enabling the learning of mathematics.

### **Expected contribution to research and practice**

The preschool teachers focused on in this study are working with the youngest preschool children, those aged one to three. Based on the national network on toddler mathematics we know that these preschool teachers are interested in teaching mathematics. What we want to investigate is how they themselves characterize their mathematics teaching in terms of design and content. Since the study is ongoing we cannot present other than tentative results since only few examples of empirical material are collected so far. In this final section we will discuss what we believe this study can contribute with to research and practice.

The question of whose perspective that leads the interpretation becomes focal when starting to look into this kind of empirical data. “Volume” may be considered a quite advanced mathematical concept, since it demands attention to three dimensions and the spatial relationship between length, height and width of an object, for example. The preschool teacher may on the other hand consider the act of pouring water as a very simple exploring activity without further consideration of the complexity that the activity may entail. However, the child’s object of learning might very well be of natural scientific nature or a motor skill exploration whereas the mathematical content is left for the observer to interpret, without any conclusions of the mathematical learning value made possible.

Another reflection regards how the preschool teachers interpret vertical and horizontal discourses as well as basic and advanced mathematics for these preschool children. What similarities and differences can be found? As mentioned, one possibility is that preschool teachers use different words to describe “the same kind of” mathematics teaching or reverse, maybe they use the same words to describe “different kinds” of mathematics teaching. Making such similarities and differences visible may develop the professional language of preschool teaching in mathematics.

Since the study is conducted within the frames of a national network on toddler mathematics we believe it is important to contribute to this practice. One way of doing this is to use the empirical material to investigate to what extent the members characterize the same situation similarly. One way to do this is to ask some of the preschool teachers to present one of their situations and then let all the others do a categorization. When they place the situations into Figure 1 they define what they consider to be vertical and horizontal discourses as well as basic and advanced mathematics for these preschool children. Thus, collective but not joint categorizations can be the starting point for discussions about what we mean by spontaneous versus planned mathematics, vertical versus horizontal discourses as well as advanced versus basic mathematics.

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