

# Pre-primary school teachers' approaches to mathematics education in Finland

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**ABSTRACT:** The purpose of this small-scale study is to examine Finnish pre-primary teachers' approaches to mathematics education. Qualitative analyses from six in-depth interviews reveal different strategies and goals. The teachers describe themselves as the facilitating participant, express that mathematics should be framed in playful settings, and assume that it is to be learnt indirectly. The study discerns different pedagogical goals for mathematics education, such as working on counting procedures, preparing for the next school level, building for a better future, and teaching for mathematical literacy. These constitute the teachers' pedagogical approaches to early mathematics education. Context is experienced as influencing their practice, together with an overall aim to foster a positive attitude towards mathematics. This is discussed in relation to the teachers' current practices and the contextual framework in which education is conducted.

**Keywords:** Finland, mathematics, teaching, pre-primary education

## Introduction

This article is based on a small-scale qualitative interview study aiming at examining teachers' pedagogical approaches to mathematics education. The rationale for this study is pre-primary school teachers' enhanced responsibility for discerning children at risk and initiating early interventions that the new legislations of 2010 stipulates. Teacher's approach to mathematics education is considered as one important factor for children's opportunities to develop mathematical knowledge and skills in their early years. This study thereby contributes to this discussion of contemporary interest by investigating how six teachers working in Finnish pre-primary school characterize their teaching in mathematics, and how they describe their intentions with mathematics education.

## Pre-primary education in Finland

Every child in Finland has the legal right to attend cost-free pre-primary education the year they turn six years old<sup>1</sup>. Pre-primary education is a practice situated in time between preschool (offered to children from the age of ten months until the year they turn six) and compulsory school, which children begin the year they turn seven. Early childhood education, including preschool and pre-primary education, builds upon a strong social pedagogical approach whereby care and the development into a socially competent and independent child are highly valued (Hujala, 2002). Since the year 2000, pre-primary education has been offered to every child as preparation for and a bridge to compulsory school (Finnish National Board of Education, 2010). At the time of this study attendance was non-mandatory but high, with 99% of all six-year-olds attending this pedagogical practice (Kumpulainen, 2011).

The main aim of pre-primary education is to strengthen children's opportunities to learn and develop skills for further learning (Law on basic education 21.8.1998/628). Reforms in the school legislation for education in the early school years (Finnish National Board of Education, 2010) have placed greater responsibility with teachers than before to monitor and recognize early signs of children's difficulties in cognitive abilities and skills, such as mathematics. Studies of the implications of early knowledge and skills as well as their effects on later achievements in school clearly show a significant relation between earlier (preschool) and later mathematical skills (Aunio & Niemivirta, 2010; Krajewski & Schneider, 2009). These studies lend further support to the need to identify children who are at risk of lacking basic knowledge before entering compulsory school. The legislation requires teachers to be even more aware of children's mathematical skills and development if they are to recognize these children at risk, but also for organizing education that will support every child. The question of how pre-primary teachers in Finland conceptualize their professional work is thereby a relevant question in both research and the development of early years education. In this particular study, the focus is on teachers' pedagogical approaches to mathematics learning, including their ways of organizing for learning and formulating appropriate learning goals.

Pedagogical approaches among teachers are complex phenomena, with great influence on the art and nature of the learning opportunities offered to children. According to Bennett (2005), educational policy changes generally lead to shifts of two kinds: towards either a pre-primary perspective or a social pedagogic perspective. The perspectives are closely related not only to the teachers' conceptions of pedagogy and their knowledge of curricula

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<sup>1</sup> Pre-primary education was not mandatory at the time of the interview study, but was made compulsory in Finland on January 1st 2015.

and young children's learning, but also to the traditions and contextual framework the teachers take part in. Both perspectives have implications for how learning is organized and what learning objectives are offered to the children. A pre-primary perspective leads to instruction- and knowledge-based teaching, and a social pedagogic perspective directs attention to developing the whole child in thematic learning environments.

Pre-primary teachers in Finland may be certified as either a kindergarten teacher or a primary school teacher, and the great majority of teachers working in pre-primary classes are certified (Kumpulainen, 2011). However, these two certifications are quite different in content, even though both entail a university degree in education. Many pre-primary teachers in Finland have a Bachelor degree in education (kindergarten teacher), which is a multidisciplinary teacher degree with a strong focus on knowledge of child development, social skills and ethical values, in order to foster democratic citizens (Karila & Kinos, 2012). Still, these teachers may also be responsible for pre-primary education in academic subjects such as literacy, language and mathematics, i.e. knowledge areas that are more dominant in the primary school teacher training programmes.

### **Teachers and mathematics**

In studying experiences of education, one important aspect is how teachers understand a certain subject to be taught and how it is learnt by the children. How one understands a subject reflects how guidelines and curriculum goals are interpreted, what content he/she chooses to work with, and how different methods are used. Such issues are often discussed in terms of pedagogical content knowledge (Ball, Thames & Phelps, 2008; Shulman, 1986), which partly includes knowledge of the subject matter, but even more how the teacher understands the learning of the subject matter and what difficulties may occur, which effect how the teacher organizes the learning activities. Ball et al. (2008) discuss these issues in terms of knowledge of content and students, knowledge of content and teaching, and knowledge of content and curriculum. This means that the teaching practice is a complex act, including the subject conceptualized in pedagogical frames, how the subject is made possible for the children to learn and related to curricular framework, both national guidelines and preparations made by the teacher.

A large-scale study of Swedish preschool teachers (Doverborg & Pramling Samuelsson, 2009) reveals that many early childhood teachers sense that they lack sufficient knowledge of mathematics, with the consequence that they do not feel confident to work with mathematics as a learning object (see also Lee, 2010; Lee & Ginsburg, 2007; Sheridan, Williams, Sandberg & Vuorinen, 2011 for similar results). Thiel (2010) gives credence to this in a study of early childhood teachers' conceptions of mathematics education, showing their conceptions to be quite limited in choices of content and depth. Teachers' approaches to the learning content have a great influence on the pedagogical

environment and goals, and thereby on how learning opportunities are organized (Lerikkanen et al., 2012; Schoenfeld, 1998). The pedagogical approach to the subject is also reflected in the way a teacher talks about a subject as well as the terms and metaphors he or she uses in teaching (Kilhamn, 2011; Kullberg, 2010). In this sense, teachers' talk about their practice is an important key to understanding the circumstances under which children participate in learning activities. This may be related to the idea of pedagogical content knowledge, as subject matter knowledge is only one aspect of teaching, intertwined with how a teacher approaches the learning child in the teaching situation.

Mathematical content is broad and complex in nature, and is regarded as not easily comprehended without extensive training or education (Ginsburg et al., 2006; Sarama & Clements, 2009). Mathematical knowledge is not limited to procedures or factual knowledge; instead, according to a great number of research and theoretical standpoints (see Cross, Woods & Schweingruber, 2009; Dowker, 2005; Clements, Sarama & DiBiase, 2004), mathematics education in the early years should focus on conceptual knowledge, reasoning skills, communication and mathematical literacy to facilitate more advanced learning in later school years. Procedural knowledge (how to solve a problem) and conceptual knowledge (why a certain strategy will solve the problem) are generally believed to develop parallel to, and to support, each other in the complex process of mathematics learning (Dowker, 2005; Sarama & Clements, 2009).

All pedagogical actions are theory-driven, either explicitly or implicitly, which has great impact on a teacher's pedagogical decisions (Mason & Waywood, 2008). Cross et al. (2009) argue for the necessity to perceive mathematics as both a content of knowledge and a content of skills and operations, which expands the learning objective to not only learning about mathematical notions and procedures but also learning to interpret and use mathematics effectively in various situations, e.g. mathematical literacy.

Observations of Finnish pre-primary teachers' mathematics teaching give further evidence that the character of the practice contributes to children's interest in learning mathematics. A child-centred approach, in which mathematics is taught thematically and with respect for children's perspectives, seems to favour children's developing interest in mathematics and learning (Lerikkanen et al., 2012). Studies by Aunola, Leskinen and Nurmi (2006) show that teachers' goals in mathematics education, particularly those concerning motivation and self-concept, stimulate children's mathematics task motivation and thus facilitate their performance in the transition from pre-primary to primary school levels. In other words, the teacher's approach to mathematics education is an important factor in children's opportunities to develop mathematical knowledge and skills.

### **A contextual framework for understanding pedagogical practices**

In recent years, revisions have been made to curriculum and standards in the Nordic countries, with a stronger emphasis on mathematics (cf. the Swedish preschool curriculum [National Agency for Education 2011] and ongoing revisions to the Norwegian preschool curriculum [Norwegian Ministry of Education and Research 2006]). According to Jung and Reifel (2011), implementing revisions in practice demands discussions and reflections on the teachers' own teaching practice and how to organize for teaching that leads to the desired goals. However, goals are not shaped in isolation; they are influenced by legislation, national and local contexts, and the conditions under which the teacher works, which include the available resources and facilities as well as the children. The study of pedagogical practices can thereby make use of an ecological model that focuses on an individual's work in relation to these conditions, in which pedagogical practices are considered to be linked to other practices, institutions and public governing (Dalli et al., 2012). This means that any school level is linked to other school levels and national guidelines and legislation are interpreted on both macro and micro levels. In this respect, the teacher is subject to forces that – due to the frequency, timing, duration and intensity of interaction with other institutions and social structures – are critical for whether change and development are within or out of his/her power to influence. The social context and school climate in which a teacher works are other important factors to account for, as these also affect the actual pedagogical practices (Einarsdottir, 2006).

Urban (2008) discusses a powerful top-down hierarchy whereby knowledge and expectations are transferred through legislation and curricula to be applied in practice. This hierarchy is not unproblematic, however, due to the dichotomy it may impose between theory and practice. Ecological models addressing the interaction between individual and society may still be useful as frames for studying progressive change and continuity over time that have implications for the course of people's actions and decisions (Bronfenbrenner & Evans, 2000). Urban (2008) and Dalli, Miller and Urban (2012) further advocate a critical ecological model, informed by political and social realities to produce knowledge and strategies for developing educational practices. Layers of interaction on multiple levels are assumed to affect the lived experiences of the teachers, and thus their construction of pedagogical work. This includes local school contexts that are influenced by societal and political relations on both the macro and micro levels.

Cross et al. (2009, 295) say that “any effort to change educators' classroom practices must include consideration of how those teachers view their roles, the children they teach, and the purpose of the setting in which their interactions take place”. This highlights not only the teacher and child interaction but also the goals and intentions of the practice. The current study is in line with both the ecological way of interpreting teachers' professional work and the statement by Cross et al. (2009). This is further placed in relation to the

legislation by which teachers' work is regulated in Finland. In the discussion and analysis of the results, the aspect of contextual impact will be taken into consideration, giving a more complex but also holistic picture of the teachers' educational work.

## The empirical study

The aim of this study is to *examine teachers' pedagogical approaches to mathematics education in pre-primary school*. The study has been conducted at a time when teachers are obliged to assume more responsibility for discerning children's mathematical skills and knowledge. Pedagogical assessment is to be done by the teacher in pre-primary school as a basis for organizing the education in general, as well as for identifying children at risk as an initial step towards more intense support.

The teachers' pedagogical approaches will be examined through their verbal expressions of their strategies for teaching and intended goals for mathematics learning in pre-primary education. Two questions will act as the foundation for analysis:

- *How do teachers characterize their pre-primary teaching in mathematics?*
- *What are the teachers' intentions with mathematics education?*

Teaching is a complex activity that involves not only the learning content per se, but also how the teacher involves children in a learning process and which learning objects the children are allowed to explore (Ball et al., 2008). The first research question focuses on the teachers' descriptions of their teaching acts, and the second concerns their expressions of the intended learning goals in pre-primary education.

## Respondents and data for analysis

Six pre-primary teachers volunteered for in-depth interviews in spring 2011, randomly selected from a sample of teachers who had previously participated in a project on early mathematics education<sup>2</sup>. All participating teachers have at least a Bachelor degree in education, and experience of working in pre-primary education. The sample represented a diversity of contexts and educational settings, ranging from educational groups of five children to larger groups of more than 20 children, located in both rural and urban areas.

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<sup>2</sup> The teachers' role in the project "LukiMat", conducted by the Niilo Mäki Institute, was to collect data using a pedagogical screening tool.

The interviews were semi-structured, covering main themes such as the notion of mathematics, children's mathematics learning, and the act of teaching mathematics in pre-primary education, with follow-up questions to ensure that the interviewer had interpreted the answers as intended. Conducted at either the teachers' schools or the university's facilities, the interviews ranged between 20 and 75 minutes. All interviews were audio-taped and transcribed verbatim by the researcher.

### **Qualitative analysis**

The point of departure in this study is an interest in how people in seemingly similar settings under similar public conditions talk about their professional pedagogical work. The teachers' verbally expressed experiences of mathematics education, learning goals, values and working conditions are thereby considered valuable clues to how different pedagogical approaches take shape. The teachers' utterances are analysed based on similarities and differences in meaning and intention (Kvale & Brinkmann, 2009) in their expressed strategies for teaching and their ideas of primary goals for mathematics education. The analysis begins by examining how the teachers characterize their pre-primary teaching in mathematics and children's learning of mathematics. Answers in which the teachers express their role and teaching manner were coded based on the types of activities and teaching strategies, and then categorized according to their similarities and differences in pedagogical intentions. Secondly, the teachers' intentions with mathematics education were analysed, focusing specifically on their answers concerning learning goals. These were coded according to content (procedures, preparations or understanding) and then categorized according to the intentions behind the goals as expressed by the teachers. A specific interest in this study is the arguments and motives the teachers give for their chosen teaching manners and goals, which offer the opportunity to interpret the answers in relation to the context within which the teachers work.

Within a theoretical frame, such as an ecological model, it is possible to discuss the emerging pattern of approaches as reflections of the current conditions under which the respondents conduct their pedagogical work, and how the context may affect people's intentions and actions on multiple levels (Dalli et al., 2012). Due to the small-scale design, there will be no claims for generalization of the results. However, the analysis will give a picture of how teachers under these particular circumstances conceptualize their pedagogical work, and how their strategies and goals constitute their pedagogical approach to mathematics education.

## **Results**

The teachers' pedagogical approach to mathematics education is addressed first through three strategies for teaching mathematics: *the participation of the teacher*, *playful framework for learning*, and *indirect mathematical learning*. Second, the intended learning goals expressed by the teachers are described in four categories: *working on counting procedures*, *preparing for the next school level*, *building for a better future*, and *teaching for mathematical literacy*, see table 1 below for an overview of the teachers' approaches.

TABLE1 Overview of the strategies and goals described by the teachers. X<sup>(f)</sup> stands for formalized tasks, as contrary to self-initiated or individualized tasks offered to the children.

Teacher	Strategies			Goals			
	The participating teacher	Playful framework for learning	Indirect mathematics learning	Working on counting procedures	Preparing for the next school level	Building for a better future	Teaching for mathematical literacy
A	X	X			X	X	X
B		X				X	X
C		X		X	X		
D		X <sup>(f)</sup>	X	X	X	X	
E		X <sup>(f)</sup>	X	X	X		
F		X <sup>(f)</sup>	X	X			

Strategies and goals are presented in the following text, accompanied by excerpts from the interviews, followed by a conclusion discussing the pedagogical approaches that emerged in the analysis.

## Strategies for teaching mathematics

The following strategies characterize how mathematics education in pre-primary school is conceptualized. The chosen strategies will be interpreted as an aspect of the teachers' pedagogical approaches, which is discussed later in the presentation.

### *The participation of the teacher*

The teachers in this study emphasize the importance of being present in the children's learning process, expressing this as their taking part in both the children's self-initiated activities and teacher-initiated activities. Participating in children's activities offers the teachers opportunities to introduce mathematical concepts, notions and principles to the children in meaningful situations; in other words, the teacher is the facilitator for learning.

According to the teachers, participation is crucial for supporting children's development in mathematical thinking, but the ways in which they participate in children's learning vary from providing tasks and problems to solve to engaging the children and the teacher him/herself in mathematical exploration.

One of the teachers describes mathematics teaching in pre-primary school classes as demanding, flexible work in which mathematics learning is often spontaneous and starts with the children's own questions and activities. A participating teacher needs well developed listening skills and perceptive abilities in order to be able to introduce stimulating questions when suitable. The children are very much allowed to be in charge of their own learning process and activities, while the teacher explores mathematics together with them and highly values their self-initiated play. The teacher gives an example of a teacher-initiated activity (Excerpt 1), whereby she engages the children in acts in which learning is facilitated through her own inviting approach to stimulating and playful activities:

***Excerpt 1***

*Teacher A: I usually tell the children: "Let's put our math glasses on and go play math detectives and see what shapes we can find" (whispering, intense voice). And then they walk around in groups with a piece of paper and a pen, drawing what they find, and present it afterwards to the other groups. Then it's great fun!*

The key issue in this way of approaching learning seems to be the attendance of the teacher, not only as an observer but as a participant in the children's activities. This participation is observable in her active involvement in the children's self-initiated play and in her attempts to invite them to take part in stimulating activities, in which a diversity of expressions and pedagogical methods may be used, outside as well as in the classroom.

***Playful framework for learning***

A playful framework for learning is a common strategy whereby the children explore and discover mathematical relationships. All teachers but one give examples of how they offer the children opportunities to use mathematical procedures, such as counting and categorizing shapes, as tools for structuring play and organizing routine situations. Other ways of encouraging the children to pay attention to mathematics include using shapes as symbols for different purposes in organized games and play. All six teachers organize teaching situations through their choice of materials and available technologies, for example using transparent coloured geometric shapes on a light board that the children are allowed to freely play with.

All teachers claim that they frame mathematics education in playful settings. Play and games are said to be used to direct the children's awareness to specific features of mathematics. However, the analysis reveals differences in the kinds of playful activities the children are offered. Three teachers say they use paper-and-pen tasks or books, which they say the children enjoy:

***Excerpt 2***

Teacher F: *We've had a few math stories, but not reoccurring.*

Interviewer: *What kind of math stories?*

Teacher F: *We divided a paper into three parts. On the first part you draw Stina and Kalle at the beach, and then Stina finds three shells and Kalle finds two, which they draw on the second part, and on the third part they draw how many they have together.*

Interviewer: *How do the children find such tasks?*

Teacher F: *They think they're fun!*

Interviewer: *Why do you think they enjoy them?*

Teacher F: *Perhaps because it feels like school? You get to sit down with paper again?*

Excerpt 2 differs from the descriptions of three of the other teachers, who generally speak of teaching through play and games that are either based on the children's self-initiated play or integrate different knowledge areas in the same activity. One teacher gives an example of a child who did not know the number figures even though she knew the counting rhyme up to ten, and how the teacher organized activities for learning in playful ways:

***Excerpt 3***

Teacher E: *We try to play a lot in ways that incorporate it [mathematics] /.../ We had a girl who didn't recognize the digits up to ten, so we took these paper plates [with digits drawn on them] and she made a track of them and I said it was okay if they were in the wrong order, we'd do it together. We walked the track together, one, two, four; wait, was that right? And she was able to count to ten so she said no, it should be three, and we looked for it and continued to sort the plates.*

Together with Teacher E, the child participated in different sorting games, based on her knowledge of the counting rhyme, giving meaning to the symbols in a playful manner. The teacher considers this way of teaching mathematics, through individualized playful

activities, a very powerful pedagogical strategy that is both meaningful and fun for the child.

Five of the teachers mention that learning mathematics should be fun, while the last teacher uses the word “enjoyable”. All of them claim that children learn better if they enjoy the activities they take part in. However, it is not expressed what makes a specific activity enjoyable or fun; whether it is the task itself, the organization of the teaching act, or the child’s own interest.

### ***Indirect mathematics learning***

Two of the teachers express a slight fear of discussing doing mathematics with the children. They fear the children may experience anxiety over mathematics, and mention this as a reason for not always mentioning the mathematical aspects of their activities. Even though the teachers recognize mathematics in many situations during the day, they do not mediate this to the children. One of the teachers states that mathematics is a difficult topic, but that she is willing to consider the positive effects of talking about it with the children as a way to lower their threshold for actively working with it. However, she adds, that this may not be necessary for helping the children become comfortable with mathematics.

A more progressive approach to mathematics teaching and learning is expressed by two other teachers in the study, with mathematics emerging “between the lines” in activities not primarily addressing mathematics as an intended learning goal. These teachers use routines and play activities in daily life as opportunities to direct attention to mathematical phenomena together with the children, without necessarily pointing out that they could be described as mathematical:

#### ***Excerpt 4***

*Teacher B: For example, I’ve asked the children if they want a square-shaped sandwich, or a triangle, or a circle. First they said “that one”, but I always gave the word for what they pointed at and showed them that two triangles could be put together as one square. And then I realized that the children started saying “I want a triangle”. And then they started to see these shapes, we walked round the building and actually our whole surroundings; they were filled with these shapes.*

Through this pedagogical strategy, the teachers have observed a progression and development in the children’s use of mathematical language and attention to mathematical phenomena in various settings, even though the children do not necessarily recognize them as mathematical. The main challenge of using this strategy may be the

attentiveness of the teachers to recognize mathematics in daily life, as this is not problematized with the children. Mathematics then becomes merely the descriptive naming of objects rather than conceptual relationships.

### **Intended goals for teaching mathematics**

Teachers' pedagogical approach to mathematics education includes the goals they strive for, and is also related to their individual pedagogical idea of what appropriate content and learning objectives are for pre-primary school children. In this analysis we can also recognize contextual influence and expectations that have impact on their pedagogical decisions.

Every interviewed teacher has a university degree in the educational sciences, and is familiar with the curriculum that provides the guidelines for objectives and methods to use in pre-primary education. Still, the teachers' own understanding and experiences are reflected in what they consider important objectives to work with. This is expressed in four different goals for learning that emerged from the interviews.

### ***Working on counting procedures***

There seem to be expectations for what children entering primary school (the year after pre-primary school) should know, and what skills they should master, even though these expectations are not necessarily expressly stated to the pre-primary teachers. This influence teachers' reflections on their pedagogical goals, as three of the teachers in this study express that a necessary skill children should acquire is counting. They give many examples of activities and situations during the day in which they count out loud with the children, such as skipping rope and setting the table for lunch. Based on the teachers' many examples of activities in which the children train their mathematical skills, counting stands out as the main mathematical procedure. Still, the teachers find it difficult to motivate why counting is such an important skill for pre-primary school children to acquire, besides the expectations of preparatory skills when they continue to primary school. This is apparent in Excerpt 5, where the teacher struggles to motivate counting as an important skill to develop:

#### ***Excerpt 5***

Teacher C: *They do actually need the skill to count to 20 perhaps, or preferably longer, and then they need the skill to count backwards from ten. That's something I think they need to know.*

Interviewer: *Why are these skills important?*

Teacher C: *... I think you have... I think it's good to know.*

Interviewer: *But why counting backwards?*

Teacher C: *Well, both forwards and backwards, I think it's important to know how to count backwards too... because it's logical, I don't know why I think it's so important; I haven't thought about it!*

The teacher's expression in the excerpt above is similar to those that occur among the other two teachers. They have a vague idea that counting might be a useful skill. One of them reckons it may help the children in subtracting operations, but does not motivate the ways this skill favours arithmetical development. When the goal for education is directed towards learning procedures, this seems to be characterized by preparation for later learning. Learning is thereby put in a broader learning context, but not thoroughly reflected upon, as Teacher C in Excerpt 5 expresses: *"I haven't thought about it"*.

### ***Preparing for the next school level***

Pre-primary school is by nature a transition to, and preparation for, primary school. However, what this preparation and transition mean and how children are prepared for later education differ among the teachers.

Two of the teachers express their ways of teaching children mathematics as very cautious and restricting in character, and claim they fear that children, who show high mathematical ability, may experience mathematics as boring when they start primary school. The pedagogical purpose for the teachers is, in the very best intentions, to avoid challenging a child's initiatives to explore mathematical principles and concepts, even if the teacher recognizes the child's potential.

However, there is a more positive angle to this goal. One of the six teachers (teacher A) expresses very positive expectations regarding the idea of preparing the children for primary school. She expresses her work as an integrated part of the children's life-long learning, seeing the work she does in the early years as the foundation on which primary school is to take up and continue. This differs greatly from the cautious expressions described above.

In accordance with this latter view, the goal of mathematics in pre-primary education is to broaden the children's perception of mathematics. Four of the teachers give examples of children who have older siblings and have acquired a pre-conception of mathematics as primarily working in a book inside a classroom. This is important to problematize, the teachers say, and is accomplished through their work with mathematics as part of their daily activities, which can be seen and heard in children's active responses and communication with both peers and adults:

### ***Excerpt 6***

Teacher E: *You can take almost anything we do and it's mathematics in some way, even though they don't know it. One day when I said "Today we're going to have some maths" and took out building blocks, they said "Hrm, we were supposed to have maths". They didn't consider that mathematics; it was only fun.*

However, three teachers say the teaching activities in mathematics are centred on a math book. Some children expect to use the book, in order to do "real maths". But the teachers also regard the book-based work as a complement to the spontaneously emerging mathematical activities during the day. They offer pen-and-paper tasks with arithmetical problems, symbol recognition and puzzles, both as preparation for forthcoming education and as challenges for the children who show extended skills.

### ***Building for a better future***

The teachers in this study generally take their work with mathematics very seriously. Five of them consider themselves to be role models and mediators of positive attitudes towards mathematics among children. They talk in terms of "*inspiring others/.../fostering a positive approach to mathematics/.../with a positive attitude they can learn anything*" (Teacher C). Teacher A further elaborates on her role as the mediator of mathematics as being an interesting learning objective she believes will motivate the children and build a solid foundation for future learning:

#### ***Excerpt 7***

Teacher A: *If you yourself find it interesting, then they think it's great fun /.../ If something isn't fun, there's no will to learn either, or any motivation.*

These expressions suggest a picture of the teachers perceiving their pedagogical work as very important for the children's opportunities to develop a positive attitude towards mathematics. The teachers' experiences from mathematics education – positive as well as negative ones, and from both their own time in school as students and as professional teachers – are said to play an important role in their desire to support a positive approach to mathematics:

#### ***Excerpt 8***

Teacher F: *I think many believe that maths should be difficult. Maths is difficult. But if you pointed out that what you just did was maths, I think the threshold to seeing it as not that difficult would be lower.*

Teacher F expresses her perception of mathematics education in terms of bridging over a belief among children that mathematics is a difficult subject to learn. She argues for the power of the child discovering his or her abilities to do and learn mathematics, as this will build a basis for further development and encourage learning.

### ***Teaching for mathematical literacy***

Two of the teachers express their understanding of mathematics learning and teaching in pre-primary education as aiming to develop children's mathematical literacy. They express the importance of children realizing why and how mathematics is used in their everyday life, which is exemplified by their exploring mathematics as it emerges in spontaneous situations. The teachers describe activities from everyday life as examples of how to teach the usefulness of mathematics:

#### ***Excerpt 9***

Teacher B: *Well, if you go to the store and have ten euros and the fish costs twelve euros, can you buy it? Well, no, that's not enough. Maybe in that way, you sort of get the idea of the value of money and try to relate to everyday situations where you need to have counting skills and be able to divide and all these little things.*

The teachers express a specific goal in their teaching act: children are to become aware of the idea of mathematics as a practical tool in their everyday life. They explore the idea of mathematics through the children's own experiences of everyday phenomena, building a foundation of attention to aspects of mathematics from which it is possible to challenge the children's developing understanding. The pedagogical goal is thus awareness and conceptual understanding, rather than merely factual knowledge or procedures:

#### ***Excerpt 10***

Teacher A: *It [the goal] is to show that it [mathematics] is something practical, something we need. We need to go to the grocery store, and it's all around us. The goal is to become aware; not that they have to know facts, but to open their eyes, open the gates that mathematics is there.*

The same teachers do set goals for mathematical phenomena the children are to become acquainted with during their pre-primary year, such as numbers and shapes, but these are handled in a conceptual way, with a strong emphasis on attention to how they appear as part of the child's life. The children's parents are also involved in this process, broadening the mathematics education outside the pre-primary classroom.

### **Conclusion**

The qualitative analyses from the six interviews reveal interesting pedagogical approaches to early mathematics education. The ***three strategies for teaching*** mathematics described in this study show that teachers may work in diverse ways. *The first strategy* highlights the participation of the teacher in explorative and interactive

ways. This also includes an inquiry-oriented way of teaching, whereby the learning object is scrutinized and explored in different ways, facilitated by the teacher's engagement and the challenges offered. The same idea of meaning-making and knowledge is recognized in *the second strategy*, in which play is used as framework for mathematics learning but the teacher is not necessarily the driving force; rather, she offers activities in which specific learning is possible. Play is assumed to be the facilitator for learning, as it brings joy and meaning to the learning activity. *The third strategy* differs from the others in that mathematics is not foregrounded, and in some utterances indicates a fear of the notion of mathematics. The teachers are aware of learning opportunities emerging in the children's activities and communication, but seem to hesitate to explore mathematical ideas more directly with them. One consequence of this may be that not all the children participate in exploring mathematical ideas, as their awareness is not deliberately directed towards conceptual aspects of notions or principles.

The *learning goal* is the other aspect of the pedagogical approach, which reveals four categories. A conceptual understanding of mathematics is considered a priority by two of the teachers, expressed in their aim to support not only procedural knowledge but also the knowledge of why one ends up with a certain answer when solving a mathematical problem. It is, as one teacher says, about "*knowing how to think*", also recognized as teaching for mathematical literacy. Other goals, such as preparing for the next school level and building for a better future, are also progressive in nature. However, preparation for school may also indicate that certain skills will be expected when a child starts school, which may constrain the teachers' work concerning content and conformation. Even though pre-primary education does not have knowledge goals or standards that children are expected to acquire during the pre-primary year, some teachers find specific skills desirable, primarily counting. Still, they have difficulty expressing the motivation for developing this skill.

These pre-primary school teachers' strategies and goals in mathematics education give a coherent view of their pedagogical approaches to mathematics. All the teachers describe the necessity to frame their teaching of mathematics in play, games or problem-solving tasks of different types. However, there are interesting differences when one compares these approaches with the same teachers' intended goals (see table 1). The teachers who prefer mathematical tasks in books or on paper (Teachers D, E and F), even though these tasks are framed as "fun" and amusing to the children, talk about goals for mathematics education generally in terms of working on counting procedures (Teachers D, E and F) and preparing for primary school (Teachers D and E). The other teachers, who frame their teaching acts in child-centred play whereby the child's intentions and individuality in the shaping of the activities are emphasized, seem to focus their pedagogical goals on the

child's conceptual development and positive attitudes towards mathematics (Teachers A and B).

Two of the teachers (Teachers A and B) talk about the goals for mathematical learning as the development of literacy skills. These teachers also mention the need for children to develop an awareness of and positive attitude to mathematics, a foundation upon which they will build their future knowledge and skills. The other four teachers seem more concerned about specific skills, such as counting and knowing number figures, which they assume the children will need when they start school.

Only one of the teachers (Teacher A) describes herself as actively engaging as a participator in the learning act together with the children. The general strategy for teaching among all the teachers seems to be to organize activities that offer the children mathematical challenges. The participating teacher, on the other hand, is engaged in the process because she learns together with the children, exploring mathematical relationships, as opposed to providing tasks or games in which mainly one right answer is embedded.

## Discussion

The discussion that follows will problematize the teachers' pedagogical approaches and, based on their expressions, discuss the possible implications for children's learning related to the guidelines for education that the revised legislation advocates.

The data that forms the basis for the current analysis is small-scale, which by nature means that the results are not possible to generalize to the whole population. However, the teachers participating in this study show a variety of approaches, which can likely be recognized among other teachers in similar contexts. The variety is thus the main result, and should be taken as a point of departure for further pedagogical discussions in teacher education, further-training and research.

### *The complex nature of teaching in pre-primary school*

The teachers find their professional work important for children's development of basic mathematical knowledge and skills, and talk about it in terms of a relational profession whereby primary teachers and parents are involved in their work, in addition to the daily interaction with individual children. Their teaching is conducted within a practice that is

closely related to other school forms and directed by legislation and socio-cultural expectations. However, the legislation that highlights the teachers' responsibilities to identify children at risk of developing mathematics difficulties also demands knowledge of children's mathematical development, desirable learning goals in the early years, and close collaboration with preceding and following school forms. Bronfenbrenner (1977), Bronfenbrenner and Evans (2000), Urban (2008), and Dalli et al. (2012) point out that it is important to account for the contextual influence between different school forms and determinative levels, as this affects teachers' work and subsequently children's learning opportunities. As seen in this study, preconceptions of children's expected knowledge and skills when entering primary school are used as motives for the goals chosen to work with in pre-primary education, not necessarily deriving from the teachers' own pedagogical knowledge or individual children's expressed knowledge and skills, but rather from expectations and norms expressed by the teacher community and curricula.

When asked about the intentions of teaching mathematics, one goal stands out in contrast to the others: working on counting procedures. Procedural knowledge, such as counting skills, is by all means important for further and more advanced knowledge development. In this study, however, the expressed goal of primarily working on procedures (counting) stands in contrast to the goal aiming at life-long learning and literacy skills, which are conceptual rather than procedural in nature. Conceptual understanding is considered a prerequisite for the ability to transfer knowledge; in other words, to abstract knowledge from one situation to be used for problem-solving in another, also recognized as literacy skills.

### ***Bridging between school forms***

One approach that is interesting in the discussion of strategic pedagogical work is the idea of preparing for school entry. This approach has two sides. One of the teachers describes working with the very foundation of mathematics learning, from which primary school should continue. Other teachers are aware of children's abilities but constrain their development, with all the best intentions, as they fear the children will attain primary school knowledge goals too early. The national curriculum for pre-primary education (Finnish National Board of Education, 2010) states that the purpose for pre-primary education is to bridge between preschool and primary school, meaning that teachers in different school forms are expected to relate their practice to the other. Constraining children's development due to forthcoming expectations of knowledge and skills, however, is not in accordance with the Finnish legislation. According to the legislation, every child has the right to be given individual support, driven from the abilities and knowledge of that specific child. This legislation is presumably not to be interpreted as only concerning children who show difficulties in the domain of mathematics, but rather as including those who are considered gifted in certain areas as well. This sets other

demands for children's opportunities to learn and develop in accordance with their existing knowledge and abilities. Such diverse approaches are important to bring up for discussion, as they highlight the pre-conditions of pre-primary school practice and children's opportunities to get the support they are entitled to by law. The bearing question is not posed to the teachers, however, but rather to the context and conceptions of the role of pre-primary education practice on a public level.

The two approaches mentioned above are in fact expressions of two opposite views on pre-primary practice. The first is an expression of pre-primary education as an important foundation on which primary education should pick up and continue, while the second expresses a view on pedagogical practices whereby children are to adapt to a certain role as a learner, following predetermined tracks. This addresses the question of how municipalities create opportunities for pre- and primary education teachers to implement the legislations and secure continuity in learning that involves all children. Professional development favouring the pre-primary teachers should thereby include both content knowledge support (Ball et al., 2008) and, not least, co-operation with other teachers in the same and other school forms.

### ***Perspectives on teaching in pre-primary school***

In times of policy changes emphasizing education and knowledge areas, Bennett (2005) labels two general perspectives that are commonly recognized: a pre-primary and social pedagogic perspective, similar to the pedagogical contexts described by Lerkkanen et al. (2012) in terms of teacher-directed or child-centred practice. This study is situated within the pre-primary education context, indicating that education and cognitive goals are expected but not yet compulsory. However, the results of the interview study show that a social pedagogic perspective with broader developmental goals can also be recognized in some of the pre-primary practices. This is interesting because pre-primary education should, as stated in the legislation, be a bridge between preschool and compulsory school. Finnish preschool is generally characterized by a social pedagogic perspective on learning and teaching (see Hujala, 2002; Stakes, 2004), which is apparently also acknowledged as suitable for working with the six-year-olds in pre-primary education. This is shown, for example, in the emphasis on play, integrated learning and the fostering of positive emotions towards the learning of mathematics (see also Aunola et al., 2006). However, we can also see the pre-primary and teacher-directed perspective in some expressions, in which mathematics learning becomes mainly a teacher-initiated activity, aiming at learning skills as preparation for forthcoming education. The balance between goal-oriented education and a child-centred view on children's learning is a delicate balance

that teachers in pre-primary education must deal with. Even though this study is small-scale, we can see tendencies in mathematics education in which a consolidation is accomplished, for example when the teacher is an active participant and through individualized play facilitates meaningful mathematics learning.

The teachers describe their work as important, due to the necessity of mathematical knowledge and skills for future participating citizens in the Finnish community. Literacy and problem-solving are mentioned as examples of such skills. The positive approach to learning mathematics is another highlight that emerges in the interviews, described in terms of teaching through play, indirectly and through the teachers themselves as facilitators and positive role models. Teaching mathematics in pre-primary education is thereby not isolated to the specific classroom and time, but is rather perceived as building a foundation for life-long learning. The practical use of mathematics is emphasized, and conceptual knowledge – “how to think” – is valued as an important goal.

### **General conclusion**

A general conclusion regarding the approaches found in this small-scale study is that the teachers conceptualize themselves as important facilitators for mathematics learning in pre-primary education. How this is facilitated differs, and seems to relate to the goals the teachers formulate. Contextual influence, such as the next educational stage, heavily influences their practice together with an overall aim to foster a positive attitude towards mathematics, which is also emphasized in the national curriculum.

The teachers’ pedagogical approaches should be considered relevant in the discussion on early childhood education, as the child-centred approach that integrates play and meaning-making turns out to be more beneficial for fostering an interest in learning mathematics (Lerkkanen et al., 2012). It is thereby important to gain deeper knowledge of the relational structure that pedagogical practices are involved in, since teachers’ approaches and teaching actions, influenced by guidelines and expectations on both the macro and micro levels, have direct impact on children’s learning opportunities. This study contributes to our understanding of what issues may be necessary to address, both in professional development programmes on multiple levels and in further research; collaborative work between school forms as well as pedagogical content knowledge appear to be crucial.

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