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Implementing theories for preschool teaching with play-based pedagogies

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The play-based Swedish preschool is facing new challenges due to demands from the Swedish Schools Inspectorate to evaluate how the teaching of mathematics is carried out in practice. This demand has evoked a dilemma for the preschool teachers that find it unclear what teaching in a preschool means. A professional development project was set up, aiming to implement theoretical tools from research into preschool mathematics teaching. The project started in 2016 with 45 teachers over a duration of seven months. An integral part of the project is to conduct research on the impact of the preschool teachers' conceptualization of mathematics as a subject, and what counts as a mathematical situation. The participating preschool teachers collected video recordings of mathematical situations from their respective practice. The professional development is an ongoing project, the impact of the implementation of theories are currently being researched.

Keywords: Preschool mathematics teaching, play-based environment, professional development.

Introduction

The Swedish preschool is facing new challenges, it has a tradition of caring and educating and is built upon a playful custom of will on behalf of the child. The preschool is not organized in formal lessons and its curriculum does not define any subjects like mathematics or biology, but suggests a thematic way of arranging the practice so that the learning goals found in the curriculum can be met in line with the principles of social pedagogy (Bennet, 2005). Yet, since the national curriculum for preschools was introduced in 1998, some of the goals have been obviously concerned with mathematical matters and these goals were sharpened in 2010 and has now again in 2018 been slightly revised (Skolverket, 2018, valid from 2019).

Having particular goals for mathematics means that the children's learning cannot just be expected to happen through general everyday activities, but must be planned for by the preschool teachers. In previous national curricula, there has been no explicit mentioning of teaching, despite that teaching has been the overarching term used in the Education Act to describe the goal directed processes aiming for learning and development. Since 2018 however, teaching is an explicitly mentioned concept in the revised curricula (Skolverket, 2018). The changes in terminology, and perhaps also policy, came after the Swedish Schools Inspectorate expressed that there is a problem with an overall unclarity about what teaching in preschool means and how it should be done (Skolinspektionen, 2016). The dilemma is that in the play-based tradition, the organization of learning is quite different from a typical school setting. For example, children's own initiatives are much more foregrounded than the time children spend in situations that are guided by a teacher (Helenius, 2018). When the concept of teaching is imported from school to preschool, the play-based tradition is endangered. Voices have been raised, indicating that the teaching of mathematics might be particularly prone to act as a trojan horse for importing values and beliefs on teaching from school that might not necessarily fit very well in a play-based preschool practice (Fosse, Lange, Hope Lossius & Meaney, 2018).

The present paper reports on a professional development (PD) project aiming to offer the preschool teachers¹ theoretical tools for how they can think about the mathematics taught and how to think about the teaching in a structured and explicit way, that still respects the play-based tradition. Research on the effects on the teachers is an integral part of the project.

Implemented theories in the PD project

When the play-based pedagogy of Swedish preschool works at its best, it integrates a play-based pedagogy with learning of mathematics in accordance with the curriculum goals. This can not only be done by planning regular teaching activities, since it would affect the preschool activities in a direction away from play in favor of formal schooling. Teaching must thus also be organized by means of planning the environment and using spontaneous situations in deliberate ways. A theory of play-based preschool teaching must account for that. At the same time, preschool teachers have difficulties verbalizing what constitutes teaching acts. Preschool teachers tend to not regard themselves as teaching teachers (Skolinspektionen, 2016). Therefore, a theory for play-based teaching should help the teachers to structure the type of work that is involved in play-based teaching by explicating particular components of such teaching (Helenius, 2018). A structured way of thinking about teaching can be a tool for teaching in a more deliberate way. This is a way to give teachers concepts and words for discussing with colleagues and plan their teaching in a play-based environment.

Theorizing preschool teaching

A structured way of viewing the complexity of mathematics preschool pedagogy is through defining three dimensions of teacher action, with respect to mathematical pedagogy: pedagogical explication, teacher participation and situational planning (for more information see Helenius, 2018). They are not suggestions of normative categories, but examples of how the complex pedagogical practice of teaching preschool mathematics could be explicated.

First, in a *dimension of pedagogic explication* of the teaching and learning of mathematics, two different ways of including mathematics can be identified. One way is a classical teaching situation, where the participants know that the activity concerns the learning of some specific mathematical content. Following Walkerdine (1988), such situations are called pedagogical with respect to the mathematical content (Helenius et al., 2015; Walkerdine, 1988). The other way is when the situation is fundamentally about something else, but some mathematical activity is included in the situation. Such situations are called instrumental. In this theorization the child's experience of a situation as instrumental rather than pedagogical does not mean there are not pedagogical intentions from the teacher's point of view. For example, as exemplified in Helenius (2018), a teacher's decision to make a robot available to children have pedagogical intentions, but children playing with it are not thinking of it as a situation which they are supposed to learn mathematics. Teachers can make an active choice of explicating the mathematical content of a situation or not. This choice can be made beforehand, in planning, or on the fly, when a teacher observes a mathematical situation that she chooses to either act on by shifting the children's focus to the learning of some mathematics, or not. Similarly, when children act on their own, with no teacher involvement, in a situation that contain mathematics, the learning may or may not be visible for the children. Thus, when the children perceive the situation as being about learning something mathematical, that situation is 'pedagogical'.

¹ We include all employees who work with teaching in the participating preschools, although not everyone has a formal teacher education.

Second, a *dimension of teacher participation* is quite obvious for children in preschool because they spend a lot of time conducting activities without any teachers involved. They know when the teacher is arranging activities, or not. The unarranged situations can provide children with opportunities to use mathematical knowledge and participate in mathematical activities. Therefore, time spent in preschool with no pedagogue involved can contribute to children's mathematical development in important ways. The same is true for time spent outside preschool, but the difference is that teachers can influence the mathematical content as well as children's experience of mathematics in situations in the preschool environment. One obvious example is planning specific activities that the teachers ask the children to do. But, there are also more subtle ways, such as planning and modifying the environment, in and around the preschool facilities so that it stimulates mathematical activities. For example, children can play with a programmable toy robot, only available to children for their free play.

This third *dimension of situational planning* relates to what Ginsburg, Lee and Boyd (2008) calls "teaching moments" or "acting in the moment", in contrast to formally planning learning situations in Swedish preschool mathematics pedagogic discourse. It is of course important for teachers to use the option to plan situations where they participate themselves. Planning has a distinct advantage in giving the teachers time to predict what may happen in a situation, and prepare for different possibilities. But mathematically interesting situations can also occur outside planning. It is important to acknowledge that situations that are not directed by the teacher also allow for play in situations where children may use mathematics. Moreover, preschool teachers can affect what happens during "free time" in many ways. This is also a part of the planning. However, preschool teachers have choices concerning what situations they want to plan and which to deliberately leave unplanned.

The Schools Inspectorate evaluation of the preschool 2015-2017 points out that preschools see that children learn a lot from playing but they also found that teachers have a strong belief that children should not be disturbed when playing. This can lead to overlooking possibilities for learning and development. The evaluation also observes that mathematics mainly occurs in planned activities lead by an adult. The theory presented above attends to this dilemma by using the tool of documentation. If a teacher notices interesting activities in free play, these can be noted and documented and the teacher can later plan for how the experiences gained in the documented situations can be reused later. This can be done either by retrospectively challenging the children that were in the original situation, but also by using ideas from the documented situation for a planned activity with other children.

Theorizing mathematical activities

One aspect of the theory above is using mathematics instrumentally. Therefore there is a need for a conceptualization of mathematics that views mathematics as something that can come out of practical problem situations, that is, a conceptualization that does not only view applications of mathematics as something you do with mathematics that is already learned or known. Moreover, a conceptualization of mathematics that is to be useful for preschool also needs to bridge everyday mathematics with formal mathematics, preferably in a rather seamless way. It has previously been argued that one theory that fulfils these requirements is Bishop's theory of mathematical activity (Bishop, 1988b; Helenius, 2018; Helenius et al., 2015; Johansson, 2015).

The background for Bishop's work is anthropological. By studying the use of mathematics in different cultures, he concluded that mathematics, just like rituals and cooking, occurs in all cultures. He also found that mathematics is different depending on where and in which culture it is evolved. And yet, certain regularities also occur in these studies and Bishop (1988a; 1988b) characterizes these in terms of six distinct mathematical activities that he claims are found in every

culture and can be seen as the roots of mathematical thinking. The descriptions below are from Bishop (1988a; 1988b):

- Counting: The use of a systematic way to compare and order discrete phenomena.
- Measuring: Quantifying qualities for the purposes of comparison and ordering, using objects or tokens as measuring devices with associated units or 'measure-words'.
- Locating: Exploring one's spatial environment and conceptualizing and symbolizing that environment, with models, diagrams, drawings, words or other means.
- Designing: Creating a shape or design for an object or for any part of one's spatial environment. It may involve making the object, as a 'mental template', or symbolizing it in some conventionalized way.
- Playing: Devising, and engaging in, games and pastimes, with more or less formalized rules that all players must abide by.
- Explaining: Finding ways to account for the existence of phenomena, be they religious, animistic or scientific.

The purpose of basing the view of mathematics on a theory is that through an increased awareness and knowledge about the role of mathematics in everyday context, the teacher can in a more deliberate way consider several options when planning for situations where children can develop knowledge in mathematics. This may lead to using a wider class of situations in a more systematically way, adapted to children's interests, needs, experiences and qualifications.

The project's theoretical framework is focused on a mathematics based on the six mathematical activities of Bishop (1988a; 1988b), which is well established in the curriculum (Skolverket, 2018).

Implementation of the theories through professional development

The project is now running for the third time in a medium-sized Swedish city, where you can find approximately 40 preschools for children aged 1-5 years. The first round was carried out from May to December 2016. Two preschools participated. The participants were 45 teachers, with different educational backgrounds. The second round run with four preschools during August 2017 to March 2018.

Both theories that the PD is built on have the potential to be normative in the sense of putting restrictions on what preschool teachers believe are the sanctioned ways of teaching mathematics. This is a dilemma from an implementation point of view, because if a point of both the theories and the PD is that it should be helpful for describing and improving existing preschool practice rather than to introduce normative ways of thinking about this practice.

To avoid such normativity, we tried to make the PD itself very tightly tied to the existing practice of the participating teachers by using videos produced by the participants of their practice as a basis for discussion. The recordings were done as a response to loosely formulated tasks concerning, for example, what mathematics might mean or what type of mathematics the teachers should focus on. As an example, one of the early tasks was: *Videotape one planned mathematical situation and one situation that is not planned but where you think there is some mathematics going on.* The recording from this task was then analyzed by a researcher before the next session with the aim of explicating examples of Bishop's activities as well as examples of the three dimensions of preschool teaching described above. The submitted material represented choices made by the teachers themselves. Moreover, the loose phrasing also created a large variation in the interpretations of what was

considered interesting mathematical activities to submit. This variation was intended, and when the videos were discussed at the next session, the discussion leader (the researcher involved in the project) could ground the presentation of Bishop's six activities in the variety of mathematical activities already present in current preschool practice (even if all of the activities did not show up in the videos, and some therefore had to be pulled out of Bishop's hat).

Moreover, the set of videos could also be used as a basis for discussion when planned and unplanned situations were good, if the mathematics was pedagogical or instrumental and how teacher participation might have affected the situations. In other words, even these first set of videos could be used as an introduction to all three dimensions in the theory of play-based teaching.

In subsequent assignments, the teachers were asked to do more and more pedagogically complex things, like planning for a situation that characterized by a particular combination of the dimensions in the theory of play-based teaching.

Other questions that were discussed in the sessions concerned progression: Watch a videotaped situation and analyze what mathematics occurred in the situations. Think about this in terms of progression. Are there more basic ways of dealing with the mathematical ideas and concepts that are visible in the situation? What would constitute a more advanced way of dealing with those concepts? How an activity that would bring children toward a more advanced way of dealing with the same mathematical ideas could look?

In total, for each PD group, the PD included three such sessions and associated tasks distributed for half a year. This is not much, but it has to be taken into account that preschool teachers have much less time for both planning and competence development than school teachers. In addition to the PD-pedagogy described above, in between the sessions with the researcher, the preschools also got support from a local school developer and the teachers were also given time to discuss the different issues of the project on every workplace meeting (approximately once a month).

Researching the effect of the implemented educational theories

Discussions with the teachers indicate that they find the six activities of Bishop to be both easy to understand and helpful for identifying different mathematical activities. The framing of activities as planned and unplanned, but still being mathematical situations, may at a first glance be a relief for the teachers. The project is all about creating mathematical situations that stimulate and challenge the children with different kind of questions and it is built on the curiosity and interest of the children. The teachers seem to be happily provided with teaching tools for framing their profession.

Still, these indications must be consolidated in a proper study. To investigate if the teachers' perception of teaching and mathematical activities has been improved by the project, a systematic data collection was carried out during the fall of 2018. The methodology is built upon using documentation from the PD rounds, new submitted video material, and interviews with teachers that will be analyzed in relation to the theoretical perspectives used in the PD. During the first two rounds of the PD project, we have collected data in the form of videotapes from planned and unplanned mathematical activities that the teachers encounter between the monthly meetings. We are now about to analyze the impact of the implementation of theories for theorizing preschool teaching and for theorizing mathematical activities. Because the objective of the PD was to help the teachers develop an elaborate and structured way to view (think and talk about, analyze, plan, etc.) the play-based mathematics teaching in preschool, the research question I ask is: Do the teachers that have completed the PD display an elaborate way of discussing mathematics learning activities in preschool? The term 'elaborate' will here be taken to mean using concepts (though not

necessarily terminology) from the two theories that form the basis of the PD when discussing preschool activities. To evaluate this question, the following method will be used. A sample of five teachers will be asked to submit new videos and documentation responding to the same set of tasks that were given during the PD. Using a stimulated recall methodology, the teachers will be asked to discuss both the old and new videos. Stimulated recall is a method very well suited for situations where you record the activity, using sound or video (Calderhead, 1981). The participants are given the chance to see or listen to what was recorded and are given the chance to make comments, either freely or guided by interview questions. The recorded material is a way of stimulating, or challenging, the respondent's way of thinking when it comes to the filmed or recorded episode (Haglund, 2003). By using the pedagogical documentation from the project, which consists of the filmed planned and unplanned educational activities, as well as notes taken during the activities, the purpose is to go back and investigate teachers' own perception of their conceptualization about mathematics, and the teaching of mathematics in preschool. By also including new material, teachers are given the chance to also reflect on developments of their practice. Progress will be coded both in terms of if teachers after the program can analyze and talk about a depicted situation in a deliberate way in line with the theories used in the PD, and in terms of if teachers can suggest a larger and more relevant spectrum of alternate teacher actions, or ways of challenging the children in depicted situations. This part of the methodology has previously been suggested by Lembrér, Kacerja and Meaney (2018).

Concluding reflection

The quality of the pedagogy is of great importance for the learning of children. Pedagogical quality depends on how the teachers structure their work. By clarifying the special ingredients of the mathematics in Swedish preschools, as well as the role of the preschool teacher, I claim that quality can be improved. This is the intention of the described PD project.

In the PD project, participating preschools teachers can work with how to think about teaching and how to think about mathematics as a subject to be taught in preschool. The hypothesis is that an increased awareness of what mathematics is and what can be categorized as mathematical situations will be used by the preschool teachers for developing the teaching. As described above, the implemented theoretical tool for framing teaching preschool mathematics is the six mathematical activities of Bishop (1988a; 1988b), for sorting, planning and connecting different elements in the different activities. A theoretical tool for framing the planned and unplanned situations is given by Helenius' (2018) three dimensions for theorizing preschool teaching.

This paper has described a project aiming to implementing theories from research into preschool teaching practice. Next, we will evaluate the impact of our PD project by conducting research on the participating preschool teachers' conceptualization of mathematics as a subject, and mathematical situations as planned or unplanned activities. Data will be collected after the third round of the PD project, making research on the implementation of theories an integral part. By the time of the conference CERME 11, we will be able to report on the impact of the project.

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