CHILDREN’S PLAY AS A STARTING POINT FOR TEACHING MATHEMATICS IN PRESCHOOL

Kerstin Bäckman
University of Gävle

This research project add to the knowledge and awareness that children learn in their everyday activities. Children’s encounters with mathematics in these activities give them experiences as a ground for education. The understanding of children’s mathematical encounters in their play has developed during the work with my doctoral thesis. A socio-cultural perspective gives the theoretical frame. The data drawn on for this paper is video recordings of 4-year old children’s play in four Swedish pre-schools. It also includes interaction with peers and teachers. One research objective for this project is if and how children’s play can be a starting point for teachers’ teaching. The result shows that teachers’ questions in play support children’s exploring.

INTRODUCTION

A child’s early learning in mathematics is essential for further learning processes. It is therefore important that children have rich and various mathematical encounters and mathematical experiences in preschool. Research focused on early mathematics highlights the importance of education and early mathematical skills (Clements & Sarama, 2009; Claessens & Engel, 2013, Ginsburg & Amit, 2008). Research also shows that children learn mathematics in daily activities by interaction with peers, family, environment and in culture (Bishop, 1992; Carruthers & Worthington, 2006, Munn & Kleinberg, 2007).

There are two strong approaches to teaching in early childhood. One is based on play with informal teaching in which the teacher follows the interest of the children. In the other approach with more formal teaching, the teacher chooses the content beforehand and plan learning situations. Both approaches can support children’s mathematical learning. With the play based approach the teacher has to see the mathematics in children’s activities and use daily situations for teaching. It is a challenge for the teacher to quickly decide which didactic solutions is needed for the moment. With the other approach the teacher can plan what they want the children to learn and design the learning situations. The planning can also include what questions and instructions they should use to promote the learning of a certain content.

Children’s encounters with mathematics in the daily activities give them experiences as a ground for education. In this study the mathematical content belongs to geometry i.e. shapes, geometric figures and geometric pattern. Piaget and Inhelder
mean that children construct their knowledge about shape when they manipulate with shapes like they do in play. According to Clements and Sarama (2009) teachers can and should challenge children’s experiences and thereby promote learning. In Sweden most children spend a great part of their childhood in preschool. Play is an important part of children's daily lives and could be the starting point for preschool education. If preschool teachers discern mathematics in children's play it can be a ground for discussion and reflection. In this way, education in preschool can be designed according to children's perspectives.

One research objective for the study is if and how children’s play can be a starting point for teachers’ teaching. Can children’s own intentions in play make it difficult for the teacher to visualize the mathematical content for the children?

THEORETICAL BACKGROUND

When teachers in preschool design their teaching, play is an important part (Garvey, 1991; Ginsburg, 2006; Ginsburg & Amit, 2008; Munn & Kleinberg, 2003; Nutbrown, 2006; Pramling Samuelsson & Fleer, 2008). According to Wood and Attfield (2005) the potential of play in teaching has great importance because it is integrated into the learning process. In play, children can develop skills such as language, mathematics, communication and social skills. Moreover children can change their actions and try new ways and explanations. They can transform their use of artifacts when they are playing (Wood & Attfield, 2005). Bishop (1992) has formulated six mathematical activities and play is one of them. In play children can think hypothetically and follow rules. They can develop and participate in play and games with more or less formalized rules that the participants have to follow. In play children can guess, estimate or predict what might happen. They can also explore shapes, geometric figures and pattern, dimensions, positions and develop reasoning.

Different play contexts provide meaningful opportunities for children to use and develop mathematical skills. It may include problem solving situations in which children can think, try, draw and tell how they think (Ahlberg, 1998). Play gives children the opportunity to use mathematics for example, when children act co-players and helpers, i.e. when children talk about and explain a play or rules in a game for another child (Pramling Samuelsson & Fleer, 2008). Furthermore, Wood and Attfield (2005) argue that education should give children the opportunity to use flexible and creative ways of thinking and acting, and that various play contexts can offer rich opportunities for it.

In order to experience and learn about geometric content like shape and figures, pattern and measurement, it requires environments that are designed to offer a variety of geometric shapes and figures. The variation should be giving children the opportunity to explore and discern similarities, but also differences, and give rise to
discussions about shapes and their properties, as well as a wide variety of different kinds of shapes and a width of geometric tasks and challenges (Clements & Sarama, 2009). The authors highlight four guiding features in the environment which can provide education about shapes. The first feature is that preschool should give children the opportunity to experience many different kinds of shapes. It includes both examples of the characteristics of shapes and opportunities to discern similarities and differences among shapes as well as figures that are non-examples. Examples of this can be different kinds of triangles and shapes which are not enclosed or where the lines intersect and when the lines not are straight but curved.

Feature number two is that preschool teachers should encourage and challenge children's descriptions to enrich the language. For example, to teach children to explain why a shape belongs to a certain category, or why it does not belong to a certain category. The third feature includes the environment, that preschool should be offering a rich variety of shape classes for example circles, triangles, squares, rectangles of various sizes, colors and materials. According to the authors, this includes making visible that the squares are examples of rectangles. The fourth feature is to challenge children with a wide range of interesting activities and tasks. Activities that include reflection and discussion when children compare, identifies and explores various geometric shapes and figures are of importance for the geometric learning (Clements & Sarama, 2009). According to the same authors, digital learning resources such as computers and software provide support to these learning processes.

Play gives teachers the opportunity to observe children's expressions and mathematizing of for example shapes (Carruthers & Worthington, 2006; Nutbrown, 2006, Van Oers, 2010). Play can also help children use imagination and creativity when they consider how an object works, how, for example, the ball rolls and what they can do with it. Teachers and children can discuss and reflect on the objects’ characteristics, whether shapes are round or curved, which forms have corners, and how many corners there are (Heiberg Solem & Lie Reikerås, 2004). When children play with blocks and build constructions preschool teachers have the opportunity to reason with children on different classifications and attributes but also offer opportunities to develop spatial abilities like body and spatial awareness, and measurement (Clements & Sarama, 2009).

Carruthers and Worthington (2006) and Van Oers (2008) argue that there is mathematics in children’s play and it is up to the teacher to understand what mathematics occurs in different play contexts. Children's understanding can be understood in their action and thought patterns, i.e. schemas. For example, when children are learning about shapes, one such schema is the rotation schema. This is shown in the child's movements as they run around in circles, spinning on the subjects, studying washing machines drum rotational motion, rolling things or rolls
themselves, as signs of the rotation schema. The authors mean that children learn mathematics in their surroundings when they interact.

Claessens and Engel (2013) highlight the importance of early mathematics knowledge and skills as they predict other content areas like language. They suggest that if children, in the early years of schooling, are able to focus on patterns recognition and measurement as well as on advanced numbers it will benefit students learning later in school. The authors mean that teachers’ instructions are necessary for children’s outcomes in mathematics.

**METHODOLGY**

In the present study the phenomena of teaching and children’s mathematical experiences are scrutinized in preschool settings. Focus is on children’s actions and intentions and what they focus their attention on in their mathematical encounters when they are playing. The research focus is also on teachers approach and teaching.

The data selected for this paper is video observations of 35 four–year old children’s play in four Swedish preschools. It also includes interaction with peers and teachers. The video observations make the mathematical content visible in children’s play and children’s actions. It includes language that is both verbal and nonverbal, glances, gestures, nods, smiles, what tools children are using and how they use them, on their own or together with peers / adults.

This study is directed toward preschool children's learning which entails a particular responsibility to comply with applicable ethical considerations. Because video observations are used to observe different situations in preschool it is necessary to protect identity and integrity of the children. Parents and teachers have given written consent for the children’s participation in the study. In video recorded situations, the participating children's oral consent is taking.

**RESULTS**

The results show children’s experiences of block building and manipulating with geometric figures. The study shows that children often play by themselves and the following observation is one example of that. The boy is in the first example focusing on the different attributes of the shapes in a sustainable perspective. He seems to have goals with his building when he is trying to put different shapes on top of each other.

It is early morning in one Swedish preschool and Erik, 4 years old, are building with blocks in the hall. One of the preschool teachers stands beside him and talking to a...
parent. Erik doesn’t pay any attention to the conversation between the adults. He is building with blocks in different shapes.

Erik quickly builds a high stack of eight blocks. The blocks consist of seven cubes in three different sizes, as well as a tetragon. Every second block is a small cube and every second is a larger cube. On top is one tetragon. Erik starts then build a lower construction, consisting of six half-cylinders. He is totally focused on the construction and is trying different ways to place the half cylinders. He seems to aim at building both horizontally and vertically. When the blocks fall down he solves the problems of twisting and turning blocks in order to find a sustainable way to place them on each other. At the same time, there also seems to be a wish to have symmetry in the building work. He starts with a half cylinder and builds staples with identical half cylinders on each side of the half cylinder in the middle. When the blocks are in place, without falling down, he takes a tetragon and puts it on top.

Erik explores geometric shapes by placing them on and next to each other in different ways. He distinguishes various block qualities as he twists and turns, and builds. The episode shows that the discernment of critical aspects of the phenomenon, geometric shape and characteristic, takes place in a context. He seems to have an idea or intent with the construction and he experience how these blocks with different shapes may or may not be stacked. Erik is concentrated while he is constructing even if he looks up at times. It appears that he has some goals in mind with his building and he is not disturbed by the adults and children talking to each other next to him. Only when he has built two towers and several children come to the hall he gets up, takes the car in his hand and stands up next to the construction.

Erik continues the construction as soon as some passing children are gone:

Erik points out two cubes in the tall tower and says,
E: "It's over and it's over."

Then he points to the two top blocks and says
E: "Those should be removed."

He takes the top two blocks from the highest tower and places them on the floor, a cube with a tetragon top. He then takes a tetragon lying on the floor and places it on top of the tall tower. He does this while he keeps a little blue car in his hand. He looks at the high tower and says,
E: "There you go."

Erik’s building give him experiences of similarities and differences between blocks. He does not talk about the shapes or the features but he is very focused on the construction. The teacher talk with one parent in the hall and later on the teacher is walking through the hall passing Erik and the construction. She stops and said:
Teacher: “What a nice building. Very high!”

Then she moves to another room. Erik looks up when the teacher is talking but he is quiet. Another example from the data is when a 4-year-old girl is playing with geometric figures. The figures on the table in front of her are in different shapes and colors, for example: circular shapes, triangles, squares, pentagons and other polygons.

Meg has started to twist and turn geometric shapes. She has put the red shapes in various forms in front of her and then adds a blue circle, a yellow circle, an empty space and then a yellow circle.

The teacher is sitting at another table observing Meg's designs and asks Meg

Teacher: "What now should be put in the empty space in your pattern?"

Meg is sweeping across the geometrical figures with her eyes and takes a blue circle shape which she places in the empty space.

Teacher: “What is next in your pattern?”

She looks at the teacher and smile while she lifts up the last yellow circle.

Teacher: What color is on the circle shape?

Meg: "yellow" as she put down the shape of the pattern. Meg takes a blue circle

Teacher: "blue".

Meg laughs and adds the blue circle for the yellow in the pattern.

The teacher makes Megs pattern visible for Meg when she supports and confirms the girl’s actions in words. The use of questions and the input of words of colors are strategies in the feedback process to make the pattern visible. The girl has to abstract and reflect on the pattern. The teacher and the child are talking about color as criteria for circles in the pattern. Maybe the child never thought of colored circles as repeating in her pattern but the teacher recognized that the color was repeating. The teacher is scaffolding and gives feedback with questions and by setting words on features.

DISCUSSION

In this section I will reflect on and discuss play as a starting point for teaching and education in preschool. It includes children’s experiences and teachers scaffolding. Scaffolding includes the use of feedback with different strategies, i.e. active listening, open ended questions, affirmation and math talk.
Children explore the local environment and in interaction with peers and adults or by themselves children discover mathematics. For the children, play contexts seems to be important. Play contexts includes where they are, i.e. indoors or outdoors, who they are with, what they decide to do and how to do it. Children encounter and create an understanding of mathematics from their experience and perspective. When they mathematize and communicate, they may experience different aspects of a mathematical content. Ginsburg (2006), describes play and learning as two sides of the same coin, i.e. children play and learn at the same time. The author argue that play motivates and enhances children's cognitive and socio-emotional development. Vygotsky (1978) emphasizes that play is the most important form of a child’s learning. For researchers to be able to say that learning occurs, knowledge of children's understanding before and after a learning situation is often required. In the present study the interpretations of children's learning are based on what they are given the opportunity to discern and thereby learn.

The results show what experiences children express. The example with Erik shows a common situation in preschool. Teachers have to talk with parents and other adults and they have to take care of many children. Still they want to give the children some feedback. Bishop’s (1988) suggestion that play gives children opportunity to explore shapes, geometric figures and patterns, dimensions and positions is right in Erik’s case. He explores, tries and retries what blocks fit together, and it seems that he observe the blocks features before he put them together. Maybe he is having some hypothesis about different shapes features and sustainability. Erik’s experiences in this play provide valuable opportunities to explore different shapes. He is engaged in his construction and the teacher can use these experiences in later discussion about different shapes. The example with Meg shows a situation when she is playing and exploring colored circle shapes and put some of them together in a repeating pattern. Meg is also engaged in her exploring and will have experiences from the figures shape and of pattern. The teacher asks questions about repeating colors on the circle shapes in the pattern in order to draw attention to the pattern. The girl seems to observe the parts i.e. the repeating with colors and maybe she distinguished the pattern to.

The differences between the two observations are both from the child’s perspective and from the teacher’s perspective. Erik’s play is initiated from himself and he seems to have goals in the construction. The teacher gives short feedback about the height and that the construction looks nice. In the other example with the girl she seems not goal-oriented like the boy. She looks at the different shapes and put them in front of her at the table. The teacher recognized a pattern with colored shapes in the girls actions and the teacher tries to direct the child's attention to the repetition of color and that there is a pattern, i.e. both whole and parts.
Both children are having experience from shapes in their construction. The experiences in the play can be a ground for children’s learning. Children's activity in the thought processes affects learning and they also learn by observing and participating with others in play and routine situations. They are not passive recipients, but active in the process when they participate in different situations. This is an agreement with Clements and Sarama (2009) and other researchers, and they point out that preschool teachers use of questions, feedback and by offering a rich environment can lead to a deeper learning. With the feedback strategy the teacher can ask children to explain their thinking and actions. The teacher in the example with Erik can ask about his thoughts and provide specific information about different shapes. They can talk together about different features. The teacher used affirmation as feedback to Erik when she talked about the height of the construction but she didn’t ask him anything at this time. The teacher in the example with Meg was scaffolding her when the teacher observed that Meg was able to construct a repeating pattern with the geometric figures.

The study has highlighted and given insights on the importance of continuing to raise awareness among preschool teachers regarding preschool children's mathematical experiences in everyday life. The most important is that mathematics is present in a variety of situations in which children participate. Sometimes it may not be the mathematical content that is focused by the children, but the activity itself. The results show that children use mathematics as a tool and are thereby able to discern a mathematical content with the support of peers and preschool teachers. In interactions with peers and adults, children's previous performances can be further enriched by the contents illustrated in various ways. Children's own activities are a variety and diversity of actions, which are expressed when children communicate a mathematical content with both words and gestures.

In this study, the traditional teaching concept has been extended to preschool. Teaching in preschool includes ‘here-and-now’-situations as well as planned situations. Education can, based on what the children express in their actions, include communication around the object's various features. Such situations offer both children and preschool teachers to jointly exchange of thoughts and reasoning, and can then be considered as teaching situations. Clements and Sarama (2009) as well as Claesson and Engels (2013) argue that correct instructions are important and an implication of that is that preschool teacher need knowledge in geometry in order to avoid ‘poor’ practices were teachers give simple and sometimes wrong statements. With knowledge maybe the teacher in Erik’s case later on can have the opportunity to talk to him about how many sides and how many corners different shapes have. They can count and reflect on differences and similarities. According to Carruthers and Worthington (2006) and Van Oers (2010) it is up to the teachers to observe mathematics in children’s play and support them with relevant material and feedback.
Clements and Sarama (2009) claim that children’s ideas about shapes stabilize when children are about 6 years old. In that perspective it is important with the language teacher use when they talk with children about shapes. They can facilitate connections between words and features. The teachers can also let children describe and reflect on features. Maybe the teacher’s questions and feedback are more important than instructions in preschool. The use of open-ended questions can direct the child’s attention to similarities as well as differences, to specific characteristics and attributes.

The objectives of teaching are of great importance and the approach must take into account the child's perspective. Responsiveness and active listening is very important to understand children's mathematical representations. Otherwise there is a risk that teachers’ intentions limit the learning opportunities. In the case of Meg the teacher’s intention was to support the girl’s discernment of pattern by asking about the colors. From the child’s perspective the teachers interest, questions and statement is positive feedback and maybe enough in the moment.

A carefully designed learning environment in preschools that provides opportunities for children for mathematizing is needed. Teachers can be present where children are and use different didactic approaches and didactic choices. The presence of teachers offers the opportunity for deeper learning in ‘here-and-now’ situations like play. The didactic choices include questions directed at both the mathematical content and to children's perceptions of the specific content. Here is flexibility around the mathematical content in children’s activities ‘in the moment’, and responsiveness to the child directs their attention to important aspects of the work.

In preschool mathematics education concerns teaching of different content and covers the skills preschool teachers may need when they teach mathematics. Such skills include the ability to observe mathematics in children’s play and to direct the child's attention to a specific feature by asking questions. This includes both theoretical and practical knowledge about children and children's learning as didactic issues and strategies, and how the teacher can didactify a content.

**CONCLUSION**

With in-depth mathematical and didactic knowledge, preschool teachers can be attentive to the children's expression and able to observe mathematics in children’s play. The teachers can meet and reflect on the experiences children have in play and thereby improve teaching and learning. The teachers’ scaffolding with different feedback strategies are of importance.

Maybe it is teachers’ open ended questions rather than instructions that support children’s learning in preschool. Play is a valuable part in children’s everyday life and can give teacher opportunities to meet and reflect mathematics in regard to
children’s perspective. Children have own intentions in play and the teacher have to be attentive to both intentions and experiences in teaching.
REFERENCES


