Under Threes’ Mathematical Learning

Introduction

This article highlights the mathematic learning of the youngest preschool children, with the aim of challenging the strong learning discourse that focuses mainly on objectivity and rationality. I would instead like to direct attention to other perspectives on learning, to help promote and improve children’s mathematical development in early years.

Sweden is one of few countries to have a curriculum for preschool. Preschool is not just child care, it is also intended to be an environment that supports and stimulates children’s learning and development. According to the curriculum, preschool activities ‘will be based on children’s experiences, interests, needs and opinions’ (National Agency for Education 2010, Lpfö 98 p. 9). Mathematics is an area that has been clarified in the revised edition of the curriculum, which asserts that preschool should promote children’s mathematical learning. Most 1–3-year-olds in Sweden spend more than 6 hours a day in preschool. How then is mathematical learning in these ages supported? Unfortunately, there is scant current knowledge of how children’s mathematical learning develops during these ages. Preschool children are often seen as a homogeneous group, even though there are large differences between the interests and needs of a 1-year-old and a 3-year-old, as well as a 5-year-old. Furthermore, it could be argued, if the activities in preschool are to be based on children’s experiences and needs, we know far too little about the experiences of 1–3-year-olds in mathematics and how learning should be promoted in these ages. More knowledge is needed on how to provide for the youngest preschool children with references to the intentions of the curriculum. Reis (2011) asserts that toddlers’ mathematics must be discovered, clarified, described and further examined (p.182, my translation).
The data from this study is a contribution to the research field. The study is built on observations in preschools, with a focus on the youngest children’s activities in order to gain insight into how and in what situations they acquire mathematical experience. The results and ensuing discussion provide new knowledge and call attention to early childhood education based on children’s experiences, interests and needs.

Background

Apart from the revision of the preschool curriculum concerning goals in mathematics, the Swedish Government has set aside funds for further education for preschool teachers, to strengthen the role of mathematics in preschool. In preschool, there are children between the ages of one and six. Usually, the youngest, those between one and three, are placed in special ‘toddler’ groups. What significance then should a strengthening of mathematics have for these youngest children? Research on mathematics in preschool, targeted specifically at the age group 1-3, is sparing, with most of the field focusing on older preschool children. According to toddler educational research in general, however, theoretical models and activities designed for older children cannot easily be transferred to younger children (Johansson 2005; Lökken, Haugen and Röthle 2006). Recent research focusing on young preschool children’s learning asserts that children between the ages of one and three often use their body as a tool for learning. These studies stress the importance of adults who can understand and interpret what children express with their bodies, as their spoken language is not yet fully developed (Johansson 2005; Lökken, Haugen and Röthle 2006; Sandvik 2009).

Mathematics in preschool

Recent research in the field of preschool children and mathematics has been mainly cognitively oriented. For example, preschool children’s understanding of mathematical concepts has been studied and interest has been directed towards how preschool children develop an understanding of terms like ‘major’, ‘minor’ and ‘a lot’. Studies have also been made of how 3–6-year-olds learn to discern patterns and characteristics and to distinguish one object from another (Ahlberg 2001; Björklund 2007, 2009; Doverborg and Pramling 1999; Doverborg and
Another recurring theme is studies of how children solve mathematical problems. These studies often focus on children interacting with other children and adults to develop their mathematical thinking. The results of this research, which often builds on Vygotsky’s ideas about the prevalence of proximal development zones, indicate the importance of challenging children’s mathematical thinking (Ahlberg 2001; Björklund 2007; Doverborg and Pramling 1999). Several studies also show how the children themselves are actively involved in creating knowledge and meaning relating to mathematics (Packer and Goicoechea 2000; Cobb and Yackel, 1996; Mix 2009). Furthermore, studies show that preschool teachers are often uncertain of themselves in their work with mathematics and give priority to other skills (Doverborg and Pramling 1999; Kowalski, Pretti-Frontczak and Johnson 2001; Palmer 2011).

_Toddlers’ mathematics_

Studies interested in the youngest preschool children and mathematics are scanty from both a Scandinavian and an international perspective, which means that we know very little about mathematics learning in these ages. Sheridan, Pramling and Johansson (2009), who videotaped young preschool children in play activities, found for example that in the period between 1 and 3 years of age there is a ‘tremendous development of the aspects of the basic mathematics that children meet’ (p. 147). These researchers argue that the difference in these children’s skills is so great that the age between 1 and 3 can be seen as a critical period for the understanding of mathematical concepts. In a longitudinal study, based on variation theory, Reis (2011) shows how children aged 1-3 develop mathematical knowledge and understanding through activities with rings and cups. The results show number sense capabilities such as the one-to-one principle, counting and estimating. The mathematical skills and knowledge building of preschool children aged 1-3 has also been studied in Finland by (Björklund 2007, 2009), where the findings were that children of these ages use mathematics to establish social rules and describe the world around them. In addition, they used mathematics to solve problems. Other international research on young preschoolers and mathematics is also scant, focusing mostly on children’s understanding of mathematical concepts. Like the national studies, the
main research interests revolve around cognitive learning (see for example Gelman and Gallistel 1978; McCrink and Wynn, 2009; Le Corre and Van de Walle 2006; Geist and Geist 2008; Baroody, Li and Lai 2008; Mix 2002). Research on young children’s learning in other research fields emphasizes the importance of the body as a tool in children’s learning processes. Regarding the research field of mathematics, there are few studies that focus on the body’s importance in the learning process, which is remarkable. Mathematics in early childhood education needs to be both expanded and developed, asserts Palmer (2011), who claims that mathematics in early childhood education should visualize with the body, for example through music, art and dance. This overview calls attention to the need for additional studies in mathematics for 1–3-year-old children in preschool. The pedagogical and educational research conducted in the field has mainly focused on children’s conceptual understanding and has to a high degree examined preschool children of other ages. In addition, the mathematical concepts and definitions of mathematics used in the studies are often taken for granted. Moreover, there is little research with a broader understanding of the concept of mathematics, nor especially much research that focuses on how children use their bodies when they solve mathematical problems.

**Theoretical approach**

The focus of this study is on how children make meaning and significance of the concept of mathematics and how this is expressed. Theoretically, the study is inspired by the previous childhood sociological research where children are described as active in their own learning processes, but also are determined by discursive rules. The starting point is thus a non-essential approach, in which children are seen as ‘multiple personalities’ and the subject is understood as fluid and changeable (Butler 1993; Lenz Taguchi 2004). It also includes designations like ‘children’ and ‘childhood’ and age divisions that both shape and are shaped by children and other individuals, as well as material objects which also participate in the creation of ‘child’ and ‘childhood’. In the same way designations like ‘mathematics’ and ‘the mathematical child’ are understood. This means that the study is based on the idea that children ‘are’ not mathematical, but are more or less ‘made’ mathematical, depending on how they
are treated, the contexts in which they participate and how mathematics is identified in the environments they participate in (Palmer 2010).

Inspiration has also been taken from Barad’s theories, where subjects are seen as active agents which intra-act\(^1\) with things, matter and the environment with their bodies (Barad 2007). Barad challenges the postmodern theories which contend that language is crucial for the creation of meaning. She believes that language is thereby attributed to too much power:

Language has been granted too much power. The linguistic turn, the semiotic turn, the interpretative turn, the cultural turn: It seems that every turn lately, every “thing” – even materiality – is turned into a matter of language or some other form of cultural representation (p. 132).

Barad’s theory offers a broader perspective on understanding toddlers’ learning. She involves the environment around the child and asserts that surrounding objects are also important in the construction of knowledge. This is a new and challenging way of understanding learning during these years. Piaget (1959; 2002) for example focuses on cognitive learning and from his perspective the child’s construction of knowledge is an individual issue where social and cultural factors are underestimated. He asserts that all children’s learning and development is general, with all children following the same ‘staircase’, independent of contextual differences (Piaget 1959). From this point of view the environment outside the child’s mind is not worth attention. Other people and the objects around the children do not appear to affect the child’s development of knowledge. This individual view of learning has been criticized in recent times (e.g. Donaldson 1978; Hundeide 1977). Critics questioned if all children develop in the same way. Piaget’s methods and analysis have also been questioned from an ethical-moral perspective. Donaldson for example asserts that many of the examples Piaget used in his experiments are incomprehensible to children (Donaldson 1978). Barad asserts that language is granted too much power, which also challenges the theory of Vygotsky regarding the proximal zone, which discusses the distance between the actual developmental level and the level of potential development which is possible to reach under adult guidance or in

\(^1\)Barad uses the concept intra-act in order to describe the relation between matter and humans
collaboration with more capable peers, who, through social interactions, transfer strategies to the less advanced child. A fundamental aspect of the theory, which gives a great deal of power to language, is that one part of learning is social. Vygotsky’s assertion is that children develop knowledge first at a social level in interaction and then at an intrapsychological level inside the child (Vygotsky 1978).

In Barad’s (2007) understanding, discourses even include the material, not just language and linguistic communicative expression. Her approach widens our understanding of matter to cover not only human bodies. Barad’s complementary perspectives can contribute to a better understanding of the youngest children’s learning processes. With Barad’s perspective it is not only the child’s thinking and language that affects the learning situation. Surrounding objects, the environment in the preschool, peers, teachers and emotions also participate in the creation of knowledge in the specific situation. Thus, if the environment is important, teachers must take this into consideration when organizing the everyday activities of preschool.

From Barad’s perspective the material is not given: ‘Matter is neither fixed and given nor the mere end of results of different processes. Matter is produced and productive, generated and generative’ (p. 137). Even things that surround us are part of materialization processes. This understanding assumes that subjects cannot be separated from objects and matter. Even things and matter are understood as active agents and thus co-producers in the production of meaning. This means that young children’s mathematical learning is seen as a co-operation between the child, subject and things and objects around them. It is a mutual dependency between subject and matter – the object. Lenz Taguchi (2010) explains this as learning, as becoming and subjectification is something that is going on at the same time; doing and being what is going on simultaneously. Learning can thus be understood as a bodily experience in becoming, in this case ‘becoming mathematical’. According to Barad (2007), it is about the practicing of knowledge in its creation. Learning takes place in the gap between people and objects, materials and environments which thus create and recreate each other. In these in-between gaps, we can detect differences and other new ways of thinking and understanding (Lenz Taguchi, 2010). With these theories as inspiration, my
purpose was to examine how some toddlers in the preschool work with mathematical problems in play situations not guided by the teachers. How do they deal and solve maths problems and is it possible to observe how children intra-act with their body, objects and the environment?

Methodological considerations

Participant observation was conducted during one week in a toddlers group in preschool. At the time there were eight girls and five boys aged 12-36 months in the group. I observed the children in their ongoing activity between the hours of 8.00 and 15.00. My main interest was to study the children’s own activities, when they decided what to do themselves. This choice was made because the main focus was children’s own interests and their initiatives in learning mathematics. I then wrote down situations where I perceived some form of mathematic expression in the children’s activity. Mathematical elements can found in almost everything children do and there were surely maths situations I didn’t observe. However, my investigation generated a large amount of data that showed lots of situations where the children strove to understand mathematics, which strengthens the credibility of the study.

As a researcher I possess great power over the interpretations I make of the participating children’s expressions. My purpose is to try get as close as possible to the children’s perspective and express it as best I can. Is this possible? Of course, not entirely. We cannot be sure that our interpretations do justice to the children we are studying. The ability to interpret children’s intentions and expressions of opinion is limited and the knowledge that can be obtained is complex and ambiguous and cannot be claimed to be complete (Johansson 2003). Trying to approach the child’s perspective as researchers means that we have to try to interpret and understand ‘that which presents itself to the child’ (Johansson 2003, 43). It is an important matter that researchers be open to complexity and ambiguity. Children have few opportunities to make their voices heard. The youngest children, who have not yet conquered spoken language, are particularly at the mercy of adults. As a researcher I can assist them in expressing their voices, which requires a good deal of me as a researcher. I rely on previous research on younger preschool children’s learning, which is based on the child as
an active subject in learning situations. I also use the theoretical concepts related above to describe the basis for my assertion that my study is based on the child’s perspective.

The data was analysed in three steps. In the first step I tried to find situations where the children themselves took an initiative to learn mathematics using their bodies. According to the research review most studies focus on children’s cognitive learning; therefore my purpose was to draw attention to another perspective, namely bodily learning. In the second step I was interested in how the children used their bodies to interact with the environment – with toys and games, with objects, with their peers, with adults – and how their emotions were involved in the situation. In the data material there were several examples of how children used their bodies to learn and how they interacted with surrounding objects. In the last step I turned my attention to the outcomes, with inspiration from Barad’s theoretical perspective.

*Sara works with maths*

From the data material one situation was chosen to serve as an example of how children use their body as a tool for learning and how they interact with the things around them. This situation is one of several similar situations which I interpreted as children working to solve mathematical problems. The situation shows how one-year-old Sara encountered mathematical problems and dealt with them. The main theme is that Sara discovered the big car in the hall and wanted to play with it. The situation shows how Sara confronts mathematical problems and interacts in the learning situation with her body, things and matter she encounters.

In the hallway there is a big car made of wood that kids can climb into and pretend they are driving. Sara comes toddling on unsteady legs, turns down the hallway and pauses for a moment on the threshold. She spots a boot right next to her feet. She bends down and lifts up the boot and puts it nicely next to the other. Sara obviously has knowledge that boots should be in pairs; they should stand side by side with their mate. She looks happy and smiles to herself. Then she looks up at me as if to confirm that she has done something good. Now she sees the big car in the hall. She looks around and suddenly gets in a great hurry, throwing herself on the floor and crawling instead of walking. My interpretation is that Sara knows it’ll go faster if she crawls and now she wants to reach the car as soon as possible so no friend will get there before her. Sara has experience of
time; she knows that if she hurries maybe she will be the first to arrive at the car. She knows how to use her body to make it go fast. The body is her tool to move quickly. She knows exactly how to move her hands and how her legs will follow the movement. She knows how it feels to crawl on the floor in preschool. The floor feels hard and rigid to her hands and knees. With her body, she suddenly experiences something on the floor. It is gravel in her way, under her knees, and some has got stuck in her hand. It hurts to crawl on. Gravel affects her forward movement and arrests her pace. Sara stops crawling, sits up on her knees and looks surprised at her hand, where a sharp grain of gravel has pressed in and got stuck. She shakes her hand, but the gravel is still there. She takes her other hand and brushes away the gravel from the first one. She looks with astonishment at the small pit that is visible in her hand where the gravel was seated, then she starts crawling again. Now she has to rush to the car. Once there, she stands up on wobbly legs, stands still for a moment and leans against the car. Then she tries to get into the car. She lifts up one foot but doesn’t lift it high enough, so her foot repeatedly hits the edge of the car. When she tries to lift her leg a little higher, she wobbles and almost falls but manages to keep her balance. She stands still for a moment as if to concentrate and then she swings up her leg and manages to get one foot into the car. She turns around with difficulty; now she is standing with one foot in the car and one outside. Sara then leans her body and uses it as a lever to swing her other leg into the car. She looks happy. Now, she is sitting comfortably in the driver’s seat and begins to ‘drive’ the steering wheel. She follows the movement with her whole body as she drives. She makes eye contact with me who is standing next to her observing, and she smiles with her whole face.

But suddenly there’s something troubling her. She is quiet and serious, stopping to check something. She turns and looks back, first from one side, then the other. She seems to be thinking about something. My interpretation is that when Sara is in the car, she experiences an overwhelming feeling of the car’s size. She feels the size of the car but she is not content with this. She needs to examine the size further. Laboriously she starts to step out of the car. Once she is out she starts determinedly to walk around the car. All the while she keeps one hand on the car and follows all the way around with her hand. Sometimes she stops for a moment
while she ponders on something. In some places, she has to bend down a little to follow the car’s shape. When she has gone all the way around she climbs into the car, sits down and begins to ‘drive’. She looks happy and pleased, and she looks at me and smiles broadly.

**An intra-active understanding of Sara’s mathematical learning**

The data above has been analysed with inspiration from Barad (2007) and her theory of ‘agential materialism’. Barad asserts that: ‘The world is a dynamic process of intra-activity and materialization in the enactment of determinate causal structures with determinate boundaries, properties, meanings, and patterns of marks on bodies’ (p.140).

Sara cooperates with her environment, she is part of the world in an ongoing intra-activity with the environment, other humans and things around her. With inspiration from Barad (2007) boots can be viewed as co-creators in a mathematical learning situation. The fact that it lies down and signals ‘put me up’ means that the boot can be seen as an agent in the learning situation. The boot influences Sara’s learning process. With Barad’s (2007) theory, learning situations follow a flow or, to use Barad’s term, diffraction waves. These waves occur when bodies (physical or human) bump into each other. The meeting leads the flow in a certain direction. The boot and Sara meet and a co-operation begins. Something happens to Sara when she sees the boot lying down. She connects to the object ‘boot’ (Hultman 2011; Lenz Taguchi, 2010). The boot intra-acts with Sara and gives rise to thought processes that in turn cause Sara to act in a certain way. She picks up the boot. The situation also involves her emotions, with the action making her happy. The encounter with the boot thereby gives rise to new events. Sara looks at me and she smiles; I respond to her emotions and smile back. The learning is constant in motions and different chains of events hook into each other.

The small piece of gravel also co-operates with Sara when it digs into Sara’s soft body. She does not yet understand that it is her body’s weight that presses the small stone into her hand. She can’t explain it in words, but her body registers the pain when it digs into her hand. The body learns and will remember. Merrell (2003) uses the concept of ‘body mind’ for an understanding that nothing can be
attributed to only the head or body. It is about a flow, a reciprocity between the body and the head. It is thus not possible to separate what we learn with our bodies and with our thinking. There are reciprocal flows that are a fusion of spirit and body (Merrell 2003).

For a long while Sara intra-acts with the big car in the hallway. This encounter leads to Sara learning in unpredictable ways and is a learning process that emerges precisely in that situation. Sara’s learning takes place in a kind of ‘space’ between her and the things around her and the environment, with all of these being co-creators and intra-acting in the learning process (Lenz Taguchi, 2010). Sara sees the car, knows it’s fun and knows how to play with it. Sara connects to the car. It stands there and asks her to play. When she tries to climb into the car, she meets resistance. Her legs hit repeatedly against the hard wood; Sara’s smooth legs against the hard car. Each time her leg collides with the car, pain is propagated by Sara’s body. Finally, she lifts her leg high enough to be able to climb into the car.

And now she has one leg inside the car, and the other outside. Sara has an embodied experience, a ‘body mind’ (Merrell 3003), of how she can use her body to get the other leg into the car. She leans her body and puts her weight on one leg, to help swing the other into the car. Later, when she gets into the car the second time, she has new knowledge in her body that tells her how high she has to lift her leg to get into the car.

By walking around the car, Sara tries to understand size and shape with the help of her body. She measures the car with her whole body and experiences its size while walking around it. She also applies the help of her hand when she follows the car’s surface. She feels the shape of the car with her hand and how it feels in her hand. She also experiences the shape of the car when she has to bend down to follow line of the car. Sara perceives materials and shapes with her hand. Palmer (2011, 45) argues that: ‘the body registers and remembers lights, sounds, colours and mathematical concepts such as perimeter, time, length and distance’. However, it is not certain that the child in the actual moment is able to describe this experience with spoken words (Palmer 2010). This should not be understood
as a glorification of the body, where thinking is subordinate to the body. Rather, ‘mathematical learning understands as something that goes in and out of our porous bodies’ (p. 45). Mathematical concepts ‘are captured by the body, thoughts, skin and senses and force themselves upon the children and become as one with them’ (p. 45). To be mathematical is an intimate collaboration between many different components (Palmer, 2010). In the same situation, Sara works with categorisation, time, directions, evaluation of distance, position description, spatial awareness and size. She does it in an ongoing co-operation with objects and materials around her.

How to meet Sara’s initiative to learn?

In planning for an educational activity it is important to ask oneself where the learning should begin. In the research, one can identify two dominant and competing perspectives on learning. One perspective is based on a preset linear course, while the other looks upon learning as something that can start anywhere and go anywhere. Learning is not pre-set, rather it is seen as rhizomatous – unpredictable and non-hierarchical (Lenz Taguchi, 2010). Linear learning begins outside the child and can be understood as adults defining what is important for children to learn. What has to be learned is thus predetermined, and the teachers are planning to reach this goal. The destination has been determined and the teacher is the tour guide. Lenz Taguchi (2010) expresses this view as: ‘a logic that must always begin with the formulation of predetermined goals and universal values: [......] we start at the end of it to be achieved and what we want to evaluate’ (p. 131). Learning is seen as a linear and hierarchical process; teachers who know and children who don’t and thus have to be taught. The core of this approach is to get children to learn what teachers have decided they need to learn. Teachers try to find methods or a ‘recipe’ to follow that can be used to achieve this goal. Instead of seeing complexity and diversity as an asset, this perspective seeks uniformity (Osberg and Biesta, 2009). But if the activity is to begin in ‘the child’s experiences, interests, needs and opinions’ (National Agency for Education, 2010, page 9), is it possible to determine what should be taught in advance? Then I think we miss the point of the educational activities. An alternative approach that would better match the goals of the curriculum is the pedagogy based on inspiration from Reggio Emilia, whose starting point is to
begin with the child, in the midst of his or her sense, knowledge and interests. It’s about starting with children’s knowledge – what they already know and express – and with their own language (Åberg and Lenz Taguchi, 2005). Important concepts behind this view, which is also referred to as intra-active immanent pedagogy, is for teachers not to be tour guides but fellow travellers on a journey where the goal is not predetermined and not even central. The children will lead us with their questions, spoken and unspoken. Their creativity, bodies, senses, desires and emotions are what is central. The children pose new questions for us and formulate problems. This is a view of learning where it is impossible to separate the learning subject from what is to be learned. Learning can be described as an embodied experience of being (Lenz Taguchi, 2010). From this perspective it is important to highlight the different ways in which children express themselves and understand concepts and words. Diversity is the base in the learning process. Palmer (2011) believes that mathematics often ‘knocks on’ and raises issues which lead the children to explore. The teacher’s role then becomes not only to teach the children mathematical concepts but also to enable children to experiment and explore their world mathematically. Elfström et al. (2008) argue that to understand a concept, it is important to be in touch with your body, feel and touch, hear and see, and not least to be moved emotionally.

Learning through intra-active pedagogy begins in the midst of the child’s own sense. What mediates Sara and how could the educational activities support her in her learning? Sara conveys an interest for mathematical concepts such as categorisation, time, size, shape and distances. Her exploration of mathematics can be linked to the concept of spatial perception, which scientists assert is fundamental to mathematical thought (Björklund 2007; 2009; Solem and Reikerås 2004, etc.). Spatial perception is about how children explore their world with their bodies, determining distances, measuring how large an area is and exploring size and shape. Sara clearly shows that she likes to use her body to explore mathematical concepts. But previous research on preschool children’s mathematical learning focuses mainly on how children express and show that they understand mathematics. In research on young children’s mathematical learning in general, the body is remarkably invisible. This means there is a challenge for teachers to organise learning environments and situations that
involve both body and brain. When it comes to materials that stimulate mathematical learning, it is important to remember that it should be possible to explore them in a number of various ways. It is also important to get away from dualistic thinking and taking notions of mathematics ‘for granted’. When it comes to mathematics objectivity and rationality are powerful normalised notions. Central to the meeting with Sara is thinking beyond these dualisms and instead transcending and going beyond a dividing logic (Palmer, 2011). It is important not to think about mathematics as a distinct separate activity. The optimum situation for Sara’s learning is for teachers to think in new ways about content and structure. Otherwise, it’s easy for them to end up in the traditional ways of thinking. Sara expressed that she wants to use the body in her learning. Her learning needs can be met with what Palmer (2011) refers to as ‘music math’ or ‘dance math’ (p. 47). Sara needs to experience mathematics in her body. One way to meet her in her learning could be to problematise size and shape in dance, movement and music. Such activities are already familiar in preschool. What is new is to actively connect mathematics with bodily activities. The point is to dare to borrow tools from other areas and dare to work in each other’s discourses. Lenz Taguchi (2010) speaks of a ‘trans-disciplinary learning’ that goes beyond the dualism of logic, viewing learning as moving between, across and beyond disciplines. This is not about working side by side on the basis of the different substances of traditional thinking, it’s about thinking outside the box, innovatively and creatively (Palmer, 2011). In this way we are also creating a new educational concept that has the potential of transcending established thinking and opening up more broadly. Sara cannot yet use spoken language to express mathematical knowledge. But with her body, she can perceive mathematical concepts. The body, thinking and the senses capture mathematical concepts and become one with Sara. Her body will remember and store the memory in her ‘body mind’. The starting point in meeting with Sara should not be to define which mathematics is appropriate to present to her. Instead, we should begin in the fact that we do not know what mathematics will become to Sara.
Conclusion

In intra-active pedagogy, there are no clear boundaries between human bodies and things. As a teacher, it becomes important to consider that even the environment in preschool and things that are there are elements in a mathematical environment. The building blocks, toys, pillows, books, crayons, sandboxes, along with everyone’s bodies – all of this could be understood as active performative agents doing something with learning and with the child’s identity. The learning that is expressed is influenced by what is in the room. This means that teachers need to consider how the environment is designed and also to observe how the children intra-act with the environment. It is important to reflect on given assumptions about how things are organised. It takes knowledge and commitment to catch sight of the children’s own initiatives to mathematical learning, as it is about breaking ingrained and taken-for-granted patterns. Teachers must have their eyes and ears open to what children are doing, because the journey of learning will start there, in the children’s own initiative and interests. As a teacher you should meet children in their own examinations and searches for answers.

To summarise, with this article I would like to focus attention on the need of the youngest preschool children to use their bodies to develop their mathematic knowledge. My ambition has also been to highlight the teachers' need to become aware of seeing bodily learning as an important complement to cognitive learning. My purpose is to offer new perspectives on education in early years and inspire preschool teachers to think more broadly and across borders when working with mathematics in these age groups.

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Abstract

The aim of this study is to analyse and discuss those strategies for learning that are essential for toddlers’ development of an understanding of basic aspects of mathematics. Analysis focuses on authentic episodes where toddlers aged 1-3 are seen interacting with other people. The settings chosen for the qualitative analysis emanate from a variation theory of learning approach. In such an approach, learning is defined as a change in understanding, and in order to change a person’s understanding of a certain phenomenon, various aspects must be focused on simultaneously. Accordingly, critical aspects that a learner has not been previously able to focus on may emerge during interaction with others since such settings provide an
opportunity for the problemisation of differing aspects and perspectives. This study seeks to discern toddlers’ strategies for learning through the observation of those strategies that the toddlers themselves initiate, which may reveal the competence for learning that young children possess.

**Keywords:** toddlers; strategies; learning; variation theory; mathematics

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**Learning and teaching early mathematics in a toddler-group**

Author: PhD Camilla Björklund  
Senior Researcher  
Department of Early Childhood Education  
Åbo Akademi University  
Finland

Research has shown that young children encounter many aspects of mathematics through the daily routines in day care. These opportunities may or may not be used in order to support the development of the children’s understanding of and skills in early mathematics. Early mathematics is an important part of toddlers’ developing understanding of their surrounding world, as mathematics for young children aims at describing relations in space and between amounts as well as communicating about relations in their surrounding world. Educators working with the youngest children seem to be in need of an improved awareness of the basics of mathematics, the social and communicative aspect of mathematics and how mathematics is experienced by the children. An in-service program based on the idea of “Learning study” within the theoretical frame of Variation Theory of Learning, has been done during the year 2009. The aim of in-practice training is to make the educators aware of the child’s perspective, understanding and learning opportunities that emerge through the day and in planned educational settings. Four kindergarten teachers took part in the in-service program. Together with the researcher they reflected upon their practice aiming at improving the same practice with a specific focus on aspects of early mathematics. These educators work with children 1-3, 4-5 and 6 years, all within the day-care system in Finland. The paper that is to be presented is an analysis of the work carried out in the toddler-group (children 1–3 year olds) with a focus on the educator’s as well as the toddlers’ learning processes.

**Abstract**

Mathematical knowledge has developed from human activities through thousands of years and is bound to the world and cultures that men and women experience. One can say that mathematics is rooted in humans’ everyday life, an environment where people reach agreement regarding principles in mathematics. Through interaction with worldly phenomena and people, children will strive to understand their surrounding world, gaining experience that they can then in turn use to understand future situations. The environment in which a child grows up, thereby plays an important role in what that child experiences and what possibilities for learning that child has. This article aims at describing what possibilities there are for toddlers to experience and learn basic aspects of mathematics, such as mathematical concepts and the relation between parts and whole, in interaction with other people and the surrounding world. In order to fulfil this aim, an analysis has been done of critical conditions of learning that may be discerned in toddlers’ daily activities. Four authentic episodes are described and discussed in this article. Results from the qualitatively analyzed videographic study of toddlers’ experiences of mathematics in day-care show that variation, simultaneity and reasonableness seem to be critical conditions of learning, as well as the possibility to focus on important aspects in a phenomenon. Adults working with toddlers thereby play a very important role in setting perimeters for toddlers’ experiences and possibilities to explore mathematical phenomena.

KEYWORDS: early childhood education, interaction, learning, mathematical development, toddlers, videography

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**Karin Franzén**

*Paper presented at the NERA conference Jyväskylä Finland mars 2011*

**Mathematics for toddlers - Discourses on the right to learn and the task to teach**

The aim of this project is to investigate which meanings, formal and informal, that ascribes mathematics for the youngest children in Swedish preschool (1-3 years). According to international studies Swedish children have insufficient knowledge in mathematics (Pisa 2008) Studies also shows that despite girls perform good results in
mathematics in primary school they lose interests for the topic when they grow up. This development causes the Swedish government to support further education in mathematics for practicing pre school teachers. They have also suggests a rewriting of the curriculum intending to strengthen the role of mathematics in pre school. Most of the pre school children age 1 -3 goes to special toddler groups. An interesting question then is; Toddlers mathematics what should it be?

Today there are few Swedish studies that focus in the youngest preschool children’s mathematical learning. Recent studies have mainly been directed to children’s cognitive learning and their understanding in mathematical concepts. The projects ambition is to bring a wider insight in toddler’s mathematics. Data should in a first step be collected from the preschool practice by interviewees of teachers and by observations of the children’s activities and the teachers work. In a second step results from the study should be analyzed in cooperation with the teachers in order to plan interventions. The relevance for the project must be seen as high because of the lack of empirical knowledge in both the research field mathematics for the youngest in preschool, and the field of gender and mathematics in these ages.

Presentation on EARLI conference 2009  Maria Reis, University College of Borås/ University of Gothenburg,, Fil. Dr. Jonas Emanuelsson, University of Gothenburg and Prof. Torgny Ottosson, University College of Borås

The development of toddlers’ mathematical activity in preschool

Abstract

The focus of this paper is to describe and discuss what resources toddlers’ use to develop basic mathematical competence in a preschool setting. This development is described from the point of departure of the theory of variation and a Gibsonian view on perception, in terms of differences and similarities in a temporal sequence of situations where
toddlers work with concrete materials such as building blocks of different kinds. The data consists of video documentations of children’s everyday activities. We argue that we can see that the children have different ways of handling the tasks and situations at hand. The children can often discern where an object should be placed in relation to other objects according to relative size, orientation and rotation. When the task is changed, to a large extent the children has to “start from the beginning” often and has difficulties in generalising previous experiences, and previously used resources when working with other tasks.

Introduction

The aim of this paper is to describe the development of toddlers’ mathematical activities in preschool. This development is described in terms of differences and similarities in a temporal sequence of situations where toddlers work with concrete material in preschool. The situations chosen for analysis are a sub-sample of a larger corpus, and they show toddlers working with a material called the “ring tower”. The task is to put an ordered series of rings on a shaft. The rings should be ordered according to their size.

The theoretical framework draws upon phenomenography and variation theory. We will address qualitatively different ways in which children explore and handle situations involving basic understanding of mathematical concepts (Marton, Runesson, & Tsui, 2004). Further Gibson’s (1979) approach to perception, especially the concepts of affordances and constraints offered by the material, is also made use of in the analyses. Young children can often solve dilemmas of mathematical meanings by utilizing the affordances (Gibson & Pick, 2000) they derive from the materials, the activity and the context.

An extensive body of research exists within this area of interest. Different research traditions and various views exist regarding what constitutes a conceptual understanding of mathematics and the development of mathematical knowledge. The bulk of this research focuses on young children’s counting. Piaget is one of the most well-known researchers in this field and research on young children’s development of mathematical skills has been dominated by attempts to verify, discount or reinterpret his theories. Other researchers focus on size, form and order (Baroody, 2004; Clements, & Sarama, 2007; Clements., Wilson., & Sarama, 2004; Fuson, 1992; Mix, 2002; Seo., & Ginsburg, 2004). The mathematical concepts related to this study mainly relate to size and shape of concrete objects.

What is studied is the activity in terms of what resources the toddler uses to accomplish the task in question.

Methodology/design

The data consists of video documentations of children’s everyday activities in preschool. Children of these ages do not talk very much. The need to do fine-grained analyses of non-verbal interaction constituted is one basis for the decision to document with video. Another important choice was to arrange situations (in contrast to just to record spontaneously upcoming situations). One reason for this is to ensure sufficient occurrences of activities of the types investigated and to make sure that the data
material is sufficiently rich in mathematical activities that lend themselves to micro-longitudinal studies. One important feature of this arrangement is that we have offered concrete material of the same kind as the children are used to, but the material has been slightly changed in important aspects. An exemplification of these changes is that the tower of four rings has been changed to a six ring tower.

Findings

The study is ongoing but we can tentatively say quite interesting things about the character of the results. In the material we can see that the children have different ways of handling the situation. Often the children ask peers for help. Also, they often instruct each other when working in pairs or small groups.

For the children it is easier to see and change the rotations of the rings than to put the rings in order of size. When the children have shown that they master the building of a tower on the shaft they often can build the same tower but upside down. When a task is changed, it appears, however as if the child has to "start from the beginning" and has difficulty to generalize previous experience to other tasks. An example here is when a tower task consisting of 6 cups is changed into a similar but with eight cups instead.

Discussion

There are a few relevant previous studies with a similar focus, toddlers’ exploration of pre-mathematical knowledge together with peers in day-care settings. The focus in this case is not psychology or experimental studies but an interest to study “in situ” and focus on how this development is interactively constructed “here and now” rather than as a part of a “laboratory game” (Lave, 1988).

References


Numeracy among 1 to 3 years old children in preschool

Ingrid Pramling Samuelsson & Elisabet Doverborg
Göteborg University, Sweden

Abstract
A longitudinal study called “Children’s early learning” started 2005 in Sweden with the aim of studying the quality of preschool related to children’s learning. The quality is described in terms of the Early Childhood Education Rating Scale ECERS (Harms & Clifford, 1980), as an external evaluation as well as a self evaluation. In all, 38 preschools are included and their children born 2004 and 2005, altogether 225 children. One of the areas in which children’s learning are traced has been in early mathematics. The very first structured play task in early mathematics is carried out in dialogue with these children. The task focused on questions like: large and small, matching, counting, first and last and sorting objects (in size or colour). The researcher and each child played with objects for about 15 minutes. The interaction was video recorded, and later transcribed and analysed qualitatively in terms of variation of ways of dealing with the different tasks.

The aim of this presentation is to describe the various ways in which children act in this particular structured play task on early mathematics, and in which a phenomenographical approach related to early mathematics is used (Marton & Booth, 1997; Pramling, 1996). Children’s acting will also be viewed developmentally, that is related to their age.

Background
A great part of early mathematics is based on learning to understand different notions and words. Words of comparisons, like e.g. large and small are of importance, as well as
words describing the position like first or last which children have to grasp before they can create an understanding of and can tell which animal is the first or the last one in a row. For many children are comparison and positioning words difficult to grasp the meaning of and relate themselves to. Young children however, make themselves understood even if they can not use the proper word (Solheim Heiberg & Reikerås, 2004). Malmer (1999) claims that for many children it is not the lack of arithmetic understanding, which creates problem within mathematics but the lack of understanding of world. This is particularly important when one deals with the very youngest children who do not always jet have developed the correct notions.

To compare two objects is basically the foundation for experiencing differences and similarities, a large bear respectively a small bear, but also a green or a read bear. Mason (2003) means that generalisations and being able to discriminate certain features are basic knowledge in mathematics. Björklund (2007) also emphasise the importance of giving children many opportunities to experience similarities and differences for their emergent understanding for how objects or phenomena can be related to each other.

Hannula angående färg och from!!!!

Already, from the age of one children meet adults who direct children’s attentions towards counting in different situations It can be that the child has to dress in one cap and two woollen gloves, or it can be at the dinner table where children and adults may count how many spoons of porridge the child eats or how many meat-bolls there are on the plate. Many researchers claim that children early have an understanding for numbers and counting (Baroody, 1987; Fuson & Hall, 1983; Gelman & Geleistel, 1978; Ginsburg, 1977). To develop a capability to count includes however, two different capabilities. The child must have developed a stable counting sequence, that is, to count 1, 2, 3, 4, 5, and so on. They must also understand that all objects need to be counted, but only one time. To count a number of objects that can be moved seems to be easier for children than counting objects that can’t be moved or touched (van de Wallle, 1998). Elkind (2007) claims that there are three steps in the procedure of becoming able to make mathematical operations. He claims that children build their number conception through three levels of meaning: 1) can use numbers in a nominal sense, that is, to use numbers as a name, 2) to use the number in an ordinal way, that is, to see the sequence, 3) to use interval numbers, that is, when numbers represent equal units and can be operated on arithmetically. Gelman and Gelister (1983) talk about 5 principles for
becoming able to solve arithmetical problems: 1) the principle of abstraction, 2) one to one principle, 3) the principle of random order, 4) the principle of definite number words, 5) the principle of numbers.

Wynn (1990) means that young children generally already at six months of age have developed what we call “number methodological expectations” (“antalsmetodiska förväntingar”) of addition and subtraction when something is taken away or added to an amount. Long before children can express a counting word, they can perceive differences in groups of two or three objects. This is a capability called “subitizing”. Children 1, 2 up to 3 years of age can often distinguish between 1, 2 and 3 objects, but when it is four or more objects children perceive it as many (Fisher, 1992). On the contrary do children not need to know the number sequence for matching objects.

Before children can express numbers with digits and symbols they can in different ways express how many (numbers) of something they perceive. When children were asked to represent five cars on a paper, they could solve the problem by: putting the cars on the paper and draw around each of them, they could draw each of them as an object, they could make a line for each car or they could just write number five (Sinclair et al., 1983; Doverborg & Pramling Samuelsson, 1999).

The structured play task
The concepts we tried in structured dialogues and play situations with the children were: words for comparison – large and small, for position – first and last, matching up till 3. The children were also encouraged to count (4 or 5 toy animals), to sort teddy bears into two boxes (two sizes and two colours), and to represent a number (draw 2 ducks). The structured dialogues and play situations are enacted as follow:

- The researcher brings out two pigs in different sizes and a fence. Together the researcher and the child build a fenced yard for the pigs where they are supposed to be fed. The researcher tries different ways to find out whether or not the child is able to distinguish between the large and small pig by encouraging the child to pretend that the large one (or the small one) wants to get out from the yard (or come to the child).
- The child is given a card with 1, 2 or 3 dots on it (in different sequences). They talk about the card and check if there are dots on its backside, something which many children do spontaneously. Then the child receives 5 ducks (made of glass) and the researcher asks the child to put as many ducks on the card as there are dots.
The child is given a piece of paper and a crayon. The researcher puts 2 ducks on the paper and asks the child to draw as many ducks as there are glass ducks on the piece of paper.

The child is given a basket with 4 different animals in it: a cow, a sheep, a pig and a panda. The researcher picks them up, one at a time, and asks: “What is this?” and if the child is able to he or she tells what the animals are called. Then the researcher puts the animals in a row, and they talk about who is first in the row and who is last. The researcher asks the child if he or she knows which animal that is standing first and which is last.

The ducks (5) and the other animals (4) are counted. First the researcher asks the child to count them, but if he or she is unable to do so, the researcher counts out aloud.

The child is given 2 green and 2 red teddy bears in two different sizes. They talk about the bears being large and small and they talk about them being different in colour. Then the child is given two nice boxes with lids and the researcher tells that some of the bears can live in one of the boxes and some in the other.

The whole sequence takes 15 minutes maximum and the researcher plays and jokes with the child and the objects.

Method and survey group

This study is mainly qualitative and the collected data are video-observations. Today this form of data collection is used a lot in research on young children (See e.g. Pramling Samuelsson & Lindahl, 1997; Johansson, 1999; Lindahl, 1996). The video recordings give the researcher opportunity to view one and the same sequence, over and over again. Often this is quite necessary as young children’s vocal expressions and gestures can be hard to catch and understand at one single viewing.

A phenomenographic approach is used for the analysis (Marton, 1981; Pramling, 1990), that is, to find the various ways in which children solve one and the same task. This involves what they say and how they act and react in each situation. The result of the analysis is presented in categories of experience, that is, how the task or the situation appears, from the child’s point of view – how the child put meaning into it. The qualitatively different categories as such should not be seen as more or less advanced. However, when studying the total group of children and the numbers of experiences within each category, the age development becomes obvious. The age trend then becomes an empirical evidence (Pramling, 1983; Doverborg & Pramling Samuelsson, 2000). The results, in terms of categories, spring
out of data in combination with the researchers’ knowledge of the field – in this case the field of basic mathematics (Schwartz, 2005).

The analysis starts with detailed transcriptions of 25 observations in order to get an idea about the differences in the children’s ways of dealing with the tasks. The rest of the video-recordings have only been transcribed partly with additional notes. When then the final version of the categories are developed, the next step is to find out, for each task, in which category each child’s experience should be placed, by scrutinizing the video-recordings once again.

225 children from 38 different preschools with a large variation of socio-economic background have been recorded. The children, 110 girls and 115 boys, are between 1.0 to 2.11 years old. For the statistical analysis children are divided in four age levels. As we can see below there are most children between 1.6 and 1.11 years of age, and least under 1.5 year.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Age (years)</th>
<th>Number of children</th>
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<tbody>
<tr>
<td>1</td>
<td>1.0 – 1.5</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>1.6 – 1.11</td>
<td>116</td>
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<tr>
<td>3</td>
<td>2.0 – 2.5</td>
<td>49</td>
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<tr>
<td>4</td>
<td>2.6 – 2.11</td>
<td>41</td>
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<td>Total:</td>
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<td>225</td>
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Results
The ways in which the children act (verbally and in actions) are first and foremost qualitatively analyzed. Here follows a short description of each category found. In some of the tasks it is quite easy to interpret the children’s actions, in others it is harder to find really distinct differences. We have however, described the categories as distinctive and qualitatively different.

1. Comparing large – small
In this task it becomes visible whether or not the children know which pig is large and which one is small, and subsequently there are no variations. Some children talk about the size in terms of dad or mum as large and the baby as small, i.e. they relate to their own family when

2 The four categories of age groups represent the age each child has reached, that is, in age group 2 it means that children are between 1.6, but not yet turned 2, when they have they are in the next group.
they talk about the size of the pigs. Some children do not use the concepts large or small, but choose the right pig when asked to pick up one or the other.

A: Knows large and small.
B: Does not know large and small.

Table 1: Percentage of children knowing large and small distributed by ages groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>% of Children</th>
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<tr>
<td>1.0 – 1.5 year</td>
<td>1.0 – 1.5 year</td>
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<td>23%</td>
<td>60%</td>
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We can here see in the Table above a very clear age trend ranging from 23% for the youngest to over 80% for the oldest children, in their capability to distinguish between large and small.

2. Matching up till 3
In this task the child is expected to match objects in terms of ducks and dots. It seems like most children want to place all the ducks on the card, so after they have placed ducks on the dots they continue to place all the ducks there. Here we have tried to listen to their body language, i.e. if they first place ducks on all the dots, but hesitate for a split second before they continue placing ducks on the card we have chosen to interpret that as they are able to pair the correct number. The children talks about the dots as eyes or buttons etc. A lot of children say “many” about 3.

A: Pairs dots and ducks correctly.
B: Places ducks on the dots, but continues to fill the card with ducks.
C: Covers the card with ducks, not caring about the dots at all.
D: Does not place any ducks on the card.
Table 2: Percentage of children matching in different ways distributed by age group.

The age trend is also here clear, first of all for the children who correctly pair dots and ducks. We can see that none of the youngest children can do so, but about 40% of the oldest can. We can also see the age trend backwards in category C, where about 64% of the youngest children fill the card with ducks without noticing the dots, while only about 17% of the oldest do so. We can also notice that it is very few children how do not use the card at all to put the ducks on.

3. Counting
When it comes to counting objects a clear and nuanced picture appears.

A: Counts 5 (ducks) and/or 4 (animals) and points as counting the correct numeral sequence.

B: The child counts out as many numerals as there are objects, e.g. 1, 2, 3, 6 or 8, 9, 3, 4. The child obviously has an idea of counting as something you do by using numerals, but has not yet a correct numeral sequence.

C: The child counts out numerals, but has no stable numeral sequence, nor the understanding that each object has to be counted, e.g. 1, 2 or 2, 4, 8, 6, 1, 2.

D: The child waves with his/her hand in the air as he/she is counting objects without counting out the numerals, or he/she makes this movement saying “this, this, this.”
Some children do this spontaneously without anyone counting out the numerals for them, other children do so when the researcher counts.

Table 3: Percentage of children counting in different ways distributed by age groups.

As we can see in Table 3 above, very few children have a correct numeral sequence related to objects. It is however, just below 40% for the third age group and just above 40% for the oldest children who use counting numerals, although their numeral sequence is unstable.

4. The animals: First and last
Many children can name some of the animals, either by telling which animal it is or by imitating the animal’s call, moo, baa etc. The most difficult animal is the panda. But those who does name it often calls it bear, but it also gets all other names. The children are keen on playing with the animals, but the researcher places them in a row and asks: “Which animal is first in the row and which one is last?”

A: Knows first and last.
B: Knows first and last, but here the last means the animal that follows the first (i.e. the second) to the child.
C: Knows only first.
Table 4: Percentage of children knowing first and last distributed by age groups.

<table>
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<tr>
<th>Problem 4</th>
<th>1.0 – 1.5 year</th>
<th>1.6 – 1.11 year</th>
<th>2.0 – 2.5 year</th>
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Knows first and last shows a clear age trend, although it is very few children also of the oldest who know. It is however about 30% of the oldest children who knows fist.

5. Sorting teddy bears
Most of the children who can express themselves verbally say that these animals are teddy bears or just bears. The children’s different ways of solving the task are:

A: Puts large teddy bears in one box and small in the other.

B: Red in one box and green in the other.

C: The child mixes colour and sizes. There could be 3 in one and 1 in the other, or 2 and 2, but in different colour and size.

D: All teddy bears in one box. When the researcher asks: “Shouldn’t there be any bears in the other box?” the child just dumps all of them in the other box.

All though the researcher tries two or three times to make the children split the teddy bears between the two boxes the children usually repeat what they have done at their first try. It appears that most of the children who are able to sort by colour also had been naming the different colours earlier in the test.
Table 5: Percentage of children sorting bears in different ways distributed by age groups.

This is the task where the age trend is minimal. It is almost as many children sorting after size as after colours. The amount of children who put two bears in each box, without using size or colours is the largest group in all ages. It is around 40% for the three age groups and 30% for the oldest children who put all the bears in one box.

6. Representing ducks on a piece of paper
Most often the children just draw lines or circles on the paper. Sometimes they tell what they have drawn, a boat, their dad etc. However, we have been able to distinguish some ways of acting where they seemingly have started to represent.

A: Draws lines and places the ducks on these.
B: Attempts to draw a line around the duck.
C: Draws on the duck.
D: Just scribbles.
Table 6: Children representing ducks on paper distributed by age groups.

The age trend is also in the above Table clear, although it is very few children who solve the task by drawing a line and put the duck on it. For the other categories there is no age differences. We can also see that the largest group in all ages just scribble.

Discussion

The most interesting aspect of this piece of research is the qualitatively different way described in which children act and relate themselves to the different tasks. In all tasks, except the one with large and small we can find different ways in which children approach the task. It may be that there are different ways also when it comes to comparing large and small, but we could not find it. It is however fascinating to see that also very young children have ideas how to act when they are put in front of specific problems.
We want to point out that almost 50% of the children in age group 2 (aged 1.6 – 1.11), 76% in age group 3 (aged 2.0 – 2.5) and 81% in age group 4 (aged 2.0 – 2.11) know the difference between large and small. It seems to be the easiest problem within basic mathematics, to compare large and small.

When it comes to matching up to 3 and how children solve the task of placing ducks on the dots, the most common is that children pairs ducks and dots, but then continue by adding more ducks to the cards. However, 25% of the children in age group 3 and 37% in age group 4 know numbers up to 3. There are children who obviously also know what the number of dots means, even though we have not categorised that particularly, but we can see some children automatically take three ducks and put immediately on the three dots. In many of these cases, the researcher has also then tried with four dots which some children solved as well. It seems in other way as if some children are not only able to match, but also have a beginning number conception already before they turn 3.

Very few children use the correct number sequence before they are 2.5 years old, but close to 30% of the children in age group 3 and 4 have an idea of counting as something you do by using numerals, but has not yet a correct numeral sequence. One can also see how children spontaneously start count the second time animals are sat up in a raw, and also sometimes when they have the four bears, they start count.

Children have had difficulties in solving the task of knowing the difference between first and last, even though the researcher names to animals: “the cow goes first, then comes the sheep, the bear, and last comes the pig.” 12% of the children in age group 3 and 27% in age group 4 can tell the difference between first and last, while 16% in age group 2 and 27% in age group 4 only can tell which one is first. This means that when children do not have the idea, it does not help to tell them the correct answer since it does not make any sense for them.

In the task of sorting teddy bears by colour or size the children did not show any particular difference in their preferences. Already in age group 1, 11% are sorting by colour and 16% by size. In age group 4, 27% of the children sort by colour and 22% by size. The most common in all age groups is that they put all the teddy bears in one box, at the same time as many solve the problem and divide the four bears in two boxes. Even though the researcher asks children putting all bears in one box, if not someone is going to sleep in the other (empty) box, all of them turn all the bears into the other box.

14% of the children in age group 3, and 24% in age group 4 represent ducks on a piece of paper by drawing a line which they place the duck on. 14% of the children in age
group 3 and 12 % in age group 4 drew a line around the duck, while 12 % in age group 2, 16 % in age group 3 and 10 % in age group 4 are drawing on the duck. It is also interesting to see similar ways to solve the task as older children show, that is to mach a line and and object or to draw around the object (Sinclair et al., 1983).

References


