

WHAT MATHS DO CHILDREN ENGAGE WITH IN SWEDISH PRESCHOOLS?

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In order to better understand the mathematics that preschool children engage in, we categorised the activities made available in one Swedish preschool. Although using Bishop's 6 categories of mathematical activities and Walkerdine's distinction between instrumental and pedagogical activities overcame some of our categorisation issues, they did not solve all of them. Some activities could be included in several categories which brought us back to a discussion about who was making what kinds of distinctions and for what purposes.

Keywords: preschool, Bishop's mathematical activities, instrumental and pedagogical activities.

INTRODUCTION

There is little research on the type of mathematical activities made available either through explicit interactions or incidentally through the provision of physical resources in preschools. In this paper, we discuss the classification of activities, from one Swedish preschool, using Bishop's (1988b) six categories of mathematical activities and Walkerdine's (1988) instrumental and pedagogic tasks. We anticipated that our decisions from this pilot study would contribute to a larger study on what mathematics is in Swedish preschools.

Often the school curriculum with its emphasis on number knowledge has driven the research into mathematics at preschools (see Clarke, Clarke, & Cheeseman, 2006). However, the abstract nature of number terms can mean that they are more difficult to learn than relational terms such as heavy, empty, etc (Hore & Meaney, 2008). Yet, preschool teachers may consider mathematics to be only "sifferskrivning och ramsrakning (writing numerals and reciting counting rhymes)" (Doverborg, 2006, p. 7; our translation). Consequently, although the Swedish preschool curriculum, implemented in 1998 (Skolverket, 1998), included mathematical topics, such as measurement, shape, space and time, there is uncertainty about whether Swedish preschool teachers introduced children to these ideas.

However, trying to determine what mathematics is in preschools, by making distinctions between mathematical activities may be counterproductive. In a study in a Swedish

preschool, Emilson and Folkesson (2006) used the ideas of Bernstein to suggest that, “in the chosen situations we have seen how a strong classification and framing risks restricting children’s participation, and that a weak classification and framing can promote the possibility for children to participate on their own terms” (p. 235-6). Not highlighting distinctions between mathematical topics may allow teachers to more easily adapt to children’s interests. This, therefore, raised the issue of who was distinguishing activities and for what reasons.

COLLECTING THE DATA

The data for our research came from a private preschool in a large city in southern part of Sweden. We had asked to film situations which involved mathematics. Filming was undertaken with different classes/groups over several days in November and December, 2011. Altogether, there were about eight hours of filming, which involved children engaging in activities both indoors and outside. The videos were transcribed.

ANALYTICAL DECISION MAKING

At meetings in December 2011, February and March 2012, at least four researchers analysed all the videos. Each meeting highlighted the need to make decisions about how we were doing the categorisation. The two main decisions were to determine the sort of mathematics that children were engaged with and to determine whether it was important that the children or the teacher perceived the activities as being mathematical ones.

Categorising mathematical activities

Although not acknowledged, the mathematical ideas highlighted in the revised Swedish preschool curriculum are based on Bishop’s (1988a; 1988b) six categories of mathematical activities (see Utbildningsdepartementet, 2010). Bishop saw these categories as universal for any culture and labelled them as mathematics, with a small “m”. The discipline of Mathematics, which he capitalised, included specific versions of the six activities and thus was one kind of mathematics. Bishop’s six categories, therefore, have a different background and focus than the topics often connected with school mathematics, although there is some overlap. The categories were:

Counting. The use of a systematic way to compare and order discrete phenomena. It may involve tallying, or using objects or string to record, or special number words or names.

Locating. Exploring one’s spatial environment and conceptualising and symbolising that environment, with models, diagrams, drawings, words or other means.

Measuring. Quantifying qualities for the purposes of comparison and ordering, using objects or tokens as measuring devices with associated units or ‘measure-words’.

Designing. Creating a shape or design for an object or for any part of one’s spatial environment. It may involve making the object, as a ‘mental template’, or symbolising it in some conventionalised way.

Playing. Devising, and engaging in, games and pastimes, with more or less formalised rules that all players must abide by.

Explaining. Finding ways to account for the existence of phenomena, be they religious, animistic or scientific. (from Bishop, 1988a, p. 182)

By using Bishop's six categories as the basis of the preschool curriculum, the focus could be on the mathematics of children's experiences and interests, which could be considered as small-m mathematics, rather than on what they do not have of school mathematics, considered to be more closely connected to big-m Mathematics.

Instrumental or pedagogical purposes

Another issue was whether the teacher and/or the children needed to recognise the activities as mathematics or whether it was sufficient for us, as mathematics education researchers, to do so. We chose to circumvent the discussion by distinguishing between instrumental and pedagogical tasks. In examining interactions between parents or preschool teachers and their children, Walkerdine (1988) made a distinction between instrumental and pedagogical tasks. Instrumental tasks focussed on achieving a specific aim and included mathematical components only to achieve that aim. Pedagogical tasks had the main purpose of teaching children about mathematics. In analysing the interactions of two mothers and their preschool children Aubrey, Bottle and Godrey (2003) found that one mother embedded the development of mathematical understandings within other tasks, especially her child's play. The other mother provided pedagogical tasks that focused on mathematical understandings in her interactions with her child. Nevertheless, we were aware that Walkerdine (1988) found it difficult at times to assign activities to the different categories and that some exchanges did not fit either category. This was the case when a mother discussed an activity, but without the intention of solving a problem or to teach a child some mathematics.

Consequently, whilst classifying the activities using Bishop's six categories, we distinguished between whether the tasks had a pedagogical or an instrumental purpose. However, we tightened the definitions so that if the main focus was on the mathematics, we classified the activity as pedagogical. When the mathematics was incidental then the activity was classified as instrumental.

In the next sections, we describe our reasoning for choosing 12 activities to represent Bishop's six categories with the two different purposes. Many times, one activity seemed to have features of several categories, both in relationship to the mathematics and its purpose. Hence, even with our tighter definitions, not all activities could be easily classified.

Counting: Instrumental

In an outside activity, the teacher had the children pretend to be magpies and collect five leaves to place them in hoops which were their 'pantries'.

Björn: Jag kan ränka, en, två, tre, fyra, fem

Björn: I can count, one, two, three, four, five.

Lärare: Fem, bra! Nu har ni fem stora löv i ert skafferi

Teacher: Five, great! Now you have five large leaves in your pantry,

The focus of the activity was for the children to find five leaves. However, the child initiated counting aloud and it seemed that it was to help the child know that they had completed the task appropriately. Consequently, we decided that the purpose for the counting was instrumental to the child making sure that he enough leaves.

Counting: Pedagogical

In contrast to the previous activity, in this exchange a child's miscounting of some jars became the focus for the teacher.

Mia: En, två, tre fyra, fem sex, sju. Sju.

Mia: One, two, three, four, five, six, seven. Seven.

Lärare: Sju ... Lena, vill du räkna alla burkarna tillsammans?

Teacher: Seven ... Lena, would you count all the jars together?

Lena: [pekräknar] En, två, tre, fyra, fem, sex, sju, åtta. Åtta

Lena: [pointing] One, two, three, four, five, six, seven, eight. Eight

Lärare: Åtta. [till Mia] Hur många fick du det till, kommer du ihåg det? när du räknade alla tillsammans? [Mia skakar på huvudet]

Teacher: Eight. [to Mia] How many did you get, do you remember? When you counted all together? [Mia shakes her head]

Mia: Sju.

Mia: Seven.

Lärare: Mia fick det till sju.

Teacher: Mia made it seven.

Mia: Nej, jag fick det till åtta.

Mia: No, I made it eight.

Lärare: Aha, du fick det till åtta.

Teacher: Ah, you made it eight.

By asking another child to also count the jars, the teacher seemed to want to contrast the two answers and thus problematise the first count. Although the original counting was child initiated, the teacher's intervention changed the purpose of the activity. However, when the child changed her answer to eight, the teacher did not pursue her pedagogical goal.

Measuring: Instrumental

When playing outside, two children described their mittens using a range of different measurement terms.

Leo: Nu är dom varma

Leo: Now they are warm.

Lärare: Är dom varma?

Teacher: Are they warm?

Bo: Mina vantar är, är tjocka

Bo: My mittens are, are thick

Lärare: Är dom där borta?

Teacher: Are they over there?

Bo: Och varma

Bo: And warm

Lärare: Är dom varma där?

Teacher: Are they warm there?

Bo: Och tjocka, tjocka och varma, dom tunna [vantar] är inne.

Bo: And thick, thick and warm, the thin [mittens] are inside.

For the children, the warmth of their mittens is something to be discussed. This is an occasion, such as was described by Walkerdine (1988), where the purpose of the activity is not to solve a problem or to learn mathematics, but to make comments. We, therefore, considered the use

of measurement terms to be part of providing the descriptions. Consequently, we classified the activity as being instrumental. However, the teacher's questions suggest that she may have wanted to focus more on these terms. Nevertheless, as was the case in the previous example, the teacher allowed the conversation to move quickly to something else and did not try to hold the children's attention to the mathematics.

Measuring: Pedagogical

After a child had filled a bucket up with sand, the teacher asked what he wanted to do next. In so doing, the amount of sand and how heavy it was came into focus.

| | |
|--|---|
| Lärare: Vad ska vi göra nu med hinken? | Teacher: What shall we do now with the bucket? |
| Viktor: Platta | Viktor: Flatten |
| Lärare: Platta den? ... Så vad betyder det? | Teacher: Flatten it? ... So what does that mean? |
| Viktor: Vända. | Viktor: Turn |
| Lärare: Vända den? Hur ska vi göra det då? | Teacher: Turn it? How do we do that then? |
| Viktor: Vända. | Viktor: Turn. |
| Lärare: Ska vi prova, ska du prova? Oj, var den tung eller lätt? | Q: Shall we try, shall you try? Oh, was it heavy or light? |
| Viktor: Tung. | Viktor: Heavy. |
| Lärare: Tung. Hur ska vi då göra då? Hur ska vi kunna vända när den var så tung? Har du nåt förslag? | Teacher: Heavy. What shall we do then? How shall we turn it when it is so heavy? Have you some suggestions? |
| Viktor: Ta ut lite | Viktor: Take out a little |

This was a difficult activity to categorise. In the interaction, the focus became the relationship between the amount of sand in the bucket – the sand's volume - and how heavy the sand was. However, the child's wish to turn the bucket upside down suggests that the mathematics was incidental rather than the main focus. The teacher queried the child about his interpretation of what he was doing, but it was the child who came up with the solution of emptying some sand out of the bucket. It may have been that it was only the teacher who recognised the pedagogical point of highlighting the relationship between the heaviness and the volume of the sand as well as trying to extend the child's ability to explain their thinking. The activity could be classified both as measuring and explaining but also as pedagogical and instrumental, depending upon whether it was the teacher or the child's perspective which was taken.

Locating: Instrumental

As shown in Figure 1, moving toy vehicles around involves children locating, themselves, other objects and the vehicle. The mathematical activity of locating, thus, is instrumental for achieving the aim of keeping the truck moving.



Figure 1: Driving a truck

Locating: Pedagogical

Whilst playing outside, one toddler climbed onto a bench and walked back and forth along it. Figure 2 shows the child requesting assistance to get down by raising her arms to the teacher. When the teacher did not immediately pick the child up, the child clambered down after first gauging how far down she had to go. Exploration of space is a feature of location activities. Although there was no teacher actively involved, we consider that locating was the main focus of the activity and so it had a pedagogical rather than instrumental purpose. She was developing a sense of ‘on’, ‘along’, ‘above’, ‘up’ and ‘down’ which at later date could be given verbal labels. Further research is needed to explore how non-verbal experiences are connected to being able to talk about them.



Figure 2: Walking along a bench

Designing: Instrumental

Figure 3 shows two girls using sand and twigs to make a mini-garden. Again, the verbal interaction was minimal. One girl focused on building up the sand around the base of the twig whilst the other girl was interested in a broken branch that was connected to the twig and how she could arrange it by moving it around. Bishop (1988b) stated that “the essence of designing is transforming a part of nature” (p. 39) and this would suggest that this activity was a pedagogical one rather than an instrumental one. However, we chose to classify this activity as instrumental as the main purpose seemed to be exploring the sand and twigs, with the garden design arising spontaneously from this exploration. This is in contrast to the previous activity where the child walked along the bench and deliberately seemed to be exploring spatial orientation, suggesting that her purpose was pedagogical.



Figure 3: Making a garden

Designing: Pedagogical

When collecting leaves, the teacher asked the children to describe the shape of one of them. This extract is just a small part of the exchange where the teacher prompted the children to use a range of terms to describe the shape.

Lärare: Hur många kanter har det?

Kerstin: En, två, tre, fyra, fem.

Lärare: Ja, det är femkantigt.

Per: Det har en, två, tre.

Lärare: Det här då? Har det några kanter?
Vilken form har detta lövet?

Annika: Det är platt (otydligt) och så är den rak.

Lärare: Platt och rak ja, vilken form har detta lövet då Annika?

Teacher: How many edges does it have?

Kerstin: One, two, three, four, five.

Teacher: Yes, it is pentagonal.

Per: It has one, two, three.

Teacher: This then? Does it have any edges? What shape has the leaf?

Annika: It is flat (inaudible) and also it is straight.

Teacher: Flat and straight so, what shape has this leaf then Annika?

Although she used one of the children's leaves as the stimuli, the teacher had a clear pedagogical purpose in drawing the children's attention to different features of the leaf. The activity is not about exploring but about using their mathematical words and understandings to respond to the teacher's requests for descriptions. The teacher knows the answers to her questions and the expectation is that the children will show what they know. In this way, the teacher ensures that the mathematics is at the centre of the exchange.

Playing: Instrumental

The teacher set up a game for determining equivalent sets by first turning the children into magpies and some plastic hoops into nests. The rule of the game was that the children had to fly to nests so that every nest had the same number of magpies.

L: Nu, förvandlar jag er, hokus, pokus, filiokus, till skator. Alla små skator varsegod och flyg in i ett bo. Var ska du flytta in Nils? Två skator som inte har flyttat in. Flytta in, flytta in i ett bo, Hans. Sådär ja, jag är den som ska tala

L: Now I change you, hokus, pokus, filiokus, into magpies. All small magpies, here you are, fly into a nest. Where are you moving to Nils? Two magpies that have not moved in. Move in, move into a nest, Hans. Like that,

om vad skatorna ska göra, men är vi lika många i alla bona?

yes, I'm the one to tell the magpies what to do, but are there an equal number in all the nests?

This was a fantasy game which had rules that the children had to follow if they were to participate. At least for the teacher, being magpies was instrumental for achieving the main focus which was on making equivalent sets. However, for some of the children flying around as magpies was a more important focus.

Playing: Pedagogical

On one occasion outside, the teacher arranged the children in a circle. The teacher asked the children to explain how to play a game, where they had to pass a squeeze from hand to hand around the circle.

Lärare: Hur går detta till nu Elen?

Teacher: How does this work now Elen?

Elen: Det var inte roligt att trycka löst

Elen: It was not fun to push loosely

Lärare: Ja, genom vanten precis som Emma gör. Där får man nog trycka lite hårdare. Kan du berätta för alla hur man gör? För alla har nog inte varit med [...] Kramar man med båda händerna samtidigt? Man trycker med den ena handen? Man trycker inte när som helst va? Hur går det till då?

Teacher: Yes, through the mitten like Emma does. There you can probably press a little harder. Can you tell everybody what to do? For all have probably not participated [...]. Do you hug with both hands at once? Press with one hand? One does not press at any time, right? How does it work then?

Emma: Du har berättat allt

Emma: You have told us everything

In this activity, the rules of the game were the focus and the discussion of them had a pedagogical purpose to ensure that everyone knew what to do. It may also have been that the teacher had wanted the children to explain the rules but her own comments meant that the children did not feel there was anything for them to explain.

Explanations: Instrumental

When outside the children collected ice from a frozen puddle and showed it to the teacher. One child stated she would not collect any more ice and the teacher asked why.

Barbro: Nu vill inte jag ta mer is.

Barbro: Now I will not take more ice.

Lärare: Varför då?

Teacher: Why?

Barbro: För jag blir smutsig.

Barbro: For I will get dirty.

Lärare: Blir du smutsig?

Lärare: Do you become dirty?

Barbro: Och kall.

Barbro: And cold.

Lärare: Och kall. Man bli iskall när man tar i is.

Teacher: And cold. One gets ice cold when one holds the ice.

For the child, her explanation was incidental to not picking up any more ice and thus the exchange was classified as instrumental. However, by repeating the child's answer, the teacher may have had a pedagogical purpose in asking for an elaboration of the explanation.

Explanations: Pedagogical

On some occasions, the teachers gave a specific explanation and this became the focus of the activity. At the beginning of a day of filming, the teacher began by explaining mathematics to the children.

Lärare: Vet ni vad barnen? I dag ska vi ha matematik. Vad är matematik? Matematik är såna (otydligt) som jag ha på fingrar och fötterna (otydligt) ... Den var liten, och sen så hade ju mamma såna här stora så vi mätte ju dina burkar för det var olika storlekar på dem, det är matematik. Matematik kan vara jättemycket, man kan räkna som vi gjorde, man räknar barnen till exempel: en, två, tre, fyra, fem. Det kan vara matte.

Teacher: Do you know what children? Today we have mathematics. What is mathematics? Mathematics is like (inaudible) that I have on the fingers and feet (inaudible) ... It was small, and then mum had like these big, so we measured your cans since there were different sizes of them, that is mathematics. Mathematics can be a lot, you can count as we did, you count the children, for example: one, two, three, four, five. It can be maths.

This explanation was not instrumental in achieving another purpose but was the main focus. However, the children would not have learnt what features constituted an explanation from simply listening to the explanation. This is in contrast to the pedagogical playing task where, from listening to the teacher's instructions, the children would have learnt about the need to follow rules to play a game. In our data set, there were no examples of the children being introduced to the features of an explanation. On the other hand, there were many occasions, such as the pedagogical measuring task where the teacher's questions prompted the children to provide or elaborate on an explanation. Thus, the children may have learnt implicitly what the features of an explanation were.

CONCLUSION

The pilot study indicates that children at this preschool had opportunities to engage in different mathematical activities. Our expectation was that we would see many activities involving learning to count as had been suggested by Doverborg (2006). Although counting did feature, it was not the only activity that the teachers provided after we had asked specifically to film mathematical activities.

Nevertheless, categorising the activities was more difficult than we had originally anticipated. Many activities seemed to have more than one mathematical focus and often it was difficult to be certain whether the activity was an instrumental or pedagogical one. In some case, the teacher and the child may have had different perspectives. When the children described the warmth of their mittens, they may have wanted simply to open up a discussion with the teacher. On the other hand, the teacher may have had a pedagogical purpose in asking questions that not only continued the conversation, but kept the focus on measurement terms, about thickness and warmth. Both the child and the teacher also used terms, such as "over there" and "inside", suggesting that a minor mathematical theme was location. Generally, pedagogical tasks were directed by a teacher but this was not always the case. In the

pedagogical location activity, teacher involvement was minimal and the child was the one who structured the activity so that the focus was on location. It may be that activities with both pedagogical and instrumental purposes support children to become aware of and use mathematical language. Klibanoff, Levine, Huttenlocher, Vasilyeva, and Hedges (2006) found that the amount of mathematical talk by preschool teachers correlated with their children's growth in conventional mathematical knowledge, although for them this was knowledge about number.

However, our difficulties in categorising the activities bring us back to the question of who is doing the classification and for what purpose. It may be that we need to think carefully about our reason for doing the classification and how our choices will influence what we can discuss when trying to describe the mathematics in Swedish preschools.

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