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Distributed authority and opportunities for children's agency in mathematical activities in kindergarten

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The aim of this study is to investigate to what extent authority is distributed and opportunities for children's agency in mathematical activities. We are drawing on a sociocultural perspective on learning to analyse the distribution of authority among kindergarten teachers and children and exercise of agency in various mathematical activities in the kindergarten. Our analyses show that authority is distributed to some extent, through questioning and opening for children's contributions. Moreover, opportunities are given in which children exercise conceptual agency with respect to mathematical reasoning concerning geometrical shapes and measurement.

Keywords: Kindergarten, agency, authority, mathematics.

INTRODUCTION

Mathematics has not been explicitly mentioned in Norwegian curriculums for kindergartens until 2006 (Ministry of Education and Research, 2006). The 2006 curriculum emphasises that the children are supposed to develop their mathematical competence through play, experimentation and daily activities, and that the kindergarten teachers (KTs) are to facilitate and empower children's mathematical explorations. Today the KT's are supposed to be able to address mathematics as a subject in their daily enterprise. It is therefore of interest to study in what ways kindergarten teachers orchestrate mathematical activities in order for the children to engage in the mathematics.

This was the background for our investigation of how mathematical activities were organised, to what extent mathematics was the core of the activities, who was in charge of the mathematical content of the activities, to what extent the children had opportunities to ap-

propriate mathematical concepts, and so on (see, e.g., Carlsen, 2013; Hundeland, Carlsen, & Erfjord, 2014). We have documented elsewhere (Erfjord, Carlsen, & Hundeland, 2012) evidence of a shift in the studied kindergartens regarding the didactic triangle characterising the kindergartens' enterprise; from a situation where a pedagogical activity (PA) was initiated with minimal mathematical input, to a situation where mathematics became the focal point in the activity – a so-called mathematical pedagogical activity (MPA). One important argument for this shift was found in the KT's roles as mathematically competent adults and leaders of these activities.

In the study reported here, we thus had an initial hypothesis: In order for the mathematical activities to become effective with respect to mathematical outcome and experience on behalf of the children, the KT's have to distribute authority and facilitate children's exercising of agency in the adult-child interaction. Furthermore we had an initial hypothesis that if the KT's distributed authority amongst themselves and the children, the learning activities may gain flexibility and children initiatives, but may suffer from less mathematically goal-directed actions. This may lead to a situation where a planned MPA in effect becomes a PA. From these hypotheses we formulated the following research question:

In what ways is authority distributed amongst kindergarten teachers and children in the observed mathematical activities, and in what ways are opportunities created for the children to exercise agency?

Agency is something that constricts or permits what one is free to do in a given situation. This question thus addresses an under-researched and important

area in mathematics education, both the focus on distributed authority and exercising of agency as well as our focus on mathematical learning activities in the kindergarten setting.

Several studies during the last decade have documented the mathematical learning opportunities offered for children when they are participating in MPAs (see, e.g., Carlsen, 2013; Clements & Sarama, 2009). These studies document that learning opportunities are indeed offered for children in the kindergarten setting. Moreover, the children are nurtured in their ongoing process of appropriating mathematical tools when participating in MPAs. However, none of these have focused particularly on the interaction between KTs and children with respect to distribution of authority and agency.

AUTHORITY AND AGENCY

In order to address the research question, we adopt a sociocultural perspective on learning and development (Rogoff, 1990; Wertsch, 1998). Within this perspective interaction amongst adults and children as well as the use of tools are acknowledged as fundamental elements constituting the learning process. Tools such as mathematical language, paper and pencil, concrete materials, etc. are used as mediating artefacts in order for persons to communicate and interact in collaborative settings. In our study there are thus two main concepts that need a clarification, authority and agency. Cobb, Gresalfi, and Hodge (2009) define authority as “the degree to which students are given opportunities to be involved in decision making about the interpretation of tasks, the reasonableness of solution methods, and the legitimacy of solutions” (p. 44). Authority is thus a term used to address who is responsible when it comes to making mathematical contributions to an on-going problem-solving process. In our use of the term agency, we are following Lange (2009), that human agency is a term used about a child's “faculty to act deliberately according to one's own will and thus to make free choices” (p. 2588).

In order to align the view of authority, agency and a sociocultural perspective on learning, we are drawing on the work of Cobb and colleagues (2009) and their analysis of students' possibilities to exercise agency in particular classrooms. According to these authors, there are two aspects that are of importance when it comes to effectiveness in supporting mathematics

learning; distribution of authority and opportunities for students to exercise agency. Furthermore, Cobb and colleagues (2009) argue that authority is closely connected with students' possibilities to exercise agency. According to Pickering (1995), agency concerns in what respect an individual's actions are emerging from free will or are influenced by others. Attributes of classic human agency are thus choice and discretion. Cobb and colleagues (2009) follow Pickering (1995) and differentiate between two forms of agency, i.e. conceptual agency and disciplinary agency. Conceptual agency is about “choosing methods and developing meanings and relations between concepts and principles” (Cobb et al., 2009, p. 45), that is attributes familiar within human agency. Pickering (1995) introduced the term disciplinary agency to emphasise that agency, when exercised within a conceptual practice like mathematics, is closely connected to the discipline in which it unfolds. In mathematics it is about employing established methods. According to Pickering, disciplinary agency is thus a specific disciplined pattern of human agency, e.g. routines with respect to symbol manipulations like $a(b + c) = ab + ac$. The notion of disciplinary agency then describes human passivity within a conceptual practice. Disciplinary agency thus “leads us through a series of manipulations within an established conceptual system” (p. 115).

Based on these notions of conceptual agency and disciplinary agency, Cobb and colleagues (2009) argue that in order for mathematical learning processes to be supported effectively, authority has to be distributed and students ought to be given opportunities to exercise conceptual agency. This argument is supported by Boaler and Greeno (2000) as well. Their study reveals that students need to be given possibilities to participate as creative agents in the mathematics classroom in order for mathematics teaching to be effective. Moreover, Boaler and Greeno argue that students need to be given possibilities to use their own language, to be given chances to think for themselves, to be given chances to make own interpretations and decisions.

Additionally, Cobb and colleagues (2009) argue that experience in exercising conceptual agency is needed in order for students to be able to reason about the usefulness of disciplinary tools in problem-solving processes. If authority is kept with the teacher, students are only offered possibilities to exercise dis-

ciplinary agency. Within a conceptual practice, like doing and learning mathematics in a kindergarten setting or in a mathematics classroom, there is therefore what Pickering (1995) refers to as a dance of agency. Conceptual agency and disciplinary agency may be intertwined and alternately take a lead. In our study the KT, the child, and the conceptual practice, i.e. a mathematical pedagogical activity (MPA), influence one another. We thus suggest talking about such activities as situations where authority may be distributed amongst the actors, giving each of them opportunities to act and exercise agency. When orchestrating a MPA, the KTs may have intentional learning goals of their mathematical activities. But since authority is distributed amongst adults and children, opportunities may be given for children to participate and possibly exercise conceptual agency.

The notions of authority, conceptual agency and disciplinary agency are used by Cobb and colleagues (2009) within a school context. As argued elsewhere (Erfjord et al., 2012), the Norwegian school context and kindergarten context differ to a large extent, both with respect to the nature of the two curriculums and with respect to organisational and structural nature. It is thus relevant to discuss how these notions may be employed in a Norwegian kindergarten context. Since kindergarten children are young and less autonomous than their counterparts in school, a KT may distribute authority in a different way than a teacher in school. The KT orchestrates mathematical pedagogical activities and she thus has most of the authority. However, she may ask the children several questions, suggest actions, asking for their opinions, their thoughts and ideas, asking for arguments and so on. In doing that some of the authority is distributed to the children, putting them in the position of being in charge for the mathematical interaction, how and in what direction this process may evolve. Nevertheless, as we will see from the analyses below, there is no doubt that the KTs have most authority in the cases we present.

To sum up, we use the term authority in line with Cobb and colleagues (2009), as something that may be given to others. In our case authority is given by the KTs to the children. When authority is given, opportunities are created in which children may exercise agency. However, as we will see, the children do not always take advantage of those opportunities to unfold their agency.

METHODS

Our study may be described as having a collective case study design (cf. Stake, 2000), because we study a number of cases in order to investigate the phenomenon of distributed authority and exercising of agency within MPAs in kindergartens. We were invited to kindergartens when the KTs argued to be orchestrating MPAs. These activities were videotaped. We analysed data from three kindergartens, and in this paper we present four illustrating excerpts to address the research question formulated for this study. We studied situations that from the outset were orchestrated by the KTs. Thus, the planned activities were led by the KTs and it was primarily the KTs that had the authority in the activities. Hence, the children's opportunities to exercise agency were limited. However, we seek to analyse to what extent authority was distributed, even though authority was mostly kept with the adults.

Our analytical process may be described in the following way: Firstly, we carefully analysed the conversations and actions between the KT and the children, paying attention to how the MPAs were orchestrated by the KTs. In doing that, we had the following questions in mind: Did the KTs invite the children to interpret the tasks? Did they accept and use the children's own wording of the situations, choices and actions to solve the tasks? The KTs actions indicate to what extent they distributed the authority in the MPAs to the children. Secondly, after having identified occasions where authority was given to the children, our next step was to analyse whether the children used their freedom to handle the situation based on their own free will. That is, whether they were able to exercise their agency in order to solve the tasks. Our attention was now particularly focused on the children's actions, whether they responded orally with own thoughts and actions or whether they only waited for the KT's suggestions. Thirdly, in order to study the distribution of authority, we paid particular attention to the teachers' conversations with the children. Did the KTs use suggestions or instructions? Did the KTs organise the MPA in a way that gave the children opportunities to act based on their own ideas? How did the KTs respond when the children presented their own ideas and acted in their own way? Fourthly, our analysis of the children's exercising of agency included paying attention to what the children did in the situations where authority was distributed. Did the children solve the problem using their own

ideas? Did the children use their own language in their problem-solving process?

ANALYSIS AND RESULTS

The analyses in this study comprise excerpts from three kindergartens. The first excerpt is taken from Duckling kindergarten in which four children and one KT participate and where the mathematical theme is measuring. Excerpts 2, 3, and 4 are taken from Pinocchio kindergarten. Six children of age 4–5 years and three female adults were involved in planned activities with the children. The common theme for these activities was geometrical shapes: triangles, quadrilaterals and circles.

Excerpt 1

A group of 4–5 year-old children went on a forest trip together with their KT. When they arrived at the place where they used to stay, the KT gave four children the task to find themselves one tree each. Then she asked:

KT: Whose tree do you think is the thickest one?

Birger: Pedro's (5 sec.)

KT: Pedro's. Maybe you can try to hold your arms around the tree, like this (holds her arms as if she is folding a tree). Which one do you think it is? Do you think it is Pedro's tree? Can you imagine how we may find out whether it actually is Pedro's tree that is the thickest one?

Lisa: Because it looks so big
(The four children are holding their arms around their tree)

KT: Because you think it looks so big.

Birger: I fold the tree like this (he holds his hands around the tree)

KT: You fold it like that. Do you think there are other ways to find out whose tree is the thickest? How can we find out whether your tree is the thickest (Looks at Pedro)? Because that was what the others thought, that your tree is the thickest. How can we find out whether Pedro's tree is the thickest? Do you have any idea?

In this excerpt the KT seeks to distribute authority amongst her and the four children. She invites them into a discussion where they are supposed to reason

about thickness of trees. The KT challenges the children to come up with their own ideas and opinions. The problem is how to compare thickness of trees. It is apparent from the excerpt that the children experience difficulties in responding to the KT's question. However, Lisa argues that it is Pedro's tree that is the thickest one because it looks so big.

The KT invites the children to contribute with their opinions. Authority is to some extent distributed between her and the children, when she asks the children to come up with their ideas with respect to deciding whether Pedro's tree is the thickest one. The children are supposed to compare thickness of the trees with their arms.

The children are given authority at various occasions. However, the children do not seem to exercise agency due to the difficulty level of the challenge given by the KT.

Excerpt 2

This dialogue took part in a sharing time with the children and the adults in a reserved small room. After a brief introduction where the KT gave the theme for the day, triangles, quadrilaterals and circles, she started off by giving the children a task:

KT: Can you see any shapes in this room?
(The children move their heads and look around in the room)

Clara: I can see a "rounding" (The child points to one of the walls in the room)

KT: Where can you see a "rounding"?

Clara: There! (She points to a transparent plastic box, where a cross section of a rolled up poster has a circular shape)

KT: Yes. Great.

This kind of interaction pattern, with suggestions from the children and confirmation or clarification questions from the KT continued for a while. The authority is handled by the KT in the sense that she has organised the activity, and she takes decisions during the session concerning what are being discussed and how the topic is investigated. Also the agency is mainly with the KT. However, the KT's acceptance of the child's vocabulary, as for example the use of words as "rounding" for circle and "circle" for a cylinder, indicates that she transferred authority concerning way to express mathematics from her to the child. In oppo-

site way she could have corrected the child's incorrect mathematics naming of the figures. The KT's invitation to the children looking for geometric shapes in the room, also gives some authority to the children in the meaning that they can select what to point at. As a consequence the object that is being discussed and interpreted as a triangle, quadrilateral or circle are chosen by the children.

Excerpt 3

This excerpt is from an activity that took part on the floor. The KT had prepared a closed cardboard box containing different shapes. On the floor three A4 sheets with big sketches of respectively one triangle, one quadrilateral and one circle were placed. The task for the children was to put their hand into the box and choose one of the shapes, describe the selected shape without looking at it, and finally place the shape on one of the sheets according to its shape. The KT asked one child at a time to do the task, and she interacted with questions to the child. One example of such interplay is the following:

- KT: It is your turn, Vicky
 Vicky: (Uses a couple of seconds to select one item from the box)
 KT: What have you found, Vicky? (She holds a ball in her hand within the box)
 Vicky: A bouncing ball (She shows the ball and bounces it at the floor)
 KT: What kind of shape has the bouncing ball?
 Vicky: A rounding
 KT: A rounding, yes. Can you place it on the "rounding" at the floor?

Compared with the activity analysed in Excerpt 2, this activity gives less possibility for alternatively solutions. In this sense the KT keeps her authority. However, the activity gives the children a possibility to describe the geometrical shape, firstly based on their tactile sense and secondly based on what the child see and is doing with the shape. Thus, the children have some freedom to describe this shape with their own wording. Similar to the activity above, the KT accepts the child's vocabulary when the child labels a spherical ball as being "a rounding". The KT also uses the child's label when she asks the child to place the "rounding" on the floor. The fact that the KT had selected a spherical shape, despite asking them to categorise the shapes as two

dimensional (triangle, quadrilateral and circle), indicates that the KT probably intended the child to categorise the ball as a "rounding" or "circle".

Excerpt 4

This excerpt is taken from an outdoor activity which involved a walking trip up to a church close to the kindergarten. The children got one sheet of paper each with three columns headed with pictures of respectively a triangle, a quadrilateral and a circle. The children were asked to put a vertical mark in the correct column each time they discovered a thing with the particular shape. A road sign outside the kindergarten was one of the first thing noticed by the children. The road sign had a quadrilateral form with an inscribed triangle. The following talk took part between two of the children and one of the adults:

- Clara: See the road sign
 KT: Yes, What kind of shape is this?
 Clara: A quadrilateral.
 KT: Yes. Put a mark there (The KT points with her finger at the column "quadrilateral" on their sheets. The two children make a mark on their sheets in the correct column).
 KT: Can you see any more shapes on the road sign? (The children remain quiet for four seconds)
 KT: One - two - three (while the KT counts loudly, she points counting with fingers headed to the road sign). Can you see the shape within the road sign?
 Ida: A triangle.
 KT: Yes. Great. Put a mark under «triangle» on your sheets.
 (The two children put a mark on the correct column in their sheets)

In this activity we observed several similar examples to the one above where one or two children talked and got some help from one of the adults. In the activity, the children had been offered authority in deciding shapes and categorisation in the three types suggested by the KT in the sheet. The interaction pattern is similar to what we found in Excerpt 2, However, the outdoor area opens up for more options of things to categorise than the small room in Excerpt 2. The children's possibility to take the agency is bigger, and the KT has less possibility to prepare the activity in the

open outside environment. However, several times during the outside activity, the KT asked the children as a group to look at particular things like a circular brick area outside the church. Such interventions gave more authority to the KT with an emphasis on particular things shaped as triangle, quadrilateral or circle.

DISCUSSION

We set out in this study to answer the following question: In what ways is authority distributed amongst kindergarten teachers and children in the observed mathematical activities, and in what ways are opportunities created for the children to exercise agency? The four excerpts show how the authority is distributed between the KTs and the participating children. The excerpts also exemplify how the children exercise their agency by participating in the mathematical learning opportunities that occur in MPAs.

In excerpt 1 the KT collaborates with the children in order to find out whose tree is the thickest one. The children come with various responses and the KT notices them and gives a response back, as paraphrasing and with a new question. The excerpt is characterised by the children's involvement in the activity, even though they are not so verbally active. The KT lets the children imagine what they think, to estimate thickness of trees, as well as to come up with reasons for their ideas. This shows that the children are given mathematical authority in this case and that they exercise conceptual agency. They are given opportunities to participate and to give directions for the MPA. At the same time we observe that the KT is in charge of the activity. She controls the activity by actively asking questions to all children at the same time, but also individually.

However, our observations show a variety concerning the KTs' distribution of authority to children and to what degree children exercise agency during their participation in learning activities. In excerpt 2, 3, and 4, the distribution of authority is limited inside a planned frame for the activities. It concerns children's oral response to questions, selections of certain objects or participation in well-defined physical actions. The KT invites the children to take part in these actions, and it seems reasonable to argue that the children perceive this participation as voluntary. In that way we conclude that the children seem to ex-

ercise agency. However, it is also clear that the KT controls the activity, and does only allow responses that support her goals for the activities.

In the situations where authority is distributed to them, the children get opportunities to exercise conceptual agency. That is, the children contribute with ideas and arguments that may strengthen their opportunities to develop mathematical meanings and relations (cf. Boaler & Greeno, 2000; Cobb et al., 2009). As we saw, there is not so much disciplinary agency to be found in the analysed cases. That is, however, not surprising, given the Norwegian kindergarten's enterprise of being process oriented and situated within a social pedagogical tradition. Thus, disciplinary agency as the use of "established solution methods" (Cobb et al., 2009, p. 45) is not that prevalent in the kindergarten since these methods to some extent do not exist in any readymade matter.

We argue that authority, and hence, agency, ought to be distributed carefully within MPAs in order for the children to become supported in their mathematical learning process. Opportunities to exercise conceptual agency are needed, but the KTs need to orchestrate the MPA in such a way that the children are able to exercise agency. At the same time the KTs ought to control the activities in order to possibly reach mathematical learning goals. This is needed due to the limited mathematical experience of the children.

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