HOW FAMILIES SUPPORT THE LEARNING OF EARLY YEARS MATHEMATICS

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This paper is based on the assumption that parents are of prime importance for their children's mathematical development. It gives account of a study that focuses on the question of how families support the learning of early years mathematics. Thereby, everyday playing and reading sessions with pre-schoolers and their mothers are the context of investigation. By means of three very short trancripts from these sessions, different kinds of support systems will be reconstructed. In particular, the research question is about the aim of the support system: What is the support system focused on? The related analyses show the diversity in young children's mathematical experiences.

Keywords: family, Mathematics Acquisition Support System (MASS), support job

INTRODUCTION

Although the discussion about early years mathematics is often confined to institutional contexts a holistic perspective challenges us to keep not-institutional contexts in mind, too. When thinking about early learning processes, the family is one of the most important places to be recognized. For the young children spend much of their time with their parents, observe them and become step by step a member of their culture (Warren & Young 2002). As a consequence, the young learners become amongst other things a part of their parents' mathematical culture as well. For this reason, the family cannot be ignored as a context of particular importance for questions about early years mathematics.

This opinion is confirmed again by Street, Baker and Tomlin (2005) who conducted a large study in Great Britain about home and school numeracy practices. One of their central results is that learning difficulties might arise from differences between home and school discourses. The researchers explain that for some children there is a gulf between these contexts: "The school replicates the Primary Discourse of middle class homes whilst it presents children from other backgrounds with a Secondary Discourse." (Street et al. 2005, p. 7) According to the authors, many children are restricted in their prospects to succeed in mathematics education because they are confronted with a problem of discourse: The switch between home and school discourses can be difficult because of different values, rules and patterns (ibid., p. 44ff. and 70ff.). This result exemplifies why research about families is also important with regard to institutional contexts. Everyone who wants to teach children mathematics has to know about their earlier ways of learning mathematics to avoid difficulties:

> "If children are frequently presented with tasks which are unconnected with their earlier ways of knowing about mathematics, they may come to reject it and to begin to feel that they are failing." (Pound 2006, p. 20)

In summary, it can be said that the families' support of learning (early years) mathematics is of prime importance for the children's development. While we already know something about *what* children learn in the familial context (Blevins-Knabe 2008, S. 2; Blevins-Knabe et al. 2000, S. 50; Anderson 1997, S. 492), we know only a little about *how* they learn it.

> "Studies of the processes by which parents encourage early numerical development in the context of parent-child interactions during routine, culturally relevant activities at home are scarce." (Vandermaas-Peeler, Nelson, Bumpass & Sassine 2009, P. 67)

For this reason, in my research, I focus on the question of how families support the learning of early years mathematics. With this question in mind, I observed mother-child-dyads in game playing and reading sessions at their homes for a number of times in the course of a year.

THEORETICAL FRAMEWORK

In studying early years mathematics, we necessarily do it with a certain conception of what learning mathematics is all about. In my opinion, children do not encounter mathematics itself, but a cultural practice that is recognised as mathematical by capable member of the belonging culture (see Sfard 2006). In other words, I regard mathematics as a social construction and learning mathematics as a social construction too. This idea of learning is explicitly described in Sfard's theoretical work. She defines learning mathematics as "individualizing mathematical discourse, that is, as the process of becoming able to have mathematical communication not only with others, but also with onself." (Sfard 2006, p. 162) Against this background, supporting the learning of early years mathematics means to help young children becoming fluent in a mathematical discourse.

Concerning the support, I draw on the notion of support as it was developed by Bruner (1983) and Rogoff (1990). Bruner worked on the question of language acquisition in the very early years of a child's life which was for him mainly a question of culture acquisition. Assuming that a child primarily has a need for social contact, Bruner supposed that he has to learn his mother tongue in order to become a part of the given culture and, in this way, to relate to people around, first of all to his mother. In this context, Bruner postulates the existence of a so-called *Language Acquisition Support System* (LASS). This support system is established by a child and his mother and is realised in the form of 'formats'. Here, a format is "a standardized, initially microcosmic pattern between an adult and an infant that contains demarcated roles that eventually becomes reversible" (Bruner 1983, p.120). The adult-child-dyad creates "a predictable format of interaction that can serve as a microcosm for communicating and for constituting a shared reality" (ibid., p. 14).

Bruner sees this kind of interactional and recurrent support as a condition for the child's learning. Being part of the LASS, the child becomes part of the adult's culture and, in doing it, he learns his mother tongue. According to Bruner, an increasing autonomy within the support system can be understood as an indicator for learning progress. From my point of view, the important aspect of Bruner's concept is to understand support as a support system, that means as something that is established by at least two persons. Therefore, support is not any longer an individual achievement of the mother but a certain kind of format that is established by the interlocutors. The child reacts on what the mother does and vice versa. In this way, a mother-child-dyad creates a support system that helps the child to become part of the given culture. Transferring this notion of a support system to the field of mathematics education, I assume that families establish a support system for mathematical learning processes by means of their everyday discourses. In dependence on the LASS-concept, I refer to it as a *Mathematics Acquisition Support System* (MASS).

It was Rogoff (1990, 1989) who pushed the interactional equality of adults and children even more to the spotlight than Bruner did:

> "The mutual roles played by children and their caregivers rely both upon the interest of the caregivers in fostering mature roles and skills and on children's own eagerness to participate in adult activities and to push their development." (Rogoff 1989, p. 209)

Rogoff (1990) calls the process of becoming a competent participant in a specific type of discourse 'appropriation'. In that way, she emphasizes that learning and support of learning take place within social activities and are something different than a cognitive individual performance. In the process of appropriation, children "can carry over to future occasions their earlier participation in social activity." (Rogoff 1989, p. 213). In regard to a MASS, this means that the child supports his learning as much as the mother does. Support systems are projects of cooperation. By the way, this is the reason why the title of this paper is "How families support…" and not "How parents support…" The children themselves should be included in the group of persons who support the learning of early years mathematics. Against this background, I understand a MASS as a condition for processes of appropriation.

One could think of many investigations concerning this MASS. In this paper, the function of the MASS is investigated as it is realised in mother-child-discourses in everyday playing and reading sessions: What is ensured by the MASS? What is the MASS focused on? In order to clarify the theoretical perspective for this specific research question, I refer to a study conducted by two German linguists: Hausendorf and Quasthoff (2005) reconstruct how children's competences in telling a story as part of a conversation develop in the course of time. At the same time, the researchers investigate how this development is influenced by an emerging support system. In terms of this object of research, the authors follow Bruner (1983) and his idea of a LASS. For this reason, they describe the support processes as a *Discourse*

Acquisition Support System (DASS). Although I neglect their specific linguistic findings, in my opinion, one special theoretical element that they developed is really helpful to my concern. Hausendorf and Quasthoff talk about so-called 'jobs' in order to describe empirical phenomena. Here, 'job' is a structural task that has to be mastered when a story should be told as part of a conversation (ibid., p. 124). 'Picking something out a central theme', 'closing' and 'leading back to the conversation' exemplify jobs that the linguists have found in their data. These jobs are established interactionally and are mastered by the discourse partners jointly (ibid., p.122f.). What the child is not yet able to do, is done by its adult interlocutor. So these jobs are determined by their function (ibid., p.125). They are characterized by their contribution to the story as a whole. This functional orientation makes the idea of a job suitable for my aim. But when I intend to explore the function of a MASS I cannot really talk about structural jobs as Hausdendorf and Quasthoff do. For that reason, I use their further theoretical results, too. The linguists connect the jobs that are structural in nature to a higher aim. Namely, they state that the aim of all jobs is to complete the story and that is what is ensured by the DASS (ibid., p. 294). That means the support system guarantees nothing but the completion of the story. On this level, I can refer to that linguistic work. So one can say that there is a kind of higher job by which all the structural jobs are directed. And this higher job is what I intend to reconstruct as the focus of support systems in mathematical discourses. I call it a *support job*. This is the task that is mastered by means of the support system. Just like the structural jobs, these support jobs should be determined by their function: What is ensured by working on a certain support job? This approach to mathematical discourses allows for a functional investigation of the MASS in families.

Against this background, it is important to notice that Hausendorf and Quasthoff could find only one support job in their data. Namely, they reconstruct that the DASS is always focused on the completion of the story (ibid., p. 294). To be a little bit more abstract, one can say that the support job they found is to ensure the child's participation. The child should tell a story and master the jobs as good as possible. Only when the child is not yet able to cope with a certain job the adult performs it instead.

METHODOLOGY AND RESEARCH METHODS

The data

Over one year, I met ten German families at their homes on a regular basis. In all cases, it was a mother-child-dyad that took part in the project. The year of the regular meetings was in each case the child's last year before entering primary school. When meeting the families, I invited them to engage in games and picture books that I had brought with me. The families received no further instruction for dealing with the material or for their discourses in general. All the playing and reading sessions were filmed so that a considerable data corpus came out of that. But only those scenes that

showed a somehow mathematical topic came into consideration as a possible object of analysis.

The analysis

On the basis of my theoretical framework, I consider a MASS – and with it the support job – as a phenomenon that emerges in the interaction between a child and its mother. For this reason, my analyses are of a reconstructive manner. They are analyses of interaction (see Cobb & Bauersfeld 1995). This method refers to the interactional theory of learning, is based on the ethnomethodological conversation analysis (see Sacks 1998) and was devised by a working group directed by Bauersfeld. In contrast to the conversation analysis, it is aimed at the reconstruction of thematic developments in face-to-face interactions. For this reason, it is especially suitable for the field of mathematics education where the researcher is always interested in the content of a discourse, too. In a second step, the results of the analyses of interaction can easily be interpreted with a special focus on support systems and their inherent support jobs.

INSIGHT INTO THE RESULTS

In the following, I deliver insight into the results of my work by means of very short examples. They give an impression of the data and exemplify the three support jobs that I could reconstruct in mathematical mother-child-discourses. The scenes were chosen with the objective of showing substantially different support jobs. For some reason that should be discussed later on it can be assumed that the three support-jobs that are illustrated in the following are the only ones to be found. If this assumption is correct, there will be no support job that cannot be described with the given terms.

The support job “participation”

The first one is a little scene with Paco (5 years 4 months) and his mother, Mrs. Czipin. The two are playing a game called “Max Mümmelmann” which is about rabbit families. The belonging board has the form of a regular octagon with one point on each side. Besides each of these points, one puts a deck of hidden cards. When it is your turn you roll the dice, move the counter which is a wooden rabbit and the counter for all players and draw a card from the hidden deck beside the counter. The cards show rabbits that are characterized by numbers from one up to six. On each card, the number is represented in two ways: First, you can see the digit on the card; second, the rabbit has as many dots on its coat as the number indicates. The six different rabbits are introduced as family members. So, the rabbit children have the numbers from one to four, number five is the rabbit mother and number six, finally, is the rabbit father. Below, each card is named by means of the number on it: A ‘2-card’ is a card that has the digit ‘2’ on it and shows a rabbit with two dots on its coat. To win the game, you have to be the first who completes a whole rabbit family: 1, 2, 3, 4, 5, 6. In the following scene, Paco has already three rabbit cards: 3, 6, 2. They

are laying in front of him in exactly this order. Now, it is Paco's turn. He rolls the dice and moves the counter [1].

Paco: (*draws a 2-card, moves his 3-card a little bit to the left and puts the drawn 2-card right beside it:) 3,2,6,2*

Mother: Do you have that already or not?

Paco: No. […]

Mother: Not the colour, you have to watch the numbers.

Paco: (*looking at his mother:)* I have the five. (*pointing at the drawn 2-card:)* But this is the two, you see.

Mother: (*pointing at Paco's 2-card:)* You already have a two.

Paco: (*first looking at his cards, then at his mother:)* Which one do I have to put back?

Mother: One of the two. Each number only once.

In this short scene, Paco performs his fourth move. He rolls the dice, moves the counter and then draws a card from the right deck. As he draws another 2-card, he has to put it back. Nevertheless, Paco integrates the drawn card into his row of cards without being irritated. In a first step, his mother advises him of the rule: For deciding whether one still needs a drawn card or not, only the number is relevant, but not the colour of the rabbit. By giving him this hint, the mother supports Paco in performing his move. The only important question seems to be how Paco can participate successfully in the game. But Paco insists upon his opinion: He is convinced that he still needs the drawn 2-card. In answer to that, the mother refers directly to Paco's fault. She points at his first 2-card and, thereby, she makes clear that he has not noticed the first 2-card in his row, which is not under the rules. Thereupon, Paco obviously realizes that he has to put one of the 2-cards back. So one can say that the support job Paco and his mother work on is focused on the game itself. The established support system ensures that Paco can participate in the game as a player who is as independent as possible. That way, the game can go on smoothly. As Paco's participation is the central purpose of the MASS, I named this specific support job as "participation".

The support job "improvement"

The second example, which should be discussed in this context, is a short scene with Alina (6 years 1 month) and her mother, Mrs. Gerlach. It is interesting because their MASS is determined by a substantially different support job. Just like Paco and his mother in the example above, the two are playing the game "Max Mümmelmann". It is the mother's second move. She rolls the dice and moves the counter.

Mother: (*drawing a 2-card:)* Now, I may draw a card. Look here. (*showing the drawn card to Alina:)* I have **a**…

Alina: A mother?

Mother: No. (*pointing at the digit on the card:)* Do you know this one?

Alina: It's a…

Mother: **A**?

Alina: **Two.**

Mother: A two. Right. (*still showing her card to Alina:)* And how many dots does my rabbit have?

In this second scene, the mother performs her second move. She rolls the dice, moves the counter and, finally, draws a card that she does not have yet. In this special move, Alina is integrated. She is asked to name the digit on the mother's card. This claim persists until Alina can meet it. Although she suggests a familial framework of reference ("A mother?"), which is actually suitable as well, the mother obviously insists on a mathematical one. Not until Alina refers to the relevant card as a two, her mother agrees. With regard to the topic one can say that knowing the number words might be helpful to talk about specific cards or moves, but it is not essential. It is even isolated from the concrete issue of the mother's move. When comparing this short scene with the one before, we can see that the established MASS is no longer focused on the child's participation. Instead, Alina is part of a move that is not hers. She has to use number words in order to name a given digit. More generally, we can say that Alina is asked to practice on her mathematical skills. So the support job that the two work on is to improve Alina's mathematical skills. Therefore, I named the support job exemplified by this second scene as "improvement". As the mother's final question indicates, the support system will continue to be focused on Alina's improvement. Next, she is asked to determine the number of dots on the rabbit's coat.

The support job "exploration"

The last example is a short scene with Tonio (5 years 7 months) and his mother, Mrs. Liermann. Just like the two mother-child-dyads before this dyad is playing the game "Max Mümmelmann". In particular, they are talking about one special card in the game. It is the card with the rabbit called Max Mümmelmann on it. When you draw this "Max Mümmelmann"-card (shortcut: MM-card), you may take a card of your choice from somebody else. In the following scene, which shows a third support job, Tonio creates an imaginary example in which the drawing of the MM-card leads to the victory. It is Mrs. Liermann's turn. She has rolled the dice, moved the counter and drawn a card. As she has rolled a six, she may now perform another move.

Tonio: Look here. (*showing one finger for each number word:)* If you have a one, a two, a three… and a six…

Mother: (*nodding:)* Yes.

Tonio:	Then, you can… And if the other one has the five, you can simply take his five.
Mother:	Right.
Tonio:	Then, you have already won.
Mother:	But, in this case, you still need another number.
Tonio:	(*shaking his head:)* Which one?
Mother:	The four. Or did you mention it?

In this scene, Tonio develops an example of a situation in which the drawing of the MM-card means winning the game. He thinks of someone who has already the cards with the numbers one, two, three and six. According to Tonio, this person is the winner of the game when he draws the MM-card and can take the five from another player. The mother considers that this devised person might still need the four, too. However, she thinks it is possible that her son already mentioned the four. After this scene, the two will work on that example so that Tonio is finally able to display it in a correct and complete version. The short transcript shows that the emerging support system is not really connected to someone's move. Instead, Tonio starts exploring the situation and his mother takes part in that exploration. They come up with a situation that helps understanding the concrete meaning of the MM-card. In that process, they talk about ideas, suggestions and better possibilities. Thereby, Tonio is a kind of director. He decides on the topic, on the development of the discourse and on its end. So the MASS that this mother-child-dyad establishes ensures primarily that Tonio has enough room for his free exploration. His mother helps him when he asks for help but she allows him to decide on the course of the situation. Mathematical aspects get only relevant when they are helpful for Tonio to make progress with his exploration. In view of this central focus, I named the third support job as "exploration".

SUMMARY AND CONCLUSIONS

First of all, the examples give an impression of the fundamental differences in familial Mathematics Acquisition Support Systems (MASS). In this context, the function of a specific MASS was the matter of interest. For that reason, I reconstructed so-called support-jobs. To distinguish the three support jobs that I could find it might be helpful to see them in connection with their situational context. In the first scene, the support system is established while the child is performing its move. Thereby, the MASS enables the child to overcome some difficulties in its participation. So, the support job the mother-child-dyad works on is the child's **participation** in a smoothly running situation. In the second scene, however, the support system is established while the mother is performing her move. In this context, the demand on the child does not really follow from the game itself.

It is rather initiated by the mother. She uses the playing situation as an opportunity to work on the child's mathematical skills. In this regard, she sets a problem and evaluates the child's solution. So the support job is focused on the child's **improvement**. It is important to note that this does not mean that the child's skills really do improve. But you can see that the support system is focused on it. In the third scene, the support system is not linked to someone's move at all. The child engages in an exploration of the game which is rarely restricted in terms of time or method. The child is free to explore its ideas, questions and interests and it is the support system that ensures that there is enough room for that purpose and help if necessary. So, the support job is focused on the child's **exploration**.

When comparing the three support jobs, one can notice the following: The support job "improvement" serves the mother's idea of the situation. She interprets the playing situation as suitable for working on her daughter's mathematical skills and insists on this view. By contrast, the support job "exploration" serves the child's idea of the situation. In the context of playing, he develops a plan of a free exploration and carries it out. And, finally, the support job "participation" points to the idea of the material. Both the mother and her child are working on realising a smoothly on-going playing situation. The mother, the child and the material – one can hardly think of another factor that the support job could refer to. For that reason, one might at least be doubtful of further support jobs to be found. When relating these results to those from Hausendorf and Quasthoff (2005), one can see that *Mathematical* Acquisition Support Systems are not fixed to a certain support job. Instead, there are three different focuses.

By means of further analyses, I found out that the families can be characterized by a certain support job. Comparisons over time and also over material showed that each family steadily establishes a certain kind of support job. In other words, the support job does neither depend on the point of time nor on the material (games and picture books). When relating these results to those from Hausendorf and Quasthoff (2005), one can see that *Mathematical* Acquisition Support Systems are not fixed to a certain support job. Instead, they vary in terms of their focus.

This variety of MASS in the familial context is a challenge for every institutional context in which children should learn mathematics. The young learners have different experiences in terms of content, discourse practices and support systems. When Paco, Alina and Tonio attend elementary or primary school they need a teacher who is able to cope with their diversity.

1. Transcription rules: (1) **Bold** text marks stressed utterances. (2) (*Text in parentheses*) refers to non-verbal actions.

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