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# Chances and obstacles of ‘indirect’ learning processes in situations with preschool teachers

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*From a co-constructive perspective, interactions are key variables for learning processes. In the context of learning preschool mathematics, these interactions are often characterized by ‘indirect’ negotiations of mathematical meaning: while, on the surface, everyday problems are discussed, ‘mathematically rich contents’ are nevertheless involved and negotiated latently in these interactions. The following paper focuses on such interactions that emerge in situations with preschool teachers and children in self-designed learning situations in German “Kindergärten”. I will point out how different forms of interactive support entail different opportunities for the children to participate in the interaction and especially in the ‘mathematically rich contents’ of the ‘indirect’ learning situations.*

*Keywords: preschool teacher, interaction, indirect learning processes.*

## **Introduction**

For children, entering primary school is not the first time when they learn mathematics. It is rather the preschool or the family context in which children collect first experiences with mathematics. Compared to a time when toddlers and infants were seen as mostly incapable of learning mathematics, today, the appraisal changed to the concept that mathematics is - besides the early learning of the mother tongue - an important topic to learn and that the early years are a sensitive period for learning it. In addition to the early learning at home, learning mathematics in preschool has been a field of increasing attention over the last decades. While learning at home with parents and siblings is surely a formative learning context, learning in kindergarten is also an important factor for children’s learning biographies: it is the first time of institutional learning for young children and also builds a crucial basis for future schooling (Claesens & Engel, 2013). Hence, the question arises regarding how mathematics learning can be integrated and supported in preschool to make use of this ‘potential’.

From an educational point of view, preschool teachers play an important role in supporting young children’s learning. Preschool teachers are major attachment figures as well as “more competent others” (Vygotsky, 1979) who support children in their interactive learning processes. For this reason, the following paper focuses on these interactions between preschool teachers and children. The analyzed interactions take part in the self-designed learning situations of the preschool teachers. But, while some researchers observe, analyze and evaluate teaching and the quality of preschool teachers acting and content knowledge, below, the interplay and the negotiation of meaning between the preschool teachers and the children is centered. There is a particular situation on which this paper focuses in which so-called ‘indirect’ learning processes take place and mathematical meanings are not explicitly negotiated, but rather implicitly involved within the interaction. This focus is chosen because indirect learning can be considered as characteristic for co-constructive

learning processes since it conforms with ‘discovery learning’. But, missing explicitness within the process of negotiation of meaning cannot only be seen as characteristic; from some perspectives, it can also be perceived as an obstacle for learning. On the one hand, it can be obstructive if learners are not able to interpret the ‘hidden’ meaning and, as a result, cannot participate in the learning process. On the other hand, it is also hindering if the “more competent other” is not able to recognize what the learner associates with the interaction. Hence, it seems fruitful to examine to which extent mathematical interactions between preschool teachers and children are characterized by missing explicitness and whether this form of indirect interactive learning is really an obstacle for learning. An important consideration is the kind of supportive guidance from preschool teachers that helps children to discover also ‘hidden’ meanings.

## **Preschool learning and curricula in Germany**

In response to the low performance of German learners in international comparative studies such as PISA and the already existing curricula for preschool learning in other countries, Germany has also, since the early 2000s, established different ‘curricula’ for “Kindergärten” (meaning: preschool) and “Kindertagesstätten” (meaning: day care centers) for children 0 to 10 years in each of its states. Concerning mathematics, there is more or less concrete advice regarding how to ‘teach’ different mathematical contents. Co-constructive learning is picked out as a central theme for all contents in all these curricula. Thus, even mathematics should be learned within situations where children are actively helping to shape the interactional process. Furthermore, several studies could prove that children develop a sustainable understanding of elementary mathematics by being integrated in such co-constructive learning processes.

## **Theoretical Framework**

### **Co-constructive learning processes within the preschool context**

Under the co-constructive approach, interactions are ‘key variables’ for learning (mathematics). Within these interactions, children actively construct meaning by themselves in interplay with others. From this perspective, learning is conceptualized as the increasing autonomy of participation within interactional practice (Sfard, 2008). Therefore, the more or less active participation in processes of negotiation about mathematical meaning gives learners the opportunity to also recognize mathematical contents as the interactive rules for presentation and interpretation. Concerning the learning of mathematics, the children should participate in interactions that can be characterized as ‘mathematically rich’ to develop mathematical meaning that is full of relations and outlives the situational context. Especially in preschool interactions, these mathematical meanings are not necessarily negotiated directly; rather mathematics “is, as knowledge of abstract relations, not directly accessible” (Steinbring, 2015, p. 281), and mathematical meaning is developed in a process of the increasing ‘mathematization’ of situated contexts. For primary school classrooms, Maier and Voigt (1989), were able to show that, in most situations, the teacher keeps the interaction going on rather than explicitly negotiating mathematical (complex) meaning. Even in preschool situations, teachers and children seem to negotiate mainly every day meanings like how to tidy up or how to play with different materials. While, on the surface, every day meanings are discussed, mathematically rich meaning is sometimes nevertheless (latently) involved. For mathematics, this

conclusion seems to be obvious because, in some cases in mathematics, the concrete and every day meaning already contains the general and abstract mathematical meaning. Hence, the concrete meaning superimposes the abstract. The result is a ‘double layer structure’ where learners can participate on both levels of the interaction – the concrete situational and the abstract mathematical meaning. However, successful mathematical learning can be characterized as an increasing participation on the (latent) *abstract* level of meaning – only, of course, when there is mathematical content contained on this level. But, which level of meaning is accessible for the learner depends on her or his subjective interpretations.

### **Indirect learning mathematics in the early years**

Krummheuer (1997, p. 9) calls learning processes, which are characterized by this ‘double layer structure’ of the process of negotiation of meaning, “*indirect learning processes*” (Krummheuer, 1997, p. 9). In his approach of “the narrative character of learning”, he stresses that the indirect learning processes are characteristic of early learning in primary school. Krummheuer (1997) revealed that indirect learning processes are sometimes obstructive for learning because learners and teachers must have high interpretation competences to cope with this kind of learning (Krummheuer, 1997, p. 95). For mathematics learning in secondary school, other researchers also found evidence for cumbersomeness in indirect learning processes (e.g. Strähler-Pohl, Fernández, Gellert & Figueiras, 2014). Oevermann, Allert, Kunnau and Krambeck (1979, p. 384) more generally describe that children in their early ages often do not interpret meanings which are socially constructed and latently involved in interactions; rather, they perceive the meaning of interaction as naturally undistorted, and, so to speak, affectively truthful. In this synopsis on several studies on indirect learning processes, the following questions emerge:

- (1) whether early mathematical learning in *preschool* is also characterized by mainly indirect processes of negotiation of meaning, and
- (2) whether this kind of learning is a necessary obstacle for learning because it consequently drops children out from early learning mathematics.

From the findings above, the demand also evolves to analyze how preschool teachers can support children in indirect learning processes.

### **Methodology**

To analyze the different direct and indirect processes of negotiation of meaning, a two-step analysis is implemented. In order to analyze the explicit processes of negotiation of meaning and the included opportunities of the children to participate, (1) the interactional analysis is used (e.g. Krummheuer, 1997). For the not explicitly negotiated but latently involved meanings, an extension of this analysis is needed, because interactional analyses mainly take *situational* processes into account that generate “taken as shared meanings” (Krummheuer, 1997). Thus, mathematical concepts or processes that are not negotiated explicitly within the situation cannot be analyzed in a sophisticated manner. Therefore, (2) the interactional approach is enlarged by elements from the objective hermeneutical approach as developed by Oevermann et al. (1979). This approach focuses on the “latent rules of the interactional system” that are characteristic of the indirect learning processes on which this paper focuses. Hence, the enlargement also provides the opportunity to

even reconstruct meanings that originate from individual ‘fields of experiences’ (Bauersfeld, 1983). By this means, it is possible to also reconstruct the ‘hidden’ meaning of the interaction that originates from one of the participants of the interaction. For this purpose, (linguistic) “markers” within the interaction are taken into account. These markers are words or phrases that are used by the recipients to interpret the meaning of a communication (Heller, 2015). The final ‘product’ of that analytical process is a reconstruction of different levels of interpretational perspectives that emerge in the interactions, which are summed up in the following matrix (e.g. Figure 1). With the help of this matrix, it is possible to determine (1) meanings that are latent, which means they are not explicitly negotiated and interpreted in the interaction and only reconstructed by the so-called markers, (2) explicitly negotiated meanings, called manifest, that are interpreted by the participants in the situation, as well as (3) manifest meanings that are negotiated and that have trans-situational origins, and (4) latent meanings that can be only understood with the help of knowledge outlying the situational process and stems from a wider knowledge background.

	situational	trans-situational
latent meanings	<i>situational, latent fields of experience</i>	<i>trans-situational, latent fields of experience</i>
manifest meanings	<i>situational manifest fields of experience</i>	<i>trans-situational manifest fields of experience</i>

**Figure 1: Representation of the different levels of interpretational perspectives**

The situational and also trans-situational latent levels of interpretational perspective are both levels of the interaction that are more or less implicit. In the following sections, I will summarize how these levels of interpretational perspectives can be found in a situation with preschool teachers and how indirect learning processes take place in these situations.

### **Empirical Results - Obstacles and chances of indirect learning processes**

The presented empirical data is part of the erStMaL study (*early Steps in Mathematics Learning*) at the IDeA center (*Individual Development an Adaptive Education of Children at Risk*)<sup>1</sup>. Within the study, the research team encouraged 25 preschool teachers from different “Kindergärten” to develop and implement mathematical situations with groups of two or four children by themselves each year (from 2009 to 2012). Therefore, the teachers were asked to create the situations in reference to one of the five mathematical domains. The situations are videotaped and transcribed. One of these situations is presented below. The situation can be seen as a paradigmatic example of ‘successful’ learning situations in preschool – even if that is not directly obvious.

#### **“Which are belonging together? ... Compare!” – Increasing autonomy through constancy of the level of latent meaning**

The analyzed situation takes place with four children from a kindergarten in Germany: Hannah (3.3 years), Michael (3.7 years), Bettina (4.7 years) and Martha (5.3 years); and their preschool teacher Nicola. The materials which are used include two green paper circles with different diameters (0.5m and 1.0m) and a burlap sack which is filled with ten different yet pairwise similar objects - in each case in two different sizes. In the following described scene, two nails (3cm and 5cm) and two

building blocks (15x7x4cm and approx. 5x3x2cm) are mentioned. The blocks, as well as the nails are lying together with the other, yet pairwise similar objects on the two paper circles (e.g. Figure 2). During the time of the situation, the children are sitting on a carpet together in front of the paper circles with the teacher.



**Figure 2: Arrangement of the objects on the paper circles**

At the beginning of the scene, the kindergarten teacher Nicola asks the children to find two things that belong together. She asks: “And which are belonging together?”. After a girl, Bettina, pointed at two building blocks, Nicola continues with her instructions.

### *Scene 1*

- 456 Nicola: Take a look Bettina. (.) Put two things together. Here we make a line.<sup>2</sup>  
 457 *pointing with her finger in a line right beside the paper circles parallel to the edge of the carpet ...*  
 459 Start right here.  
 460 *pointing at one point near the edge of the carpet*

In line #456, Nicola instructs Bettina to locate (the) objects on the edge of the carpet where they are separated from the paper circles. She says that they have to be located in a line. She marks with a gesture the starting point of the array and the accompanying expression: “start right here” #459.

- 469 Bettina: *placing the bigger pin to the place that is marked second and the smaller pin to the place that is marked first by the nursery teacher*  
 470 Nicola: Exactly! This way.  
 471 *adjusts the pins on the carpet the way that they are lying parallel to the edge of the carpet and the heads of the pins are abreast*  
 472 Who wants to search for two things that belong together now?

When Bettina lays down the nails #469 on the positions marked by Nicola in #460, the teacher corrects the arrangement by putting the nails side by side until the nails are parallel to each other and the carpet’s edge. She additionally confirms the successful ending of the task through her expression “Exactly! This way!” in #471 and asks the kids who would like to find the next objects that belong together in #472. In the next scenes, the kids position pairs of objects on the carpet in a line with the first two nails. Later on, the children compare the objects in the different lines and the teacher Nicola accompanies these interactions linguistically using phrases like ‘which is the biggest’ and other superlatives that underline the process of comparing.

### *Scene 2*

- 583 Nicola: What **else** can we do with it? Does anybody have an idea?  
 584 Martha: Compare.  
 585 Nicola: Compare! How would you do that, Martha? (...)

- 586 Martha: There you can see it. It is beautiful like that.  
 587 Nicola: mh?  
 588 *turning to Martha*  
 589 Martha: It is beautiful like that. ...  
 592 Nicola: The way it is lying here or different? (..)  
 593 Martha: The way it-  
 594 *she squirms*  
 595 Bettina: is lying there.  
 596 Nicola: The way it is lying here?  
 597 Martha: mh!  
 598 Nicola: okay! mhhh (5 sec) now (.) which is the absolutely biggest of the things?

In that scene, Nicola asks the children about the use of the two ‘lines’ of objects lying on the carpet. Martha specifies the use as ‘comparing’ #584. But, after Nicola asks for the way to compare, the girl astonishingly replies that one can see it because it is beautiful #586. And the girl maintains her opinion, although Nicola asked again – probably to change Martha’s mind. Bettina even agrees with Martha #595. At the end of the episode, Nicola modified her question and explicitly asked for the biggest ‘size’ #598.

**Reconstruction of the different levels of meaning**

Nicola’s last turn, in line #598, particularly provides evidence that there is also a latent meaning involved in the interaction in Scene 2, as well as in Scene 1. On the surface, it could be interpreted that Scene 1 deals with putting nails on a carpet, but, on the latent level of the interaction, especially in Scene 2, it is understood that the preschool teacher Nicola introduces an early concept of ‘size’ by directly comparing objects of equal shapes and different sizes. The latent meanings are also revealed *within* Scene 1. This can be mainly interpreted from the marker in line #472. Based on this marker and the interpretations from the other scene (amongst others, #583-598), different levels of the negotiated meaning can be reconstructed. They are presented in the following matrix.

	situational	trans-situational
latent meanings	One big and one small pin from the paper pad should be placed on the carpet at a time	Two objects of similar shape and different size are building a pair and should be placed to visualize the exact geometrical difference in size in order to enable a direct mathematical comparison
manifest meanings	The pins are placed on the carpet <b>Marker:</b> <i>Nicola adjusts the pins on the carpet so that they are lying parallel to the edge of the carpet and the heads of the pins are abreast #471</i>	

**Figure 3: Representation of the different levels of negotiation of meaning in Scenes #456 - 472**

Three of the latent and manifest levels in Scene 1, from #456 to #472, can be reconstructed: on the manifest and situational level of interpretation, Nicola and the kids ostensibly put some objects in order, but, on the latent level, it is obvious that, within the interaction, the preschool teacher also tagged on mathematical issues concerning size. Thereby, an interpretation of these mathematical

themes is possible on the situational level. Here, it is perceptible that two similar objects are belonging together because they are equal in shape and different in size. Together with the interpretations of the second scene, from #583 to #598, the mathematical theme is additionally enlarged. The preschool teacher Nicola also addresses direct comparisons and size. This interpretation is only possible with the knowledge about the mathematical concepts.

### ***Participation and Support***

When looking at the participation of the children, it becomes apparent that the girl, Bettina, first participates on the level of manifest meaning where the (right) placement of pins is negotiated - although she could interpret the latent meaning as well. In Scene 2, it is Martha who describes the use of the lines and manifests the meaning, which is also latently involved in Scene 1. Additionally, Martha characterizes the arrangement of the objects in two lines (side by side) as beautiful. Thereby, she introduces a further aspect to the interaction that can be interpreted as profound from a mathematics perspective: one could say she described a kind of mathematical well-ordering with words of the aesthetic kind (e.g. Sinclair, 2006) when she says the lines can be compared because they are beautiful #586. As the second scene shows, the girl Martha, and maybe also Bettina, participate as a result of the 'rich' mathematical contents of the interaction and rather manifest them over time. In addition, they contribute some own mathematical ideas in the form of the aesthetic of the lines which are to be compared. It can be assumed that the increasing autonomy of the children emanates from the coherence of latent meaning throughout the situation, which is maintained by Nicola. She supports the children by consequently focusing on the size of the objects and the direct comparison. Unfortunately, she does not recognize Martha's idea #586. Further, it can be supposed that the 'double layer structure' of the indirect process of negotiation of meaning, which can be analyzed in Scene 1 in Figure 2, is supportive because it helps the children to participate over time. As does Bettina, for example, the children get the opportunity to be active on the manifest level of the interaction on which every day meanings are negotiated, while they can also interpret the latent meanings which are more abstract and maybe 'hard' to understand. In the course of the ongoing situation, a bunch of markers open several opportunities for the child to participate on more than just the every day level.

### **Discussion**

The aim of this paper was to examine whether learning processes in preschool situations with teachers and children can be characterized as 'indirect' and whether that has to be seen as an obstacle for the participation of children. While the indirect processes of learning in the context of school are seen as repressive for learning (e.g. Strähler-Pohl et al., 2014), the analysis of the situation provides evidence that indirect learning in preschool situations can be seen as a chance for children to participate and 'learn over time'. Crucial for the success of this learning over time is a 'double layer structure' of every day meanings and abstract mathematical meaning. Thereby, especially the latent and abstract mathematical meaning has to be coherently introduced throughout the whole situation. Thus, the learners can discover the mathematics and mathematize their everyday experiences over time. By means of such a 'supportive' structure, maybe even 'struggling' learners could have the opportunity to participate (somehow) within the interaction and

recognize further latent meanings later on. Of course, that structure also involves risks for the learning processes of young learners, because they can be unable to perceive the meaning of the markers that lead them to the further implicated meanings, as many studies observe. Further analysis should show, how other interactional aspects could also support the interpretation process of young learners.

## Notes

1. For more information, please visit: [www.idea-frankfurt.eu](http://www.idea-frankfurt.eu)
2. All characteristics of the spoken language (mistakes) are mentioned in the translation of the transcribed sequence. Pauses within the speech are coded using a dot for every second in round brackets. All names were made anonymous.

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